Herpetofauna of Lowland Bottomlands of Southeastern Arizona: A Comparison of Sites

Philip C. Rosen
School of Natural Resources, University of Arizona, Tucson, AZ

William R. Radke
San Bernardino-Leslie Canyon National Wildlife Refuge, Douglas, AZ

Dennis J. Caldwell
Caldwell Design, Tucson, AZ

Abstract—*We intensively sampled the riparian herpetofauna at three sites in southeastern Arizona, a canyon site, Leslie Canyon, and two lowland sites, San Bernardino NWR and Empire-Ciénega Creek at Las Ciénegas National Conservation Area. We also compiled a list of herpetofaunal records for the original lowland riparian area at Tucson using museum records. The herpetofaunas of the three lowland sites are more similar to one another than they were to the Leslie Canyon assemblage, and, collectively, the lowland riparian system may support the richest herpetofauna in the Southwest, at least when* α*-diversity is considered. A number of species not generally considered to be riparian species are well represented and in some cases locally restricted to the riparian environment. Although this environment supports (or supported) a high proportion of the most threatened vertebrate taxa in the region, conservation plans have not correspondingly focused on it, and its degradation continues in many areas.*

Introduction

Although riparian areas in the Southwest are widely recognized to be much diminished, it is less widely appreciated that lowland riparian areas, on the floors of major valleys, are the primary sites of impact. For example, of 32 Priority Vulnerable Species of vertebrates identified to guide conservation reserve design in Pima County's Sonoran Desert Conservation Plan (http://www.co.pima.az.us/cmo/sdcp/reports.html), 22 tend to be associated with riparian areas in eastern Pima County, Arizona, 20 of the 22 occur (or occurred) in lowland riparian systems, and about a dozen of these are or were almost exclusively in lowland systems. The lowland riparian zones were probably the richest ecosystems in the Southwest, as attested to by reports of early ornithologists (Swarth 1905; Willard 1912; Brandt 1951), who arrived at San Xavier del Bac, south of Tucson, before the lowlands had reached their present stage of degradation.

Early ichthyologists (see Minckley 1999) and herpetologists (Ruthven 1907; Van Denburgh and Slevin 1913) also visited the Santa Cruz riparian bottom near present downtown Tucson and reported a lowland herpetofauna that would be unfamiliar to many present-day observers. Lowe (1986, 1989) commented on the dire threats to the riparian herpetofauna of the Southwest, but provided few details about its status or original composition. The purpose of this paper is to revive the now antique knowledge of this lowland herpetofauna, provide examples where it is extant today, and contrast it with a representative mountain canyon herpetofauna. In so doing, we offer relatively complete checklists for 4 separate riparian herpetofaunas in southeastern Arizona.

Methods

We used a combination of sampling types to assemble data on the presence and relative abundance of amphibians and reptiles at three intensive study sites, and we compared the results to historical data for a fourth site. The three intensive study sites were San Bernardino National Wildlife Refuge (NWR), Leslie Canyon NWR, and Las Ciénegas National Conservation Area (NCA) in the Empire-Cienega Valley. We compared these to the originally rich streamside and riparian herpetofauna of the Santa Cruz River at San Xavier del Bac and Tucson. Environmental comparisons are given in table 1.

Study Locality Descriptions

San Bernardino NWR, first created as a native fish refugium, protects a mesic bottomland 1.0–3.4 km across and separated by low rocky and stony scarps (10–24 m) on both sides from surrounding semi-desert uplands dominated by tobosa grass, mesquite, and whitethorn acacia. This bottomland system continues into the Mexican portion of land grant; its entire length is on the order of 6 km. The bottomlands (see Hendrickson and Minckley 1985 and Lanning 1981) have a long and colorful history of use and modification, followed by the creation of the refuge in 1982. Original conditions included broad, rich sacaton grassland bottoms punctuated by springs issuing into

Table 1—Summary of southeastern Arizona lowland riparian study site characteristics. Estimated areas are based on width of riparian bottomlands plus width of adjoining strip included in samples. Categories are explained in text under "Methods."

	Leslie Canyon NWR	San Bernardino NWR	Las Ciénegas NCA	Tucson and San Xavier
Reach length (km)	14.2	3.8	26.2	26.9
Approximate area studied (km²)	23	15	126	129
Elevational midpoint (m)	1,466	1,161	1,280	758
Elevational range (m)	183	58	244	102
Site type	Canyon	Valley	Valley	Valley
R (Riparian-associated at site)	12	13	15	18
RO (Riparian obligate at site)	4	8	11	11
Species in moderate to high abundance	24	25	30	38
Species seen rarely or entering peripherally	10	13	7	4
Species total	38	38	37	42
Potential species total	50	48	56	51
Potential species total (native)	48	46	54	49

marshy ciénegas, and scattered stands of willow, cottonwood, and mesquite. The broad, level bottomland plain was the source of San Bernardino Creek. Current conditions include a deeply incised creek (now called "Black Draw"), greatly reduced sacaton, recovering agricultural fields, and extensive mesquite bosques punctuated by artesian-fed ponds and ciénegas. Exotic fishes (Hendrickson et al. 1980) were replaced by natives following the creation of the refuge, except in Black Draw, where some exotics persist. Black Draw now supports a cottonwood-willow gallery forest, mesquite, Johnson grass, an ephemeral steam, and a mature ciénega-stream with deep pools.

