AMPHIBIANS AND REPTILES
OF SONOITA CREEK STATE NATURAL AREA, ARIZONA

Black-necked gartersnake, Coal Mine Canyon.

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ABSTRACT

I surveyed the amphibians and reptiles of Sonoita Creek State Natural Area in southern Arizona, using extensive walking searches, trap arrays, and review of previous records. 36 species were found within the natural area boundary, adjacent Patagonia Lake State Park, and the surrounding mile. Previous work had documented 12 species in the area. This report documents the occurrence of 9 anuran, 2 turtle, 9 lizard, and 16 snake species.

INTRODUCTION

Sonoita Creek State Natural Area of southern Arizona lies in the "sky island" archipelago of southwestern North America, which is known for its rich biodiversity. Mountain ranges in the region contain unique biotic assemblages, with distributional edges, gaps, and outliers that lead to a variety of fascinating biogeographic questions (McLaughlin 1995; Warshall 1995). The valleys provide corridors between montane populations and allow extensions of distribution for lower-elevation species. Lowlands are generally the best-watered, most productive parts of the landscape, and have also been the most heavily affected by human use, both globally and locally.

The Sonoita Creek valley has been haphazardly visited by herpetologists for decades, but most collecting has been done along the main road, Highway 82, due to constraints of access to private property.

This inventory was a volunteer effort. The goals were to provide qualitative information about the herpetofauna of Sonoita Creek State Natural Area, particularly species presence, but also to provide information on species distribution and abundance.

METHODS AND MATERIALS - Study area

Sonoita Creek State Natural Area (SCSNA) extends east along Sonoita Creek for 7 miles from its confluence with the Santa Cruz River about 8 miles north of Nogales, Arizona, and includes lands north from the creek up to 5 miles (Fig. 1). It is managed by the Arizona State Parks Department (ASP) for the benefit of its natural values. With the initial purchase in 1994, it was the first such natural area acquired with funds from the state lottery that were dedicated in the 1990 Heritage Initiative to protect "parcels of land or water that contain examples of unique natural terrestrial or aquatic ecosystems, rare species of plants and animals, or outstanding geologic or hydrologic features."

The Natural Area has been greatly expanded with adjacent land around Coal Mine Spring, purchased in 2005 and 2006 by Arizona Game and Fish Department (AGFD; also using Heritage Fund money) and US Fish and Wildlife Service but jointly managed by ASP. When the areas are considered together, the Natural Area comprises about 8,786 acres. It ranges in elevation from 3,440 ft at the downstream end up to 5,466 ft in the Grosvenor Hills.

For purposes of this study, I included SCSNA, the adjacent Patagonia Lake State Park, and out to one mile beyond the SCSNA boundaries.

The portion of SCSNA that receives most attention is the cottonwood/willow gallery forest along Sonoita Creek, along with associated mesquite bosques. Aside from the perennial flow in Sonoita Creek, the area includes intermittent stream reaches in Fresno and Coal Mine canyons, and the perennial Coal Mine Spring. The entire area drains into Sonoita Creek. The upland vegetation of SCSNA is primarily semidesert

grassland, with small areas of oak savanna. A detailed flora of the original Natural Area, comprising 4,900 acres before the AGFD additions, found 525 native plant species and 36 exotic species (McLaughlin 2006).

An abandoned railroad bed along the Sonoita Creek has been converted to a non-motorized trail, and provides the primary access along the creek. Prior to acquisition by ASP, the area was used primarily for cattle grazing, and cattle remain a strong influence on the landscape. Other current uses include trespass off-road vehicle, horse, and foot travel along the creek bed and trail. Unlike many places near the U.S./Mexico border, illegal immigrant traffic did not appear to have a strong impact during summer 2006.

Study design

To determine which species had been previously recorded, I examined records from the University of Arizona herpetological collection for specimens collected in southern Santa Cruz County. I also examined the available unpublished literature for the vicinity.

In the field, other volunteers, SCSNA staff, and I gathered data on presence, abundance and distribution of reptile and amphibian species using two strategies:

a) Visual encounter surveys. We conducted visual encounter surveys (Crump and Scott 1994), searching all available amphibian and reptile habitats as we walked direct or meandering routes, both day and night. We routed our searches in such a manner as to optimize chances for recording the greatest diversity of species as determined from previous experience, published literature, and other sources. The primary emphasis was the riparian zones, especially along Sonoita Creek, though day and night searches were also conducted on the uplands. We conducted only one survey on the rocky slopes of the Grosvenor Hills.
b) Trapping. We established and monitored funnel trap arrays (Campbell and Christman 1982; Gibbons and Semlitsch 1982) in 4 sites. Three of these arrays were kept open continuously from July 9 to July 28, being checked twice daily by ASP staff (Appendix 3). Each array was comprised of 4 traps connected by a single 50- or 100-ft drift fence. Each trap had a box framework, 8x14x23 inches, wrapped with 1/8 inch mesh hardware cloth, with a mesh funnel at one end.

