

**2012 Surveys for Lowland Leopard Frogs
(*Lithobates yavapaiensis*)
in the Rincon/Santa Catalina Mountain Complex**

Report to Pima County Office of Conservation Science
and Environmental Policy

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--- 11 June, 2013 ---



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Introduction

Ranid frogs of the Desert Southwest have been declining for decades (Clarkson and Rorabaugh 1989, Gerst 1997, Hale et al. 2005, USFWS 2002, Sredl 1997). In the Tucson Basin the Lowland Leopard frog (*Lithobates yavapaiensis*) was a common, in perennial water even ubiquitous, amphibian in the valley lowlands that has totally disappeared from the Santa Cruz River valley over the past 40-100 years (based on museum records and anecdotes from herpetological experts). In the Tucson and San Pedro River basins this frog is currently known from the lower San Pedro River mainstem (see Rosen and Schwalbe 2002; Schlaepfer et al 2007) and in a few mountain streams. Causes of this disappearance are usually ascribed to habitat loss, nonnative predators, post-wildfire siltation, drought and disease (Ratzlaff 2012, Rosen and Funicelli 2009, Rosen and Schwalbe 2002, Savage et al. 2011, Sredl 1997, Swann and Wallace 2010) .

Land managers and conservationists working with Lowland Leopard Frogs in the Rincon/Catalina Mountain complex have suffered from a dearth of information on the species' basic distribution and abundance. The sole exception to this is the monitoring that Don Swann at Saguaro National Park has been doing for the last 16 years studying the ecology of the frog in and immediately surrounding the park. However this monitoring program was limited in spatial scope to within and near the Park's boundaries. In addition, the metapopulation dynamics that apparently drive the ecology of this species are poorly understood. The only other local population that had been studied in any depth was in the Romero/Montrose canyon complex on the western side of the Catalina Mountains. But this population was small and suffered dramatic decreases after the Aspen Fire in 2003 (Hall 2006).

As a result, a team of experts, led by Brian Powell (Pima County) and Don Swann (USNPS) met to address the need for further information on the distribution and abundance of the Lowland Leopard Frog in the Rincon-Catalina mountain complex. In a meeting in 2011, experts identified areas in the Rincon-Catalina mountain complex that should be surveyed for Lowland Leopard Frogs. Because little was known about the distribution of Lowland Leopard frogs on the eastern slopes of both the Santa Catalina and Rincon mountains this area were selected the focal region for surveys. The goal of these surveys were to generate baseline data that could be used as a

basis for developing a long-term monitoring plan for this species at an appropriate landscape scale. Following this discussion, surveys were completed during the Spring and Fall of 2012. The results of these surveys are submitted and summarized herein along with protocols used and suggestions for further work.

Methods

All sites were located within the eastern slopes of the Rincon and Santa Catalina Mountains except for two lotic (flowing) sites, Cañada Del Oro and Romero Canyon located on the north and west side of the Santa Catalina Mountains (Figure 1). Surveys were done in teams of two and were done during two seasons: spring (April-June) and fall (October-November). Sites were selected by the group of experts mentioned above as well as using topographic maps and Google Earth. I also used records from Arizona Game & Fish Department (AGFD) and museum records from Arizona State University (ASU) and University of Arizona (UAZ) herpetological collection to aid in survey site selection as well as to generate a map of the known historical distribution of the frog in the region. I interviewed several individuals that were involved in surveys in the past that may have encountered frogs: Joseph Bagnara (University of Arizona, retired), William Hayes (Arizona Game and Fish Department, retired), Don Mitchell (Arizona Game and Fish Department), Josh Taiz (U.S. Forest Service), Thomas Skinner (U.S. Forest Service, retired). Google Earth was particularly useful in identifying lentic (still-water) sites that were of interest because I could use the history function to review landscape photos over the past 20 years. This allowed me to select stock tanks with the most permanent water as sites that should be surveyed. Sites identified near known or historic leopard frog populations were given particular interest. We generally surveyed canyons to approximately 5,500 feet (1676 m) above mean sea level. We chose this elevation as the Lowland Leopard Frog has been observed to breed up to this elevation in this area (Brian Powell, pers. com., Wallace, 2012, Wallace et al 2010). We did however survey up to 6500 feet (1981 m) in Alder Canyon.

Visual Encounter Surveys (VES) for frogs were used along with dip-netting and seining where appropriate. Typically we would carefully walk the edges of a stock tank or stream and detect leopard frogs by either viewing directly or watching them leap into the water from the bank.

Generally the bank of the stream or pond were thoroughly searched and rock ledges and clumps of emergent aquatic vegetation such as sedges, rushes, and bunch grasses were probed. Leopard frogs have a very distinctive jump that allows experienced biologists to distinguish them from either the common Canyon Tree Frog (*Hyla arenicolor*), American Bullfrog (*Lithobates catesbeianus*) or other amphibians such as toads that may occur in the region. If there was any question as to the identity of an amphibian we waited for the animal to resurface from the water and identified it using hand collection or visually, at times with binoculars. During each survey, depending on the habitat, either a lentic or lotic Site Survey Form (see data sheet copies in Appendix II) was filled out and completed at the end of the survey. Photos of each site were taken unless the site was a dry stock tank. Surveys were performed from mid-morning to early morning (0100hr). Generally sites were visited at least twice unless the site was found to be dry on the first visit. We recorded Universal Transverse Mercator (UTM) coordinates with Garmin 60cx™ GPS units using the WGS84 datum. We used a Hanna Combo™ pH & EC meter to record water temperature, pH, conductivity, and total dissolved solids. A Kestral 4000™ was used to record air temperature, humidity and wind speed. Generally these parameters were recorded at the beginning of a survey. A single site could have multiple survey areas: for example Buehman Canyon was divided into three survey areas, lower reach, middle reach and upper reach because of differences in habitat.