Leslie Canyon NWR protects a short perennial stream that rises from a sacaton bottomland basin at the base of the Pedrogosa Mountains and cuts through mixed Chihuahuan desertscrub, grassland, and thornscrub in a rocky canyon in the Swisshelm Mountains. Narrow bottomland flats support sacaton, mesquite, and other grasses and thorny shrubs, while the riparian zone supports a dense, shady forest dominated by Arizona ash. The canyon bottom ranges from <0.05 km to 0.2 km across, while the sacaton basin above it is over 0.5 km across. The site was modified in the 1930s by creation of a low dam separating the sacaton basin from the canyon-bound creek. Semi-perennial, fishless pools exist above the dam, while the pools and stream below it support native longfin dace (*Agosia chrysogaster*) and a Yaqui chub (*Gila purpurea*) population that was translocated from Black Draw (Astin Spring) in 1969 (Minckley 1973). The refuge was established in 1988, and has expanded to include additional areas in the Swisshelm Mountains, but in this report we confine our consideration to the canyon proper, as described above.

Las Ciénegas NCA protects the most intact lowland ciénega-stream in Arizona. Ciénega Creek is a marshy, boggy, stream with dense herbaceous vegetation, deep pools, and a gallery forest dominated by willow and cottonwood. Its surrounding bottomland supports extensive sacaton flats, with some natural ponds and pools, mesquite shrubland, and mature bosque. Although the ciénega-stream bottom is generally less than 50 m wide, the bottomlands are 0.4–1 km across, except at the lowermost part of the study area, at the Narrows. Uplands consist of sandy-gravelly semi-desert grassland heavily occupied by mesquite and burrow weed (*Isocoma tenuisecta*). The Empire-Cienega ranches were not established until the 1880s. In the mid 1990s cattle were excluded from most of the riparian areas. Downstream of the mostly perennial reach on the study area is a 14 km dry reach followed by 10 km of mostly perennial stream and ciénega-stream.

The area from San Xavier Mission, the ancient site of the Tohono O'odham village of "Bac" (W:ak—"where the water rises") to current downtown Tucson was a rich mix of mesquite forest, riparian gallery forest, desert stream, acequia-based agriculture, xeroriparian and upland desertscrub, ciénega, and sacaton (Betancourt 1990; Logan 2002; Turner 2003) surrounded by desertscrub flats dominated by creosotebush. This formerly fabulous area (Brandt 1951, and references therein) adjoins rocky desert in a few areas, and was visited by early naturalists, including Ruthven (1907) and Van Denburgh and Slevin (1913). For purposes of this report, the study area includes the Santa Cruz River floodplain from the south boundary of the San Xavier District of Tohono O'odham to a north line in historic Tucson at St. Mary's Road. Although the area is currently heavily degraded, this report is based upon historic information.

Sampling and Museum Survey

For San Bernardino NWR, field data for this study are from 1985–1999, while for Leslie Canyon NWR, data from that period were supplemented by intensive study in 2000–2003. At Las Ciénegas NCA, limited data from 1985–2001 were supplemented by intensive aquatic trapping and terrestrial sampling during 2002–2004. In each area we focused on aquatic species using intensive search and a variety of trapping methods (see Schwalbe and Rosen 1988; Rosen and Schwalbe 1995), and made general efforts to capture and mark a variety of riparian and terrestrial species. At Leslie Canyon NWR and San Bernardino NWR, we also used pitfall traps (3 square 25 trap grids with 5 gal buckets covered loosely with plywood lids) to sample upland habitats during 1997–1999, and at Leslie we

used terrestrial drift fences with funnel traps in 2000–2003. At all sites, road observations within the site were also used, cover was turned to search for animals, and immediately adjacent areas were included as indicated in table 1.

A database of 36,925 locality records from Pima, Santa Cruz, and Cochise Counties, Arizona, was assembled from museums throughout the United States. Each record was classified into a set of geographic sub-regions, and the sub-regions included around the 4 study areas were further classified to isolate records that applied only to the riparian bottomlands and immediately adjoining uplands. Records were excluded if they could not be reasonably determined to fall within the defined study areas, except that desert rock slopes adjoining the Tucson-San Xavier bottomlands were excluded. Records labeled "Tucson" were not included except if they were specified in Ruthven (1907) or Van Denburgh and Slevin (1913). After a first round of classification, these data were re-studied to eliminate ambiguous or misclassified records.