A voucher photo was taken of each reptile and amphibian species captured. Physical specimens were made from accidental trap mortalities, animals found dead from natural causes, and road-killed animals from Patagonia Lake State Park. All photos and specimens were deposited in the University of Arizona Herpetology Collection.

I made 9 trips to SCSNA during the course of this project, from April through September 2006. I was assisted by a varying group of volunteers, most from the Tucson Herpetological Society. Total field effort included 208 person-hours over 18 calendar days. Additional effort included 228 trap days.

RESULTS - Amphibians and reptiles found

The total complement documented for the study area is 9 amphibian and 27 reptile species (Table 1). We found 8 amphibian and 15 reptile species in the study area, and specimen or photo vouchers for 9 more reptile species were delivered to us during the study. An additional 1 amphibian and 3 reptile species were documented previously but not found during this study.


Woodhouse's toad, Sonoita Creek.

Comparing methods, we found 21 species through visual encounter surveys. The traps captured 10 species, including two snake species not found during visual encounter surveys. Incidental observations by SCSNA staff, including road-killed animals in Patagonia Lake State Park, identified 19 species including 8 species not found during surveys or in traps.

Previous records

There were few pre-existing museum records from the study area, though records do exist from localities near its periphery (Appendix 1).

Relevant previous reports include a rapid initial inventory of SCSNA which involved 4 days of field work and found 11 species (Swann 1996), and a more intensive inventory of the nearby Tumacacori National Monument which found 24 species (Powell et al. 2005). We found all but one species (*Bufo cognatus*) confirmed by Swann (1996) and all but four species (*Bufo cognatus, Terrapene ornata, Sceloporus undulatus, Tantilla hobartsmithi*) confirmed by Powell et al. (2005).

Baseline monitoring data

Not counting anuran larvae, we made 396 observations of amphibians and reptiles during visual encounter surveys. Average observation rates were relatively low: using only search times by experienced personnel, we averaged 2.13 observations/hour overall, with 2.44 observations/hour for daytime searches and 1.32 observations/hour for night searches. For comparison, a 2-year herpetological inventory of the Whetstone Mountains found 2.52 observations/hour overall (Turner et al. 2003), and a 2-year herpetological inventory of Tumacacori National Historical Park found 4.52 observations/hour overall (Powell et al. 2005).

We captured 71 amphibians and reptiles in traps, for a rate of 0.31 captures/trap-day. For comparison, the Whetstone inventory had 0.10 captures/trap-day (Turner et al. 2003), and the Tumacacori inventory had 0.28 captures/trap-day (Powell et al. 2005)