Results

34 lentic sites and 25 lotic sites were surveyed during this survey project in 2012. Each site is listed with locality and habitat characteristics in Table 1 (lentic sites) or in Table Two (lotic sites). Four of the 34 lentic sites and five of the 25 lotic sites had Lowland Leopard Frog populations, as shown in Figure 2. All sites with Lowland Leopard Frogs had some form of perennial water (running or in pools). No populations of nonnative fish or frogs were found during this study. The historic sites based on museum and AGFD records are displayed in Figure 3.

Annotated list of sites with Lowland Leopard Frogs (see Photo Appendix for site photographs).

Alder Canyon (Figure 4)

This canyon begins on the east side of the Santa Catalina Mountains at 7890 ft and ends at the San Pedro River at 2650 ft (2404-807 m). The entire canyon is approximately 18.5 miles (29.8 km) long. Water was present during our surveys in two separate reaches in this drainage, centered around three marked springs (USGS topographic maps 7.5 quadrangle): Alder Box Spring, Big Alder Spring and Juan Spring (Figure Four). The upper reach is approximately 1.8 miles (2.9 km) long beginning at UTM: 528500/3592022 and ending at UTM: 526781/3591064. The vegetation of this reach was typical Interior Riparian Deciduous Forest (Minckley and Brown, 1994) A side drainage entering Alder Canyon from the northwest had several deep tinajas (deep bedrock carved pools) that contained Lowland Leopard Frogs. This upper reach is best characterized as an interrupted stream, with flowing runs, deep pools with soil development as well as deep bedrock tinajas. Adult frogs and tadpoles were found throughout this reach with the highest concentrations of adults and tadpoles in the areas immediately above and below Alder Box Spring. We saw 55 adult frogs, and one egg mass was discovered in a large pool at Alder Box Spring. We surveyed this reach once in the fall. This reach is totally within US Forest Service lands. There appeared to be more tinaja habitat above the point at which our surveyed ended in Alder Canyon proper, so frog distribution may continue up canyon.

The second reach with frogs began just above Big Alder Spring at: 529561/3592508 and ended below Juan Spring at: 521142-3593089. This reach was surveyed in late fall and was characterized as having a dense canopy of Interior Deciduous Riparian Woodland vegetation dominated by alder, cottonwood and willow trees. Aquatic vegetation at the start of the reach was dominated by thick stands of watercress (*Nasturtium* sp.). This upper end had running water that tumbled over cobble and in places formed pools at the root masses of large trees. At the confluence with Archley Canyon the running stream turned into a series of pools, after which the stream resurfaced and continued to a point a quarter mile below Juan Spring (0.4 km). We observed over 60 frogs of mixed size-classes throughout this reach. Land ownership

of this reach is split in half, with the U.S. Forest Service owning the upper half (including Big Alder Spring) and the State of Arizona owning the lower half (including Juan Spring). Curiously, the Arizona Black Rattlesnake (*Crotalus cerberus*) was more commonly seen in this canyon than the usually more often seen Black-tailed Rattlesnake (*Crotalus molossus*).

Buehman Canyon (Figure Five)

Beginning on the southeastern slope of Evens Mountain at 5830 ft (1777 m) and ending at the San Pedro River confluence at 2850 ft (868 m), this canyon stretches for 14 miles (22.5 km). We surveyed a stream reach 10.3 miles (16.6 km) long, from 1.3 miles (2.1 km) upstream from the San Pedro confluence upstream to Mesquite Flat Spring. Of this reach only a 0.9 mile long reach (with the exception of three small pools above this stream reach) had water present during our surveys and a very large population of Lowland Leopard Frogs (Figure Five). We surveyed Buehman several times, in both spring and fall. The stream did have a longer reach of running water in spring than in fall, at which time it was reduced to the section shown in red in Figure 5. Longfin Dace were found in all of the areas of water. Although there are records of Desert Pupfish having been released into this stream (date unknown) we never saw or dip-netted any. The reach with water, fish, and frogs is characterized by a thick gallery forest and canopy of willow and cottonwood. Aquatic vegetation is mostly limited to algae and, infrequently, spikerush (*Eleocharis* sp) or cattails (*Typha* sp). The stream bottom is mostly cobble or sand with very little bedrock-tinaja habitat. Land ownership was mixed, with the upper section of the stream owned by the U.S. Forest Service, the middle reach (to the confluence of Bullock Canyon) owned by Pima County, and the lower reach a mix of Pima County, private, and State of Arizona ownership. The lowermost reach of the canyon is characterized by a small slot canyon and is owned by Pima County (Pima County Map Guide). By far the highest concentration of frogs within Buehman Canyon is in a section of stream under private and State of Arizona ownership. In this section we observed well over 1200 adult frogs, as well as hundreds of tadpoles and recently metamorphosed frogs. A robust spring-seep on the canyon wall is present (unmarked on topographic maps, but see photo section) at the upper end of this reach with several large pools and remains of a concrete wall or drinker as landmarks for this area. Perennial sandy-bottomed stream sections and tree-root pools

continue down for over a mile with smaller numbers of fish and frogs. The spring-seep itself is on private land, but State land begins just 50 m downstream. This canyon contains, by an order of magnitude, the largest Lowland Leopard Frog population seen in this study, and virtually without doubt in the entire mountain complex. Sonoran Mud Turtles (*Kinosternon sonoriense*), Canyon Tree Frogs (*Hyla arenicolor*), Black-necked Garter Snakes (*Thamnophis cyrtopsis*) were found but not abundant in the leopard frog section of the stream. Gila Topminnow (*Poeciliopsis occidentalis*) and Desert Pupfish (*Cyprinodon macularius*) were stocked in this stream in the 1980's but were extirpated by 2005 (Ehret, 2009). Goldfish (*Carassius auratus*) were found in 2004 in the private spring reach (Ehret, 2009), but we didn't find them in our surveys.