The entire museum database was studied to estimate the sub-region-specific geographic (and inferred habitat) ranges for species, and this was combined with field experience near study areas to define the macrohabitat niche of the species within the sub-region that includes each study area. Species were classified as "RO" (locally riparian obligate) if they only were found and collected within or adjacent to the riparian bottomlands; "R" (riparian associated) if they were found primarily in the riparian bottomlands, but also occurred with some regularity away from it; "C" (common) if they were abundant but not numerically associated with riparian bottomlands; and "p" (present) if they occurred as an occasional record at lower than expected frequency for the taxon.

The final species list for each area was the combined field and museum records available for each species. For the San Xavier-Tucson site, only museum records were included, as recent field data under highly degraded conditions differ markedly from the original conditions found in the literature and museum records. We computed a coefficient of similarity among sites according to the formula $\% \ Similarity = 100 \ X \ 2C/(N_1 + N_2)$, where C is the number of species in common between the sites, and N_i is the number of species at each site.

Results

The number of species confirmed per site was relatively consistent at 37–42, with 24–38 species being recorded in numbers, as more than a lone specimen or occasional observation. At each site, 12–18 species tended to be numerically associated with the bottomland environments, with 4–12 being riparian bottomland obligates in the sub-region for each site (table 1). Riparian obligate species were more prominent in lowlands than in the mountain canyon site. Leslie Canyon NWR had the most divergent herpetofauna, while San Bernardino NWR and Las Ciénegas NCA were most similar (table 2); the San Xavier-Tucson fauna was similar to other lowland sites, despite being within the Sonoran Desert and supporting 9 desert species not found elsewhere.

Discussion

The lowland riparian herpetofauna of southeastern Arizona has a distinctive core of associated species including ranid frogs, *Kinosternon sonoriense*, *Sceloporus clarkii*, *S. undulatus*, *Crotalus atrox*, *Lampropeltis getula*, *Tantilla hobartsmithi*, *Thamnophis eques*, *T. marcianus*, and either *Masticophis flagellum* or *M. bilineatus* (or both). These systems may also include a number of species that are not typically thought of as riparian, and are not otherwise expected under lowland desert conditions, such as *Aspidoscelis burti stictogramma*, *Bufo woodhousii*, *Diadophis punctatus*, *Elgaria kingii*, and *Terrapene ornata*. *Gastrophryne olivacea* is also represented in one of our lowland riparian systems, and elsewhere it joins other unique species such as *Kinosternon arizonense*, *Pternohyla fodiens*, and *Bufo retiformis* in lowland bottoms originally grown to tobosa grass within the Arizona Upland. It is of interest that lowland sites show such affinity despite the transition from Chihuahuan Desert and Semi-desert Grassland environs at San Bernardino NWR and Las Ciénegas NCA to Sonoran Desert environs at Tucson-San Xavier.

Certain species habitats as presently understood may reflect a lack of knowledge about early conditions. Although the pygmy owl has lately been known in isolated bajada localities, it was originally (late 1800s) a lowland riparian-centered species (Johnson et al. 2003). The Santa Cruz pupfish, *Cyprinodon arcuatus*, was taken at Tucson, but may have already been gone by 1904 (Minckley 1999), perhaps disappearing with the early degradation of ciénega habitat. Analogously, although *Elgaria kingii* was not recorded in the Tucson riparian, we found it in 2002 in the only intact ciénega remnant on the basin floor (Rosen, personal observation). Although Ruthven (1907) characterized the Tucson lowland riparian herpetofauna with *A. b. stictogramma*, *A. sonorae*, and *S. clarkii*, these are now nearly forgotten as lowland species; Van Denburgh and Slevin (1913) found *S. undulatus* abundant at Tucson, where we found one, perhaps the last, in 1995 (Rosen, personal observation). Van Devender et al. (1994) report a locality for the tropical brown vine snake (*Oxybelis aeneus*) as "south

Table 2—Similarity coefficients based on species presence at the four study areas.

	LCNWR	SBNWR	Las Ciénegas NCA	San Xavier-Tucson
	percent			
LCNWR	100	68	64	44
SBNWR		100	85	72
Las Ciénegas NCA			100	73
San Xavier-Tucson				100

outskirts of Tucson," which at the time (1880s) could best be interpreted as the floodplain of the Santa Cruz River. Similarly, *B. retiformis* is reported from a large artificial tank adjoining the floodplain of the Santa Cruz River (Sullivan et al. 1996), and could originally have occurred under natural conditions at floodplain wetlands. The herpetofauna of the lowlands may have been richer than we can adequately document, although it retains high α-diversity.