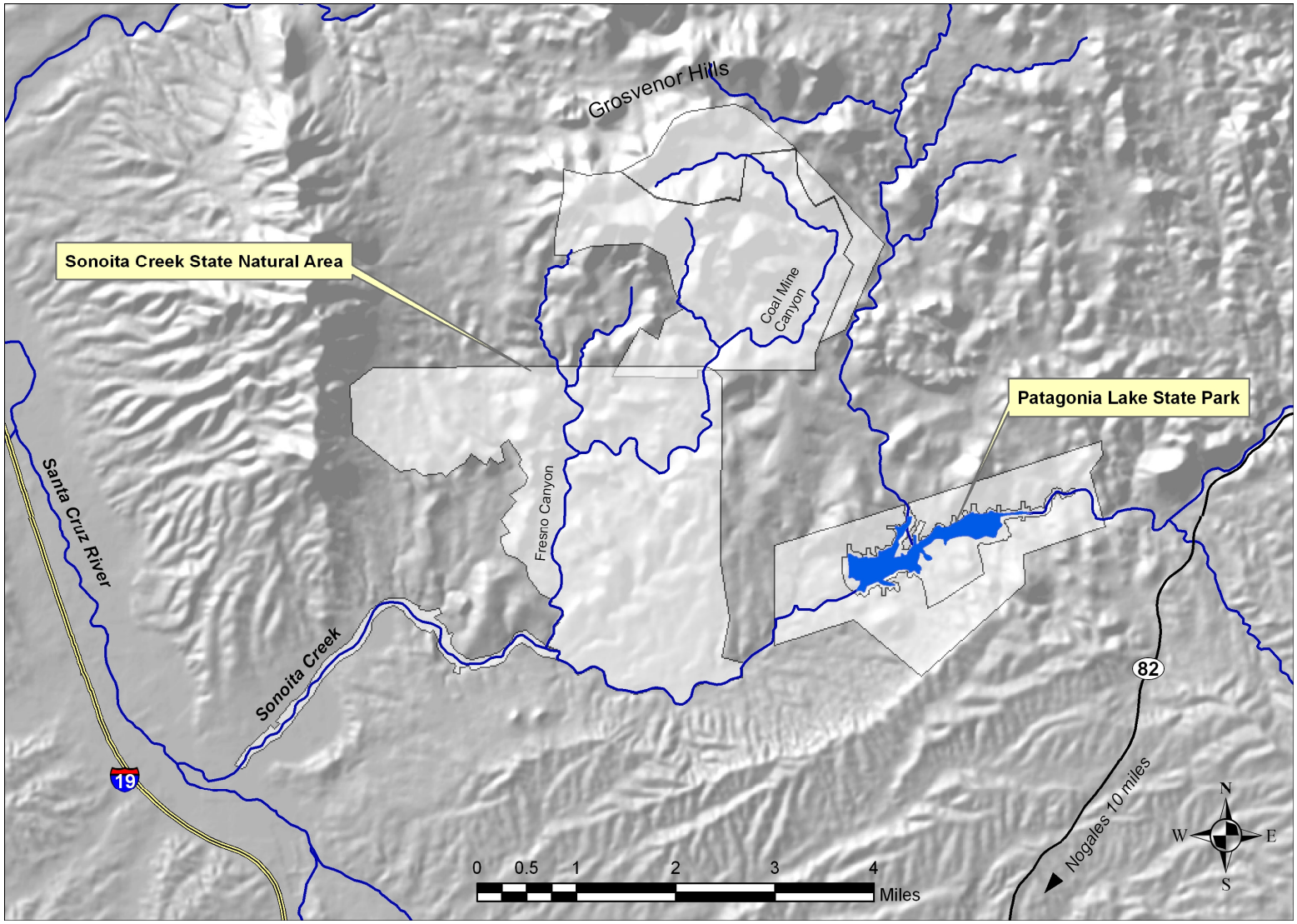

Figure 1. Sonoita Creek State Natural Area. Area shown includes recent acquisitions around Coal Mine Canyon.

Table 1. Amphibian and reptile species at Sonoita Creek State Natural Area.
Scientific and standard English names follow Crother (2000).

Latin name	Common name
AMPHIBIANS	
Bufo alvarius	Sonoran Desert toad
Bufo cognatus	Great Plains toad
Bufo punctatus	Red-spotted toad
Bufo woodhousii	Woodhouse's toad
Gastrophryne olivacea	Great Plains narrow-mouthed toad
Hyla arenicolor	Canyon treefrog
Rana catesbeiana	American bullfrog
Scaphiopus couchii	Couch's spadefoot
Spea multiplicata	Mexican spadefoot
REPTILES	
Turtles	
Gopherus agassizii	Desert tortoise
Kinosternon sonoriense	Sonoran mud turtle
Lizards	
Aspidoscelis sonorae	Sonoran spotted whiptail
Aspidoscelis uniparens	Desert grassland whiptail
Callisaurus draconoides	Zebra-tailed lizard
Elgaria kingii	Madrean alligator lizard
Heloderma suspectum	Gila monster
Holbrookia maculata	Lesser Earless lizard
Phrynosoma solare	Regal horned lizard
Sceloporus clarkii	Clark's spiny lizard
Urosaurus ornatus	Ornate tree lizard
Snakes	
Crotalus atrox	Western diamondbacked rattlesnake
Crotalus molossus	Blacktail rattlesnake
Diadophis punctatus	Ringneck snake
Gyalopion quadrangulare	Thornscrub hook-nosed snake
Hypsiglena torquata	Nightsnake
Lampropeltis getula	Common kingsnake
Masticophis bilineatus	Sonoran whipsnake
Masticophis flagellum	Coachwhip
Micruroides euryxanthus	Western coral snake
Pituophis catenifer	Gopher snake
Rhinocheilus lecontei	Longnose snake
Salvadora hexalepis	Western patchnose snake
Senticolis triaspis	Green rat snake
Tantilla yaquia	Yaqui black-headed snake
Thamnophis cyrtopsis	Blackneck Garter snake
Trimorphodon biscutatus	Western lyre snake

DISCUSSION

Species richness

Compared to nearby riparian areas, this study found similar amphibian and lower reptile diversity. Research in Las Cienegas National Conservation Area documented 7 amphibians and 30 reptile species (Rosen et al. 2005). Research along the San Pedro River corridor has documented 8 amphibian and 46 reptile species in the middle and upper reaches, comprising elevations 3,305 – 4,269 ft (Rosen 2005).

Adequacy of sampling

To determine the adequacy of our sampling efforts (i.e., how close we came to finding all species present), I constructed a graph showing accumulation of new species as a function of effort (Fig. 2). The resulting curve appears to approach but not reach an asymptote, suggesting that we came near to but did not achieve a complete inventory (Krebs 1989, Scott 1994, Soberon and Llorente 1993). However, the discovery of 10 additional species through trapping and incidental finds by others shows that we may have simply been approaching the number of species that are reasonably observable this year during walking surveys.

As a more direct evaluation, the comparison of species found by all means during this effort is similar to that in the closest reliable lists from similar habitat, as described above.

There are likely several more amphibian and reptile species to be found in SCSNA. This includes several species of burrowing snakes that may occupy the organic-rich soils of the riparian zone, several upland lizard species, and the Ornate box turtle. The rocky slopes of the Grosvenor Hills have the potential to harbor several additional species, but were not adequately sampled during this effort.