Edgar Canyon (Figure 4)

Beginning on the eastern side of Mount Bigelow at 8005 ft elevation (2440 m), Edgar Canyon runs 15.6 miles (25.1 km) to its confluence with the San Pedro river at 2850 ft (860 m). We surveyed a 3 mile (4.8 km) reach of stream, finding a large and robust frog population in the middle of this reach (Figure 4). This section of stream was characterized by boulder/cobble/gravel stream bottom with bedrock pools (tinajas). Canopy vegetation was Interior Riparian Deciduous Forest with sycamore and cottonwood trees dominating. Some pools had well developed cattail (*Typha* sp) and spikerush (*Eleocharis* sp) stands. Water was found for the most part in pools with short sections of running stream that would either connect to neighboring pools or disappear into the substrate only to reappear when the bedrock came close or reached the surface. We found the upper section of the survey reach to be largely dry with small patches of shallow stream or small pools that both appeared ephemeral. During the spring survey we observed over a thousand tadpoles but oddly no frogs of any size class. During the fall survey we observed 60 adults, 20+ tadpoles and one egg mass. Sonoran Mud Turtles (*Kinosternon sonoriense*), Canyon Tree Frogs (*Hyla arenicolor*), Black-necked Garter Snakes (*Thamnophis cyrtopsis*) were all common in the frog section of the stream. This section of Edgar Canyon is within the U.S Forest Service Catalina District lands.

Peck Spring & Six Bar Drinker (Figure 6)

These sites are located within 1.6 miles (2.6 km) of each other. Peck Spring is located in Peck Canyon, a small drainage found between Edgar and Alder Canyons; Six Bar Drinker is located in

Edgar Canyon. Both are man-made sites that are small in surface area but one contains a large population of leopard frogs. Peck Spring consists of a dammed natural spring head piped to two surface level drinkers both approximately 10 ft (3.1 m) in diameter. These drinkers are outside of the Peck canyon drainage on the southern side; a small overflow channel runs from the drinkers to Peck Canyon proper. No running water makes it to Peck Canyon as it apparently sinks into the sandy substrate. Both drinkers are at least ≈ 3 ft (1 m) deep and water continuously flows into them via a plastic pipe from the spring head. Vegetation surrounding the drinkers consists of Bermuda grass and cattails (*Typha* sp) with dense submerged mats of *Chara* sp. There is a large Lowland Leopard Frog population in the Peck Spring drinkers: we observed over 100 at this site, with mixed size classes. Dip netting produce no tadpoles, however, and no egg masses were observed. Frogs were found in both drinkers as well as in the overflow channel.

Six Bar Drinker is within the lower ephemeral reach of Edgar Canyon within a quarter mile of the Six Bar Ranch house. This is a concrete, ground level, drinker approximately 12 feet in diameter. There is little vegetation surrounding the drinker, although the overhead canopy is extensive in this part of Edgar Canyon, with dense stands of sycamore, cottonwood, mesquite and hackberry, indicating shallow groundwater. As a result, the drinker is shaded. We found 2 adult Lowland Leopard Frogs in these drinkers, although Brian Powell (Pima Co.) has been observing the frogs for several years and has observed more than we did. Both sites are owned by Pima County.

Romero Canyon (Figure 7)

Romero Canyon begins on the western slope of Sutherland Ridge in the Santa Catalina Mountains at 8574 ft (2613 m) elevation and extends for 8.24 miles (13.3 km) to its confluence with Sutherland Wash at 2270 ft (844 m). The population of Lowland Leopard Frogs in this canyon has been studied extensively by the author, particularly from 2001 until 2008. This was the first visit since 2008. Frogs were found in a 1.2 mile (1.9 km) reach that was largely contiguous water with flow between pools. This reach began at UTM: 511705/3586625 and ended at 513150/3585754. The distribution of frogs in this canyon is limited by the presence of Gila Chub (*Gila intermedia*) that are abundant throughout the lower reach (Gila Chub occur in

the pool just below the beginning UTM point listed above). This canyon was heavily damaged by fire sediment from the Aspen Fire (2003) and most of the habitat in this canyon disappeared (Hall, Forest Service report 2007). Frogs however persisted in a single off-channel spring-pool. The population of frogs in this canyon was similar to the population found in the upper reach of Alder Canyon, but decreased dramatically as the canyon habitat slowly recovered. The population now is reminiscent of its former state and the pool/stream habitat has largely recovered. We observed 44 adult frogs and dip netted 6 tadpoles. This site is mostly within the U.S. Forest Service Catalina District, with the lowermost section a part of Catalina State Park.

San Pedro River (Figure 8)

The section of this river that we surveyed begins at a beaver dam (UTM: 566457/3558748) at an elevation of 3280 ft (1000 m) and ending at a point 1.25 miles (2.0 km) downstream (UTM: 564450/3563533) at 3232 ft (982 m). This site has a thick canopy of cottonwood and willow with interspersed tamarisk. Stream flow at this site is perennial (Barbara Clark, Nature conservancy, pers. com.). We found 50+ tadpoles and eight adult leopard frogs throughout the reach. The stream was 10 ft (3.3 m) wide for the most part; cover along the banks was grass with some stands of cattails. It was difficult to search, so many frogs were likely undetected. A night survey would likely have observed more frogs in this area. No egg masses were observed. Land ownership is with The Arizona Nature Conservancy.