The richness of the lowland riparian biota presents a paradox for current conservation efforts. While conservation efforts are ongoing, they are focused most effectively on land purchases in upland desertscrub and semi-desert grassland. Lowland bottomlands are still being degraded by urbanization. There are few solid plans to incorporate natural biodiversity into the urban riparian corridors, although this would seem at least possible. In this paper, we have tried to illustrate the importance that could be attached to the lowland riparian biota, and the richness it has to offer.

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Appendix A—Herpetofaunal records for SBNWR, LCNWR, Las Ciénegas NCA (field data only), and historic Tucson - San Xavier (museum data only). Introduced, non-native species are indicated with (I).

Species	SBNWR Pitfall traps	SBNWR Other field methods	SBNWR Museum records	SBNWR Total	LCNWR Pitfall traps	LCNWR Other 1985-1999	LCNWR Drift fences	LCNWR Museum records	LCNWR Total	Las Ciénegas total	Tucson - San Xavier total	Grand total
Ambystoma tigrinum (I)					4	10	3		17			17
Arizona elegans											6	6
Aspidoscelis burti										61	28	912
Aspidoscelis sonorae					43	23	190	3	259	61	7	77
Aspidoscelis tigris											46	46
Aspidoscelis uniparens	144	407	13	564			5	4	9	733		733
Bufo alvarius		21	2	23						2	28	53
Bufo cognatus			3	3			54		54		50	107
Bufo debilis			5	5			20		20			25
Bufo punctatus			1	1						1	2	4
Bufo woodhousii			1	1							3	4
Callisaurus draconoides											42	42
Chilomeniscus cinctus											7	7
Coleonyx variegatus										1	43	44
Cophosaurus texanus			1	1						13		14
Crotalus atrox		71	2	73		11	2		13	15	9	110
Crotalus molossus						13	6	1	20			20
Crotalus scutulatus		1	1	2		1			1	4	5	12
Crotaphytus collaris	1	2	2	5						4		9
Diadophis punctatus		3		3		2	10	1	13	2	2	20
Elgaria kingii		14		14	3	2	86	1	92	8		114
Eumeces obsoletus					5		29		34			34
Gambelia wislizenii			1	1							6	7
Gastrophryne olivacea											1	1
Heloderma suspectum		6		6		1	1		2	2	7	17
Heterodon nasicus						2		1	3	1		4
Holbrookia maculata	55	56	15	126			1	3	4	62	4	196
Hypsiglena torquata	2	6		8		1	1		2	3	3	16
Kinosternon sonoriense		488	5	493		1			1	373	32	899
Lampropeltis getula		44	2	46						1	16	63
Leptotyphlops dulcis							2		2			2
Leptotyphlops humilis											5	5
Masticophis bilineatus		1		1		13	61		74	7		82
Masticophis flagellum		90		90		0	1		1	2	10	103
Micruroides euryxanthus		1		1		1			1			2
Phrynosoma cornutum		1	4	5								5
Phrynosoma hernandesi							1		1			1
Phrynosoma solare		3	2	5						8	19	32

	SBNWR				LCNWR							
Species	**Pitfall traps**	**Other field methods**	**Museum records**	**Total**	**Pitfall traps**	**Other 1985-1999**	**Drift fences**	**Museum records**	**Total**	**Las Ciénegas total**	**Tucson - San Xavier total**	**Grand total**
Phyllorhynchus browni											23	23
Phyllorhynchus decurtatus											16	16
Pituophis catenifer		49	1	50		3	7		10	8	8	76
Rana blairi								1	1			1
Rana catesbeiana (l)	1	9,085	32	9,118						347	2	9,467
Rana chiricahuensis			6	6		538	2	3	543	162		711
Rana yavapaiensis		50		50						5	99	154
Rhinocheilus lecontei		12	2	14						1	7	22
Salvadora hexalepis		19	1	20		1	2	1	4	2	4	30
Scaphiopus couchii		7	9	16	1	1	51		53	9	41	119
Sceloporus clarkii		36	10	46	11	2	85	1	99	46	63	254
Sceloporus magister											7	7
Sceloporus slevini										26		26
Sceloporus undulatus	10	14	4	28						41	28	97
Senticolis triaspis						1	2	1	4			4
Spea multiplicata			9	9			139		139	1	3	152
Tantilla hobartsmithi	4	5	6	15			9		9	2	14	40
Tantilla yaquia							2		2			2
Terrapene ornata		4	3	7	1	2	2		5	5	2	19
Thamnophis cyrtopsis						16	30	8	54			54
Thamnophis eques		148	21	169						37	9	215
Thamnophis marcianus		974	10	984						1	15	1,000
Trimorphodon biscutatus						1	5		6			6
Urosaurus ornatus	27	72	17	116		1	68	2	71	208	119	514
Uta stansburiana											15	15
Total	100	11,690	178	12,125	68	647	877	31	1,623	2,057	856	16,66