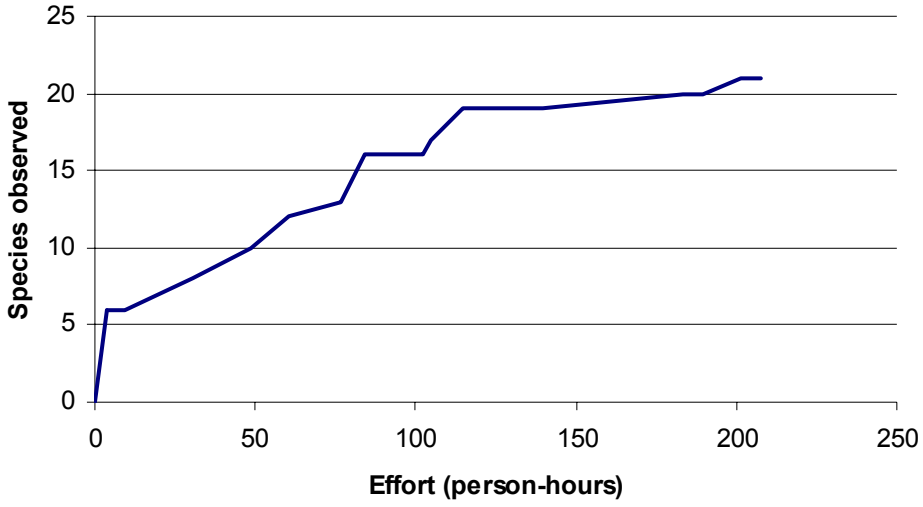

Figure 2. Species accumulation by effort. Points indicate cumulative person-hours of searching on the date we first discovered each new reptile or amphibian species. This does not include those species captured in traps, provided by others, or found only in previous records. The last new species was observed at 202 person-hours. The study was completed at 208 person-hours.

Rainfall effects

Rainfall patterns before and during this study probably affected the results. As expected, the presence of some anurans was associated with summer rains, and several snake species became more visible during that season. More interesting, though, was an apparent overall depression in reptile abundance, which I suspect resulted from several consecutive dry years. The vegetation in some areas of SCSNA exhibited evidence of recent drought, including significant or complete die-back of mesquite trees on the uplands around Coal Mine Canyon.

Rainfall data from the Nogales 6N gauge, southwest of SCSNA, shows annual rainfall from 2001 through 2005 below the 52-year average. Breaking the data into ecologically-significant seasons, summer (May-Sept.) rainfall was below average in 2001, 2002, 2004, and 2005, while winter (Oct.-April) precipitation was below average in 2002-2005.

Drought can affect reptile populations directly by reducing food availability. It also reduces the amount of vegetative cover, increasing their vulnerability to predators.

Unexpected species

The presence of desert tortoise at SCSNA was unexpected, as it is outside their commonly-understood range (Brennan and Holycross 2006). The one individual observed along Sonoita Creek may be part of an outlier population, or may be a formerly captive animal released in the area. Even if the latter is true, the species is sufficiently long-lived that the individual will likely inhabit the area for many years, and thus the species is included on the list here.

Species expected but not found

We did not find five species confirmed by specimens or previous studies in the area.

--*Bufo cognatus* is night-active during the monsoon season, with a very loud call that can be heard for miles. Within SCSNA they would likely breed in ephemeral waters on the uplands, and may have been too distant from our night searches to be heard. As a species that is widely distributed and tolerant of substantial disturbance, they might be expected to recolonize the area if they are truly absent. However, a review of museum records found no specimens from the vicinity, indicating the species has historically been absent from Santa Cruz County and the upper Santa Cruz Valley, as well as the Empire Valley. Previous observations at SCSNA and Tumacacori may have been misidentified *B. woodhousii*.

--*Terrapene ornata* is day-active during the monsoon season, and uses grasslands and riparian areas. They can be difficult to observe, but our emphasis on riparian surveys should have detected at least one if they have a significant population present. They were documented recently from the Santa Cruz River valley but may be absent from SCSNA, although if so this would represent a striking gap in their regional and ecological distribution.

--*Sceloporus undulatus* is day-active throughout the warm season, and relatively conspicuous though they can be mistaken for tree lizards. They were documented recently from the Santa Cruz River valley but may be absent from SCSNA.

--*Tantilla hobartsmithi* is a burrowing snake and rarely surface-active, and thus difficult to detect even if present in significant numbers. They are likely present at SCSNA, but undetected.

-- *Tantilla yaquia* was collected in 2005 in Patagonia Lake State Park, and has been vouchered along the Santa Cruz River near the Sonoita Creek confluence. Like *T. hobartsmithi*, it is quite secretive and relatively hard to document.