"Ridge Line Tanks" (Figure 4)

These are a trio of small unnamed and unmarked (on USGS 7.5 maps) stock tanks that are on the eastern ridge of Marble Peak between Geesaman and Gibb washes on the eastern slope of the Santa Catalina Mountains. I have adopted the names that Wallace (2011) uses in his report for these tanks. Ridge Line # 1 is the highest of the two at 5410 ft (1649 m) and Ridge Line #2 is at 5105 ft (1556 m) elevation. The two tanks are 0.3 miles (0.47 km) apart and are fed by apparently the same pipeline. The origin of this pipeline is unknown. There is a third tank located about 300 m east of Ridge Line #2, but this tank was dry the two times we surveyed the area although held water in 2011 (Wallace, 2012). Ridge Line #2 was very shallow in the spring and no frogs or tadpoles were found in this tank at that time. Ridge Line #1 was full during both spring and fall, and both adults (n = 9) and leopard frog tadpoles were observed in both seasons

(3 were dip netted in the spring and 2 in the fall). During the fall survey of these ponds both tanks had adult frogs (n = 16 in #2 and n = 24 in #1) and #2 had tadpoles (n = 2) as well.

Youtcy Spring (Figure 9)

This is a short spring run with four deep pools located in the center of Youtcy Canyon between the Santa Catalina and Rincon Mountains at UTM: 545568/3578188 at 3530 ft (1075 m) elevation. The stream reach that contained running water was about 300 ft (91 m) long. Frogs and tadpoles were found in all parts of the stream but were in the highest concentration in the uppermost pools. Frogs were common and we easily observed 31 frogs and caught 5 tadpoles in two dip net sweeps. Sonoran Mud Turtles, Black-necked Garter Snakes, Canyon Tree Frogs and Sonoran Whipsnakes (*Masticophis bilineatus*) were seen during each visit. The spring run has a heavy canopy of sycamore, willow, cottonwood, ash and walnut. Dense but small stands of cattails, and spikerush were throughout.

Annotated list of sites where no frogs were found

Cañada Del Oro (Figure 10)

Very little is known of the historic ecology of the fish or frogs that occurred in this large canyon. The drainage is 37 miles (58 km) long, beginning at 7930 ft (2417 m) and ending at its confluence with the Santa Cruz River at 2205 ft (672 m). We surveyed a 5.8 mile (9.3 km) long stream reach beginning at Wild Cow Spring (UTM: 520519/3595351) at 4923 ft (1500 m) elevation down to UTM: 519044/3601785) at 3902 ft (1189 m) elevation. We chose this area from reports of permanent water with deep pools throughout this reach (Dennis Caldwell; Will Hayes [AGFD retired]; Thomas Skinner [USFS retired]). Although there are no records of leopard frogs for this canyon, a substantial population most likely occurred at some time in the past. However, it is likely that leopard frogs were extirpated from this stream once non-native Green Sunfish (*Lepomis cyanellus*) were introduced into it. When this introduction occurred is unknown. Records from AGFD show that Green Sunfish occupied the stream in 2000 (Kendrick and Rodgvller, 2000). Green Sunfish have a strong negative impact on native leopard frogs and in steep mountain canyons such as Romero Canyon green sunfish were found to have excluded Lowland Leopard frogs (Hall, 2006). During our surveys, we found neither frogs nor fish in this reach. We did see hundreds of Canyon Tree Frogs and several Sonoran Mud Turtles. We found only three pools that had water over a meter deep. The stream channel was dry for the most part and what running water existed was small and shallow. The stream morphology was similar to other canyons observed after catastrophic sediment flows I have seen after the Aspen Fire. Although some recovery was evident, most of the stream channel was cobble and boulders with very few pools. The trees within the stream channel also were young and very few tall riparian trees such as ash and sycamore existed (See photo appendix). My interviews with Will Hayes and Tom Skinner revealed that the section of Cañada Del Oro from the Burney Mines down to the Biosphere II complex was always dry and full of sediment from the Burney Mine operations. However, in 2002 there was a small spring run below this dry section on private land (below Biosphere II and above Saddlebrooke) that was surveyed by the author and Phil Rosen. A population of Longfin Dace was found but no leopard frogs were observed. Since the Aspen Fire in 2003 this section of wash was filled with sediment.

Peppersauce canyon (Figure 10)

We surveyed this creek four times (twice at night and twice during daylight, each survey done once in spring and once in fall). We surveyed a 2 mile reach beginning at 5117 ft (150 m) elevation (UTM: 524301/3600553) ending at 4493 ft (1369 m) elevation (UTM:527328/3600214). This reach was dry except for the bottom quarter mile, which had perennial flow. Five Lowland Leopard frog specimens were collected from this canyon in 1958 (UAZ # 19723-19727). The museum records only indicate the collection location as "Peppersauce Canyon, Pinal Co. ca 4500 ft". This elevation occurs 0.5 miles downstream from where the Oracle Ridge-Mt. Lemmon highway crosses the creek and closely corresponds to the perennial reach we found. This perennial stream reach is on private land (occupied by Sycamore Canyon Academy, a "troubled teens" boarding school). We obtained permission from the Program Director, Mr. Ike Shipman to survey the creek. There were guidelines in doing this, allowing no contact with students and a sign-in / sign-out sheet. Mr. Shipman told us that the Academy bought the property from the Salvation Army in the 1990's and to his knowledge the stream on the property has never dried. We found no frogs in this reach and suspect they are extirpated from the canyon. The stream in this area is heavily shaded with giant sycamore trees. The slopes of the stream channel are covered with nonnative periwinkle (*Vinca*). The stream itself was small with three pools about a meter deep. Aquatic insect life appeared depauperate with a few *Abedus* sp. and some *Notonecta* sp. . We observed no emergent aquatic plants. Towards the end of this perennial reach much of the stream is diverted into a 2" steel pipe and piped to an unknown destination downstream. Mr. Shipman informed us that this has been the case since the 1990's at least. Soon after the water is diverted the stream runs dry. The water level of this reach did not seem to differ between spring and fall surveys.

Geesaman, Gibb and Juanito Canyons (Figure 11)

All of these canyons had long stands of Interior Riparian Deciduous Gallery Forest dominated by sycamore and cottonwood. However standing or flowing water was rare or nonexistent in all of them during our spring and fall surveys. Leopard frogs were observed in Geesaman Canyon in 2010 (Brian Powell, pers com), and in 2011 a small to moderate breeding population was

reported from Geesaman (Wallace 2012). We found no frogs in this canyon, and the entire survey reach (which included the areas surveyed in 2010 & 2011) was totally dry in the fall of 2012. These drought conditions were also found in Juanito and Gibb canyons and no leopard frogs were found in these canyons. We surveyed a 1.6 mile (2.6 km) long reach in Juanito Canyon from the intersection of the Oracle Ridge/Mt. Lemmon Control road up to Doctor Spring. We surveyed Gibb Canyon from Gessaman Spring (UTM: 526221/3593620) downstream to: UTM 528897/3594380. Gessaman Canyon was surveyed from UTM 525194/3592442 for 3 miles (4.8 km) downstream to Bat Well at UTM: 529550/3593580.

Stratton Canyon (Figure 11)

This long canyon has an extensive Interior Riparian Deciduous Forest with very little standing water throughout the 3.3 mile (5.3 km) long section that we surveyed. We surveyed from the Oracle Ridge/Mt. Lemmon service road up to Upper Stratton Spring. The stream appeared to be slowly recovering from fire sedimentation, and only two pools existed (at Upper Stratton Spring) during the spring survey.

Espiritu Canyon (Figures 12 and 13)

We surveyed the upper section of this canyon's watershed including long sections of Tres Pipas and Robles canyons. Green Sunfish were found in Espiritu Canyon in 1996 (AZG&F) in the area around the confluence of Espiritu and Bolt Canyon. This area was surveyed by Pima County in 2010 (Brian Powell, pers com) and no fish were observed, with one Lowland leopard frog observed in a large tinaja in this section of stream. We decided to survey the rather remote and un-surveyed section above these areas. Unfortunately the habitat was mostly xeroriparian with the only standing water found in one drying stock tank and two small concrete drinkers in developed spring heads. There were sections of Interior Riparian Deciduous Forest in these canyons but no surface water.

Arizona Game and Fish surveyed Espiritu and Bolt canyons in June 2000 (Kendrick and Rogveller 2000). They surveyed up both canyons beginning at their confluence upstream for approximately one mile. They found Bolt to be dry and Espiritu wetted in a series of unconnected pools at the base of a step-falls, in which Green Sunfish were found. No Leopard frogs were seen.

Paige Creek (Figure 14)

Historically, Paige Tank, Paige Canyon and the neighboring springs, Upper Turkey Creek and Buckhorn Springs had records of Lowland Leopard Frogs. Only at Buckhorn Spring was reproduction documented (Hall 2006). Buckhorn Spring's population disappeared in 2002 when the spring went dry (Hall 2006). Leopard frogs in Paige Tank were documented in 2000 (Kendrick and Rogveller 2000), but this population has not been observed since (Hall 2006); since 2006 this tank has dried almost every year for short periods of time (Hall, unpublished). No leopard frogs were found in 2012 in any of these areas.

DISCUSSION AND CONSERVATION RECOMENDATIONS

One of the most encouraging results of this survey was the fact that no populations of nonnative fishes or frogs (American Bullfrog) were found. Throughout the 1990's and into the 2000's both of these were major factors in the decline of the Lowland Leopard Frog in the region. Populations of Green Sunfish, which were particularly widespread and detrimental to populations of Lowland Leopard Frogs, are now gone from a number of sites with good water sources in the Catalina-Rincon Mountain complex. The prospect for timely reintroductions of Lowland Leopard Frogs at several presumably high-quality historical (extirpated) sites is therefore encouraging.

Conservation Recommendations

1. Present day occupied sites should be visited at least once a year to determine the status of the leopard frog population within each site, if close monitoring of status and occupancy are desired. Sites to be surveyed should include the following areas (excluding the areas covered by Don Swann's NPS surveys, (utm coordinates given, WGS 84):

- Romero (start: 511722/3586647 end: 513160/3585760)
- Tanque Verde Canyon (start: 531131/3568197 end: 539909/3571673)
- Youtcy Spring (545554/3578154)
- Buehman Canyon (start: 541093/3581902 end: 545696/3586998)
- Bullock Canyon (start: 542112/3583033 end: 541093/3581902)

- Edgar Canyon (start: 543743/3590333 end: 531709/3589653)
- Alder Canyon (start: 531351/ 3593223 end: 526602/3590934)
- Peck Spring (542271/3594086)
- Cienega Creek (Pima County Preserve, start: 534357/3542262 end: 539232/3540351)
- "Ridge-line" Tanks: 526124/3593262 and 526780/3593293

Significant historical sites where frog populations are apparently extirpated should also be surveyed on a yearly basis. This sites should include (utm coordinates given, WGS 84):

- Montrose Canyon (start: 509931/3587181 end: 511396/3586711)
- Sabino Canyon (start: 517788/3574720 end: 520935/3581011)
- Bear Canyon (start: 518742/3574402 end: 521551/3576678)
- Agua Caliente Canyon (start: 527065/3573435 end: 528587/3574035)

The Redington Pass area with its associated stock tanks should be considered as a region for attention also. Historical records of frogs collected from this area are numerous and this area has not been systematically surveyed.

Fall surveys, after the summer monsoon rains, would be best, so as to survey when abundances are often high, while avoiding maximum wetted conditions when frogs may be dispersed and surveys may be interrupted by flooding. Because it is unlikely that any of the public agencies have sufficient funding to accomplish this monitoring, a partnership-Citizen Science approach should be considered with Pima County leadership.