Of greater concern are several aquatic species for which historic specimens exist from nearby on Sonoita Creek, but which were not observed in this project:
-- Lowland leopard frog (*Rana yavapaiensis*), most recently vouchered in 1970 from Sonoita Creek, 5.5 miles SW of Patagonia. This aquatic species has been lost from many parts of its historic range due to loss of aquatic habitat, and predation by bullfrogs and sport fish (Clarkson and Rorabaugh 1989, Sredl et al. 1997).
-- Mexican garter snake (*Thamnophis eques*), most recently vouchered in 1974 from Sonoita Creek, 3 miles SW of Patagonia. This aquatic species has been lost from many parts of its historic range due to predation and competition by bullfrogs and sport fish (Rosen and Schwalbe 1988).
-- Giant spotted whiptail (*Aspidoscelis* [formerly *Cnemidophorus*] *burti stictogramma*), most recently vouchered in 1952 from 4.2 miles SW of Patagonia. This riparian species has been lost from most of its historic lowland range due to habitat degradation and loss. Recent surveys of historically occupied habitat failed to find them along Sonoita Creek, and revealed they were rare (Rosen et al. 2002) or possibly absent (Powell et al. 2005) along Santa Cruz River in the upper Santa Cruz Valley where they were previously known and might be expected to occur.

Other species of concern

Black-necked garter snake (*Thamnophis cyrtopsis*) were found near Sonoita Creek and in Coal Mine Canyon. However, only 3 were observed along Sonoita Creek and 2 in Coal Mine Canyon during the course of this study, despite repeated and extensive surveys along those and Fresno Canyon. This species is typically abundant and relatively conspicuous where present. Its scarcity suggests predation or competition by non-native species.

Among the native amphibians that were observed in SCSNA, one or more individuals of each species was found in or near Sonoita Creek, but I suspect the creek itself to be a population sink due to the suite of predatory non-native species there. Aside from ranid frogs (i.e. leopard frogs, bullfrogs), most frogs and toads in this desert region depend on temporary waters for breeding because those are largely free from predatory insects, at least when first filled (Woodward 1983). That behavior conveniently separates them from fish, crayfish, and bullfrogs, and is probably responsible for their persistence in SCSNA. Human efforts to increase the year-round permanence of water sources, e.g. the dam at Chivas Tank, have supported the expansion of non-native aquatic species to the detriment of native amphibians (although stock tanks may be [Sredl and Saylor 1998] or be managed to become [Rosen and Schwalbe 1998] important to persistence of some leopard frog populations).

Problematic non-native species

The perennial aquatic environments in SCSNA have become degraded or hostile habitat for native amphibians and reptiles due to the presence of the following non-native species:

Bullfrogs (*Rana catesbeiana*) are common in Sonoita Creek, Coal Mine Canyon, and Chivas Tank. The bullfrog is a native of the eastern U.S., and a voracious predator. Bullfrogs in the American Southwest have been shown to consistently eliminate populations of native leopard frogs (*Rana yavapaiensis, R. chiricahuensis*) and reduce or eliminate Mexican garter snakes (*Thamnophis eques*) (Hayes and Jennings 1986, Rosen and Schwalbe 1995, Rosen et al. 1995). As observed on the lower San Pedro River, lowland leopard frogs can coexist in a stream with low densities of bullfrogs, if a natural flooding regime serves to regularly reduce the bullfrog tadpole population (Sartorius and Rosen 2000, Rosen and Schwalbe 2002). But the combination of bullfrogs and sport fish will typically eliminate a leopard frog population (Rosen et al. 1995, Kiesecker and Blaustein 1998). Rosen and Schwalbe (1988) observed that 78% of a Mexican garter snake population had damaged tails from attempted bullfrog predation; we (DT, J. Parks) observed similar damage to a black-necked garter snake in Coal Mine Canyon.

Crayfish (presumed *Orconectes virilis*)
We observed crayfish in aquatic sites throughout Sonoita Creek, Fresno Canyon, and Coal Mine Canyon. They were not observed in seasonal pools in Walnut Canyon and other dry drainages. There are no native crayfish in Arizona, but they have been widely introduced and have been shown to seriously impair aquatic systems. They consume native aquatic plants and invertebrates, which reduces the cover and food available for fish, amphibians, and semiaquatic reptiles. They are also major predators on young individuals of many vertebrate species, including gartersnakes and Sonoran mud turtles (Fernandez and Rosen 1996). Crayfish have been documented dispersing up to 4 miles along seasonally wet drainages, and thus can recolonize sites that are isolated during the dry season (Blomquist 2003).

Non-native fish, including mosquitofish (*Gambusia affinis*), green sunfish (*Lepomis cyanellus*), black bullhead (*Ameiurus melas*), and largemouth bass (*Micropterus salmoides*) are present throughout the flowing portion of Sonoita Creek in SCSNA, aside from the first 0.87-mile reach of anoxic water below Patagonia Lake dam (Foster and Mitchell 2004). Green sunfish have been found recently in Coal Mine Canyon and Fresno Canyon (ASP 2006, Foster 2004). This suite of species has been shown to reduce or eliminate populations of leopard frogs, especially with they co-occur with bullfrogs (Rosen et al. 1995, Kiesecker and Blaustein 1998).