2. Understanding drivers of distribution and abundance is essential to conservation.

Distribution within each site, reproductive success, and abundance should be determined.

Abundance could be measured by a simple head (or tail) counts, egg mass counts and seasonality, and splash count. Selected sites should be visited frequently enough to identify which age / size classes may be suffering decline-causing impacts. Site conditions should be determined in terms of number of pools observed with frogs and length of the wetted reach.

Co-occurring species, especially exotics (including particularly invasive plants, such as tamarisk),

should be carefully observed and recorded. Evidence of disease should be established by a systematic sampling of swabs, and frog condition (live, dead [recent or decomposed carcass], and moribund [including notes on the nature of incapacity]) should be noted.

3. Reintroduction of frogs into suitable historic sites should be accomplished along with site surveys to ascertain the status of the frogs and environment in an “adaptive management” framework to carefully evaluate the success of reintroductions and habitat modifications, including the potential effects of non-native species such as bullfrogs and sunfish. We recommend multi-agency studies of habitat modifications with support of the Arizona Game and Fish Department and US Forest Service to evaluate the potential value of creating or modifying existing artificial water sources to support frog refugia. Sabino, Bear, Agua Caliente, Tanque Verde, Molino, Montrose, and Peppersauce canyons may be suitable sites. However, current conditions in these sites (except for Peppersauce) must be determined for prioritization, as much of our knowledge of these sites is several years old.

4. If reintroductions are to be done, numbers of frogs must be obtained and kept *Bd*-disease free prior to release into each site following established AGFD protocols. Some captive propagation may be helpful to obtain sufficient stock for large releases, which are preferable to small releases. Where to obtain stock is a concern and perhaps a metapopulation context could be used to help determine which current population stocks could be used (or combined to increase genetic variation) for a specific reintroduction site.

Figures

Figure One. Sites surveyed throughout this study, April through November 2012. Black dots indicate stock tanks, springs or drinkers, whereas heavy black lines indicate stream reaches surveyed.

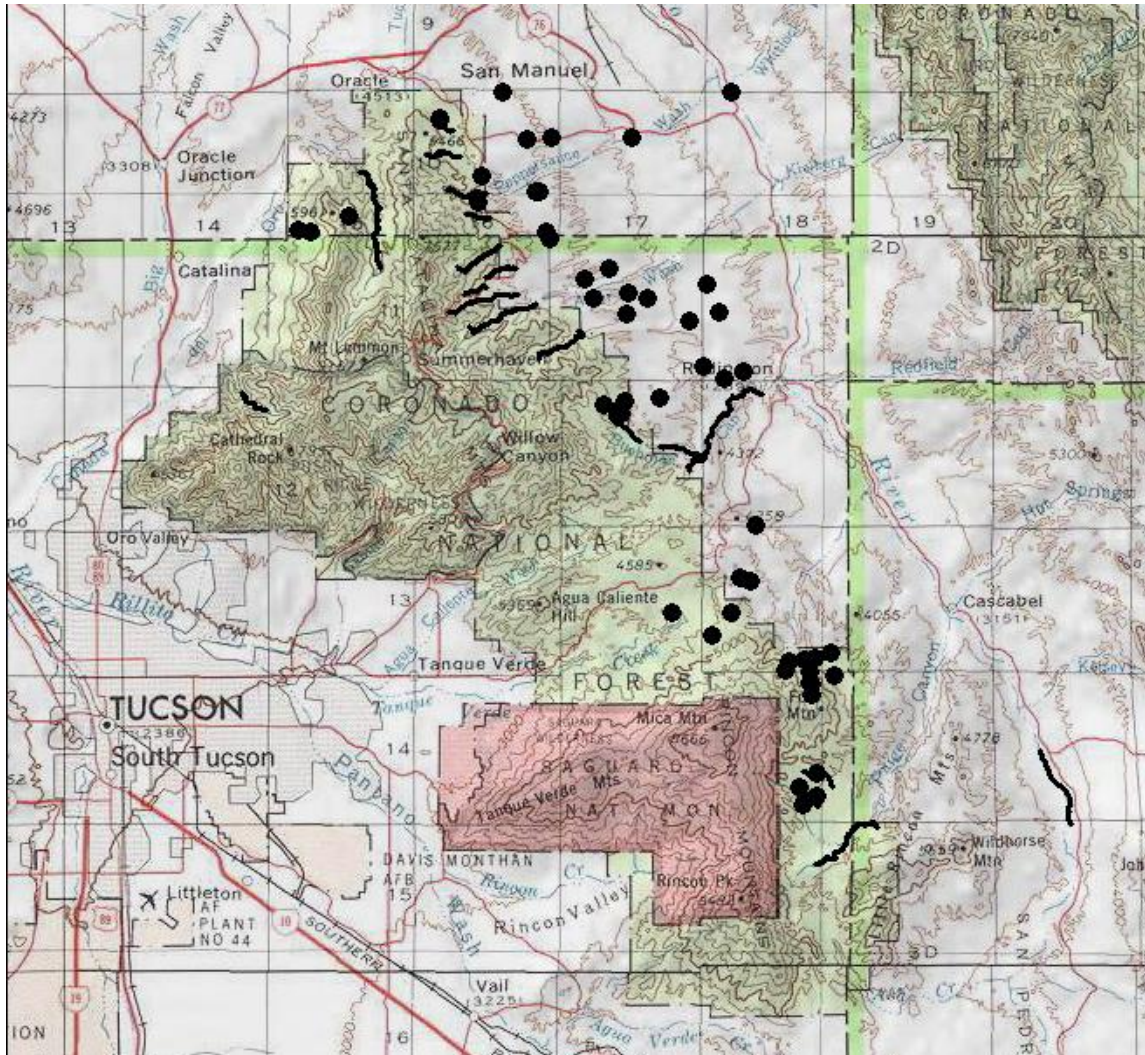


Figure Two. Sites where Lowland Leopard Frog (*Lithobates yavapaiensis*) populations were found during 2012. Red dots and lines represent tanks, springs or stream reaches in our survey. Black dots are the 2012 locations of Lowland Leopard Frog populations in Saguaro National Park (Don Swann, personal communication).

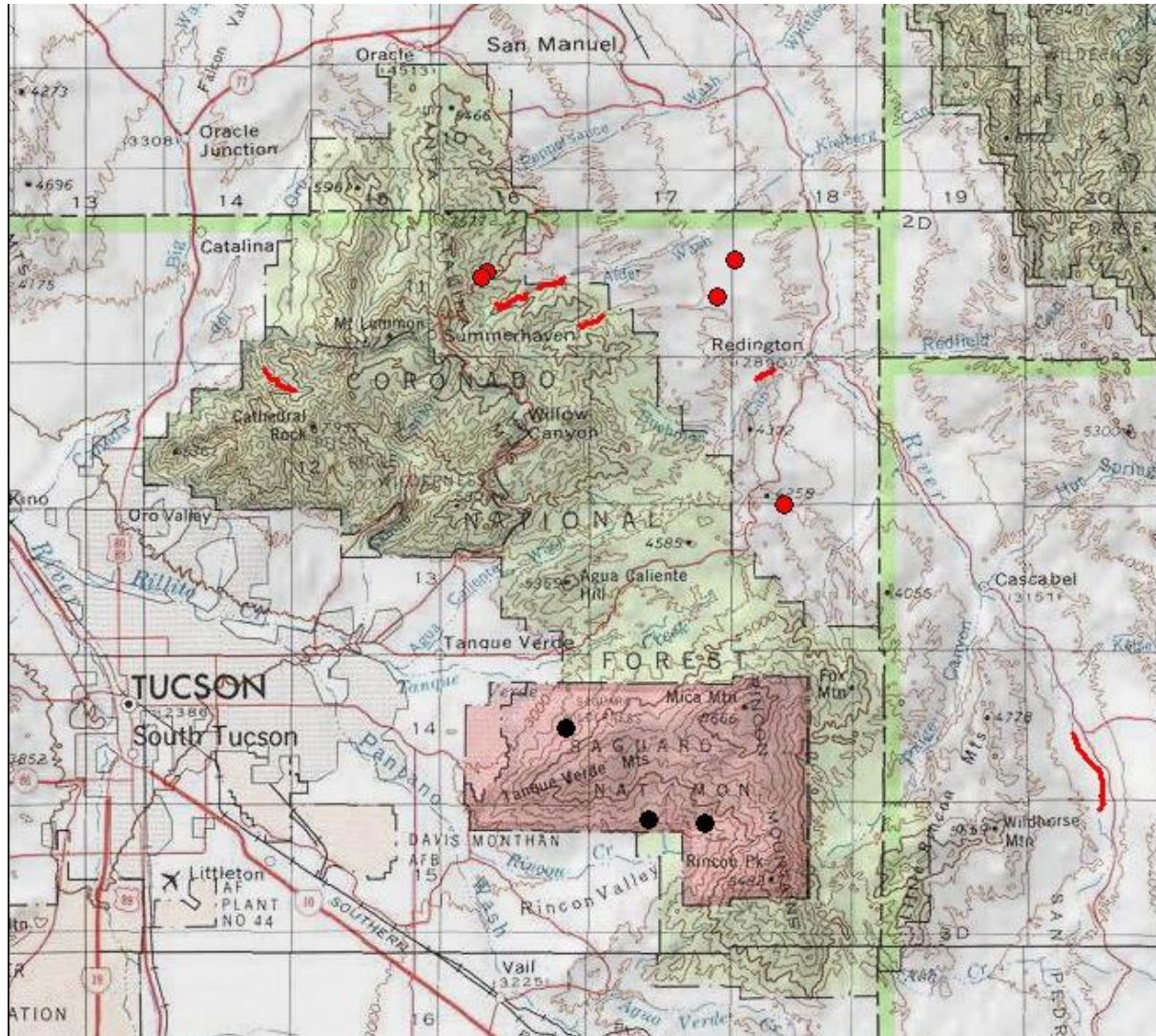


Figure Four. Localities where Lowland Leopard Frogs were found in Alder and Edgar canyons and the two "Ridge Line Tanks" near the Oracle Ridge Mine. Red lines indicate stream reaches that had frogs and black lines indicate reaches where frogs were not found. Red diamonds indicate two unnamed stock tanks near the Oracle Ridge Mine (between Geesaman and Gibb washes) that had frog populations. All sites had adults and tadpoles, and egg masses were found in both canyons.