Cattle
Cattle were frequently observed in the riparian areas during this study. The current level of livestock use has apparently altered the riparian plant communities, with likely effects on reptile diversity and abundance. The riparian community was recently found to contain large trees with very little midstory or understory vegetation (Kingsley and Gaiennie 2005).

Those data echo a range report from 1996, which noted that in the mesquite bosques prior to the summer monsoon, “the understory was observed to have been heavily grazed and there was a striking absence of middle-story herbaceous or woody plant species.” That report also noted evidence of heavy grazing pressure on the uplands (Ogden 1996).


Mexican spadefoot, Sonoita Creek

An extensive study conducted in western Arizona found that lizard populations in heavily grazed desert grassland, mixed riparian scrub, and cottonwood-willow communities had lower relative abundance and lower species diversity than those in similar, lightly grazed sites. These changes were associated with the loss of structural diversity in the habitat, loss of cover, and possibly reductions in diversity and abundance of invertebrate prey. The effects were strongest for highly active foragers like whiptail lizards (Jones 1981).

Value for future monitoring efforts

Species checklists can serve as the simplest and most effective method to detect large-scale changes in communities of organisms, if only through noting addition or deletion of species (Droege et al. 1998, Greenberg and Droege 1999). Comparisons of taxonomic completeness (i.e. observed vs. expected species present) among macroinvertebrate communities have been widely used to assess biological integrity of aquatic ecosystems (Hawkins 2006) but have also been used with native fish and frogs to assess the health of watersheds (Moyle and Randall 1998). Thus, this inventory may provide useful information for future monitoring efforts in SCSNA and across the region.

Species presence in repeated surveys can also be used to efficiently monitor population trend for individual rare species (Joseph et al. 2006), and raw data from this inventory could be incorporated into such an effort.

Sonoita Creek State Natural Area is scheduled to open to the public in November 2006. Current management plans are designed to minimize effects on natural values, but some impact on the flora and fauna may be inevitable.

Major residential development is underway in Rio Rico, just west of SCSNA, and additional subdivision of the Salero Ranch on the northern and eastern flanks of the Natural Area. These will likely bring increased recreational pressures to the area, both permitted and not. They will also likely displace cattle ranching, reducing impacts of trespass grazing.

The uplands of SCSNA have been relatively isolated and rarely visited, with difficult access and no major attractions. We anticipate that rapid population growth around this area, coupled with opening of the Natural Area, will dramatically increase recreational use of the area in the next decade. Increased use will affect habitat quality for all wildlife, may lead to new species introductions, and may increase collecting pressure on some reptile and amphibian species.

Management recommendations

Bullfrogs

Bullfrogs are highly problematic for some native amphibians and reptiles, but extremely difficult to control. Because bullfrogs can lay as many as 20,000 eggs per clutch and have multiple clutches each year, mechanical removal of a large population may be impossible. They are also capable of overland movement during the monsoon season, and thus can recolonize sites. There are some causes for hope - because they remain in a larval stage for a year or more, their tadpoles are susceptible to removal by floodwaters in stream systems with regular flooding. Also, they require permanent water, and can be eliminated by desiccation of isolated waters. The large population at Patagonia Lake cannot be removed by mechanical means, and the dam both impairs the downstream flood regime and creates a bullfrog refuge and source in the reservoir it impounds. Thus, bullfrogs cannot be effectively removed from Sonoita Creek so long as the lake remains. However, the low population density in Coal Mine Canyon suggests that flooding might be suppressing their numbers, and well-timed additional control measures such as seining and gigging might lead to effective elimination. Chivas Tank may also provide a setting for successful control; it could be pumped dry in mid-Spring, and allowed to stand dry until the start of summer rains, a technique which has been used successfully at Buenos Aires and San Bernardino National Wildlife Refuges.

Crayfish

No effective method of controlling or eliminating crayfish from perennial waters in this region has been developed,. Trapping alone is ineffective, but when combined with other methods in the appropriate season can suppress a population (Blomquist 2003). As with bullfrogs, the abundant crayfish population in Patagonia Lake means that Sonoita Creek will likely never be free of them. It may be possible to suppress the population in Coal Mine Spring through mechanical removal, but eradication there seems unlikely. I did not observe crayfish at Chivas Tank, but if present there, it is possible they could be removed by desiccation of the tank. Native chubs are effective predators on juvenile crayfish, although they can also facilitate bullfrog population explosions (P. Rosen, personal communication).

Livestock

Fencing of the western boundary of SCSNA was underway during this study, and should greatly benefit the upland and riparian communities. Its value would be greatly enhanced by constructing separate fences around Coal Mine Spring, Chivas Tank, and any permanent water in Fresno Canyon. The length and topographic complexity of the SCSNA boundary entail a high probability of undetected fence breaks and thus trespass cattle. Excluding livestock from those upland watering sites would reduce cattle's ability to remain within the Natural Area.

Eliminating cattle use of the Sonoita Creek riparian zone should remain a high priority. Their removal would allow increased habitat diversity and benefit the populations of many native species.

Clark's spiny lizard, Walnut Canyon.

Chivas Tank

As noted above, Chivas Tank offers an opportunity to create a permanent water source free of exotic species by first drying the tank completely. This would allow restoration of lowland leopard frogs and Mexican garter snakes to SCSNA, and might serve as a refuge population of topminnow. Such a project would first require a search of the watershed for other bullfrog populations that might recolonize the site, and, if these are found to exist, would also require a strategy for dealing with them.

Coal Mine Spring

As noted above, it may be possible to suppress the bullfrog population at Coal Mine Spring, though it seems unlikely they can be eliminated. Such management would support the persistence of black-necked garter snakes at the site, and might be sufficient to allow restoration of lowland leopard frogs.

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Appendix 1. Amphibian and reptile specimen status for Sonoita Creek State Natural Area. Scientific and standard English names follow Crother (2000). Vouchers for this study were deposited at the University of Arizona Herpetology Collection (UAZ). Number observed includes all survey methods and incidental observations during the study period.

Latin name	Common name	Latest voucher nearby[1]	Observed by I&M at TUMA[2]	Observed by Swann at SCSNA[3]	Number Observed this study	Photo this study	Voucher this study	Other
AMPHIBIANS								
Bufo alvarius	Sonoran Desert toad		X		9	X		
Bufo cognatus	Great Plains toad		X	X	0			
Bufo punctatus	Red-spotted toad				36 (+200)[6]	X	X	
Bufo woodhousii	Woodhouse's toad	1980	X		10	X		
Gastrophryne olivacea	Great Plains narrow-mouthed toad	1980	X		18	X		
Hyla arenicolor	Canyon treefrog	1970		X	24	X		
Rana catesbeiana	American bullfrog		X	X	45	X		
Scaphiopus couchii	Couch's spadefoot	1999	X		3	X		
Spea multiplicata	Mexican spadefoot	2001	X		9	X	X	
REPTILES								
Turtles								
Gopherus agassizii	Desert tortoise				1	X		
Kinosternon sonoriense	Sonoran mud turtle		X	X	19	X	X	
Lizards								
Aspidoscelis sonorae	Sonoran spotted whiptail	1999	X	X	110	X		
Aspidoscelis uniparens	Desert grassland whiptail	1966	X		7	X		
Callisaurus draconoides	Zebratail lizard			X	8			
Elgaria kingii	Madrean alligator lizard	1980			2	X		
Heloderma suspectum	Gila monster				2	X		
Holbrookia maculata	Lesser Earless lizard	1972	X	X	28	X		
Phrynosoma solare	Regal horned lizard	2000	X		4	X		
Sceloporus clarkii	Clark's spiny lizard	1973	X	X	56	X		

Latin name	Common name	Latest voucher nearby[1]	Observed by I&M at TUMA[2]	Observed by Swann at SCSNA[3]	Number Observed this study	Photo this study	Voucher this study	Other
Urosaurus ornatus	Ornate tree lizard	1972	X	X	113	X		
Snakes								
Crotalus atrox	Western diamondbacked rattlesnake		X	X	5	X	X	
Crotalus molossus	Blacktail rattlesnake	1976			2	X		
Diadophis punctatus	Ringneck snake	1975			1	X		
Gyalopion quadrangulare	Thornscrub hook-nosed snake	1959			0			X[4]
Hypsiglena torquata	Nightsnake	1999	X		1	X		
Lampropeltis getula	Common kingsnake	1981			1		X	
Masticophis bilineatus	Sonoran whipsnake	1975			2	X	X	
Masticophis flagellum	Coachwhip	1991	X		4	X	X	
Micruroides euryxanthus	Western coral snake	1991	X		1	X		
Pituophis catenifer	Gopher snake	1970	X		5	X		
Rhinocheilus lecontei	Longnose snake	1973	X		1	X		
Salvadora hexalepis	Western patchnose snake	2002	X	X	1		X	
Senticolis triaspis	Green rat snake	1975			1			X[5]
Tantilla yaquia	Yaqui black-headed snake	2005			0			X[7]
Thamnophis cyrtopsis	Blacknecked garter snake	1957			8	X	X	
Trimorphodon biscutatus	Western lyre snake	2002			1	X		

Notes

1. Includes records from the University of Arizona Herpetology Collection with localities within approximately 5 miles of SCSNA.
2. Observations by the Inventory and Monitoring Program at Tumacacori National Historical Park (Powell et al. 2005).
3. Observations by Don Swann at SCSNA (Swann 1996).
4. I was given a 2003 photo of *Gyalopion quadrangulare* taken at Patagonia Lake State Park by Perri Miracolo.
5. SCSNA staff have observed *Senticolis triaspis* several times in recent years, but have no photos.
6. Observations of *Bufo punctatus* included an estimated 200 recently-metamorphosed individuals.
7. I was given a 2005 specimen of *Tantilla yaquia* collected at Patagonia Lake State Park by Ken Kingsley.

Appendix 2. Amphibian and reptile species not found at Sonoita Creek State Natural Area but documented nearby.

Latin name	Common name	Latest voucher nearby[1]	Observed by I&M at TUMA[2]
AMPHIBIANS			
Eleutherodactylus augusti	Barking frog	2003	
Rana yavapaiensis	Lowland Leopard Frog	1970	
REPTILES			
Turtles			
Terrapene ornata	Ornate Box Turtle	1997	X
Lizards			
Cnemidophorus burti	Giant Spotted Whiptail	1952	
Gambelia wislizenii	Long-nosed leopard lizard	1968	
Phyrnosoma hernandesi	Short-Horned Lizard	2001	
Sceloporus undulatus	Prairie Lizard	1954	X
Snakes			
Heterodon nasicus	Western hognose snake	1930	
Salvadora grahamiae	Mountain Patchnose Snake	2001	
Tantilla hobartsmithi	Southwestern Blackhead Snake		X
Thamnophis eques	Mexican garter snake	1974	
Thamnophis marcianus	Checkered garter snake	1980	

Notes
1. Includes records from the University of Arizona Herpetology Collection with localities within approximately 5 miles of SCSNA.
2. Observations by the Inventory and Monitoring Program at Tumacacori National Historical Park (Powell et al. 2005).

Appendix 3. Trap locations.

Site name	**Dates used** (in 2006)	**Habitat sampled**	**Fence length** (feet)	**Elevation** (feet)	**Geographic coordinates** (decimal degrees)	
Gastellum	June 3-4	Riparian, cottonwood/willow, immediately adjacent to Sonoita Creek	100	3,559	N31.47756	W110.91497
Array 1	July 9-28	Mesquite/hackberry bosque. 75 m SE of Sonoita Creek	50	3,647	N31.48321	W110.88216
Array 2	July 9-28	Upland, 110 m NW of Sonoita Creek, ocotillo dominated	100	3,749	N31.48433	W110.88374
Array 3	July 9-28	Riparian, 20 m NW of Sonoita Creek, cottonwood/willow / hackberry	50	3,644	N31.48245	W110.88343

Appendix 4. Vouchers from Sonoita Creek State Natural Area. Photo and specimen vouchers for this study were deposited at the University of Arizona Herpetology Collection (UAZ). Listed here are the specimen vouchers.

Genus	Species	Date Collected	Locality	Collected By	Specimen number
Aspidoscelus	*sonorae*	7/13/2006	100 m N Sonoita Creek, 1.5 km SW Patagonia Lake Dam, 3750 ft el.	D.S.Turner	UAZ 56555
Bufo	*punctatus*	7/10/2006	100 m N Sonoita Creek, 1.5 km SW Patagonia Lake Dam, 3750 ft el.	D.S.Turner, Tony De Santis	UAZ 56562
Bufo	*punctatus*	7/10/2006	100 m N Sonoita Creek, 1.5 km SW Patagonia Lake Dam, 3750 ft el.	D.S.Turner, Tony De Santis	UAZ 56563
Bufo	*punctatus*	7/10/2006	100 m N Sonoita Creek, 1.5 km SW Patagonia Lake Dam, 3750 ft el.	D.S.Turner, Tony De Santis	UAZ 56564
Bufo	*punctatus*	7/16/2006	100 m N Sonoita Creek, 1.5 km SW Patagonia Lake Dam, 3750 ft el.	D.S.Turner	UAZ 56566
Crotalus	*atrox*	7/20/2006	Entrance gate to Patagonia Lake State Park	D.S.Turner	UAZ 56558
Kinosternon	*sonoriense*	5/14/2006	Walnut Canyon, tributary to Sonoita Creek, 3661 ft el.	D.S.Turner	UAZ 56560
Kinosternon	*sonoriense*	8/12/2006	Chivas Tank, 1.5 mi N of Sonoita Creek, 3733 ft el.	D.S.Turner	UAZ 56561
Lampropeltis	*getula*	7/1/2006	Hwy 82 at 1 - 11 mi (rd) NE of Nogales	Tony De Santis	UAZ 56559
Masticophis	*bilineatus*	8/16/2006	Patagonia Lake State Park	D.S.Turner	UAZ 56554
Masticophis	*bilineatus*	7/7/2006	Patagonia Lake State Park	Ken Morrow	UAZ 56557
Masticophis	*flagellum*	7/14/2006	100 m N Sonoita Creek, 1.5 km SW Patagonia Lake Dam, 3750 ft el.	D.S.Turner	UAZ 56553
Salvadora	*hexalepis*	8/30/2006	Patagonia Lake State Park	D.S.Turner, Steven Haas	UAZ 56552
Scaphiopus	*multiplicatus*	7/10/2006	100 m N Sonoita Creek, 1.5 km SW Patagonia Lake Dam, 3750 ft el.	D.S.Turner, Tony De Santis	UAZ 56565
Thamnophis	*cyrtopsis*	7/20/2006	100 m N Sonoita Creek, 1.5 km SW Patagonia Lake Dam, 3750 ft el.	D.S.Turner	UAZ 56556