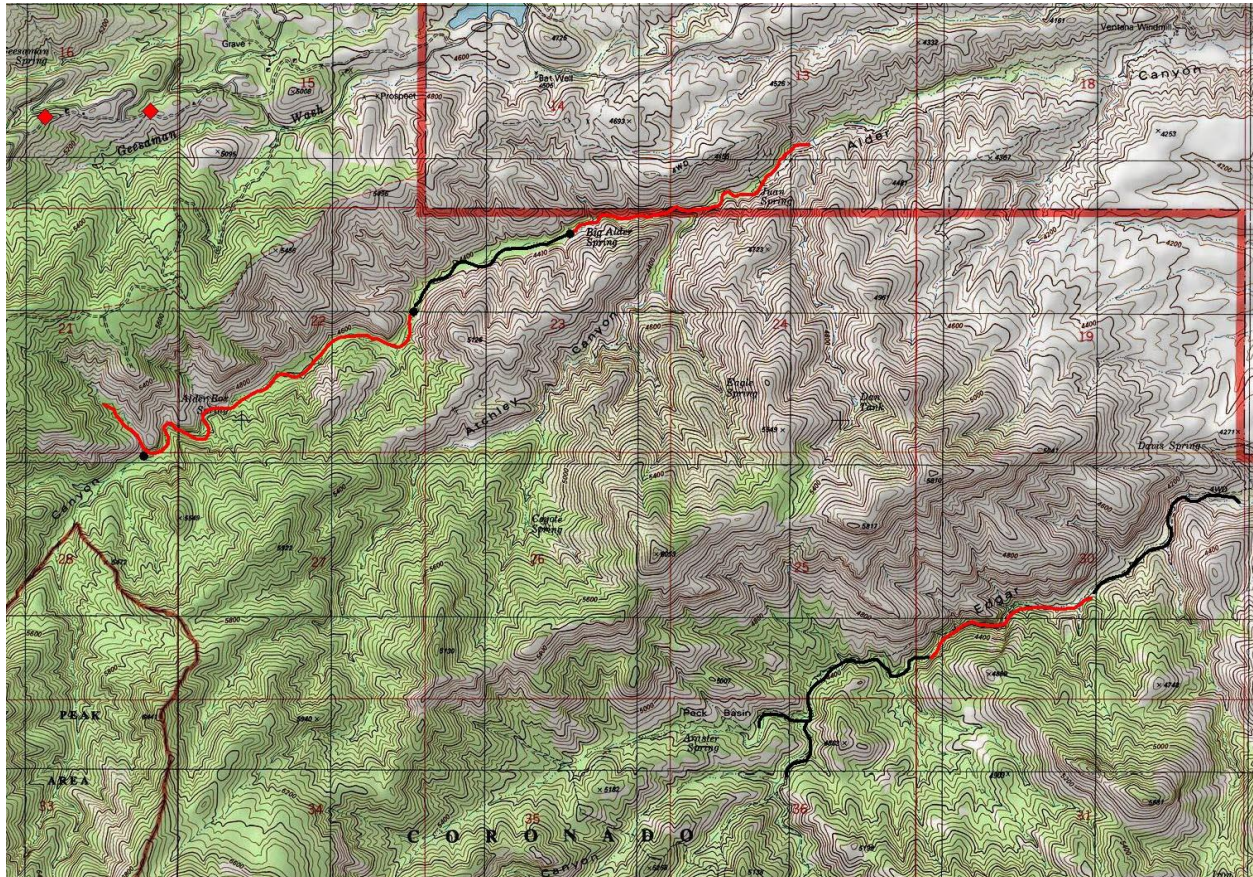


Figure Five. Buehman Canyon. Red line indicates reach with Lowland Leopard Frogs and black lines indicate where surveys did not reveal frogs. Red diamond indicates area where three small pools were found in October that contained frogs.

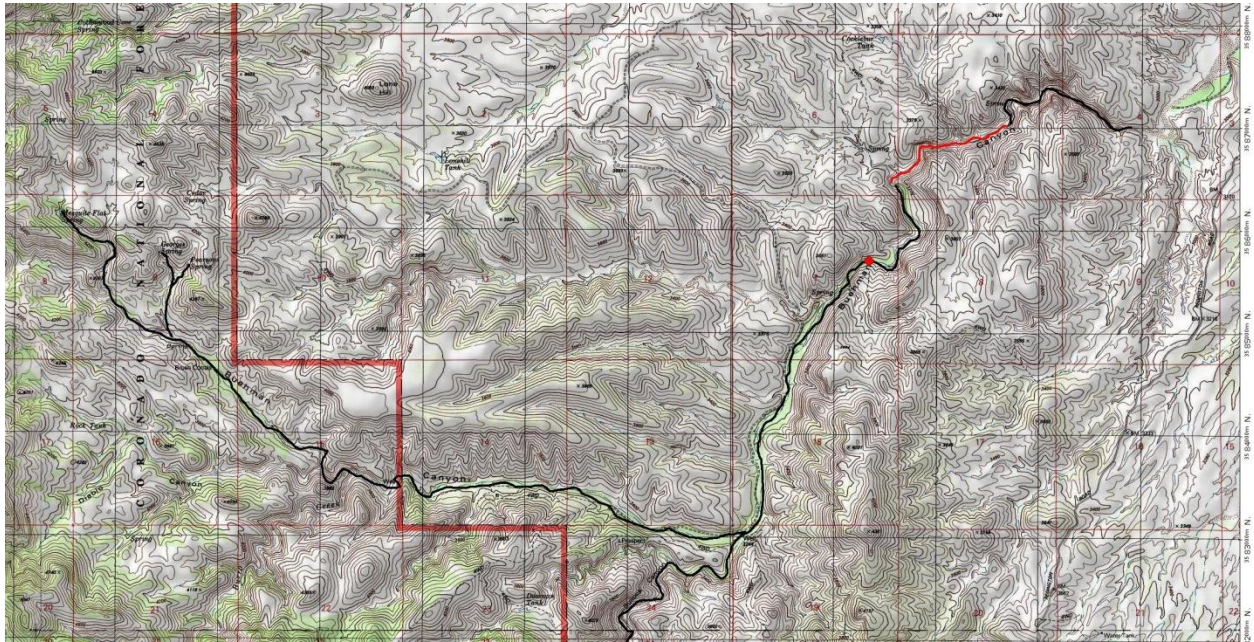


Figure Six. 6-Bar Drinker and Peck Spring (red dots). Lowland Leopard Frogs were found in both locations, with a large breeding populaton found in Peck Spring (see text for details).

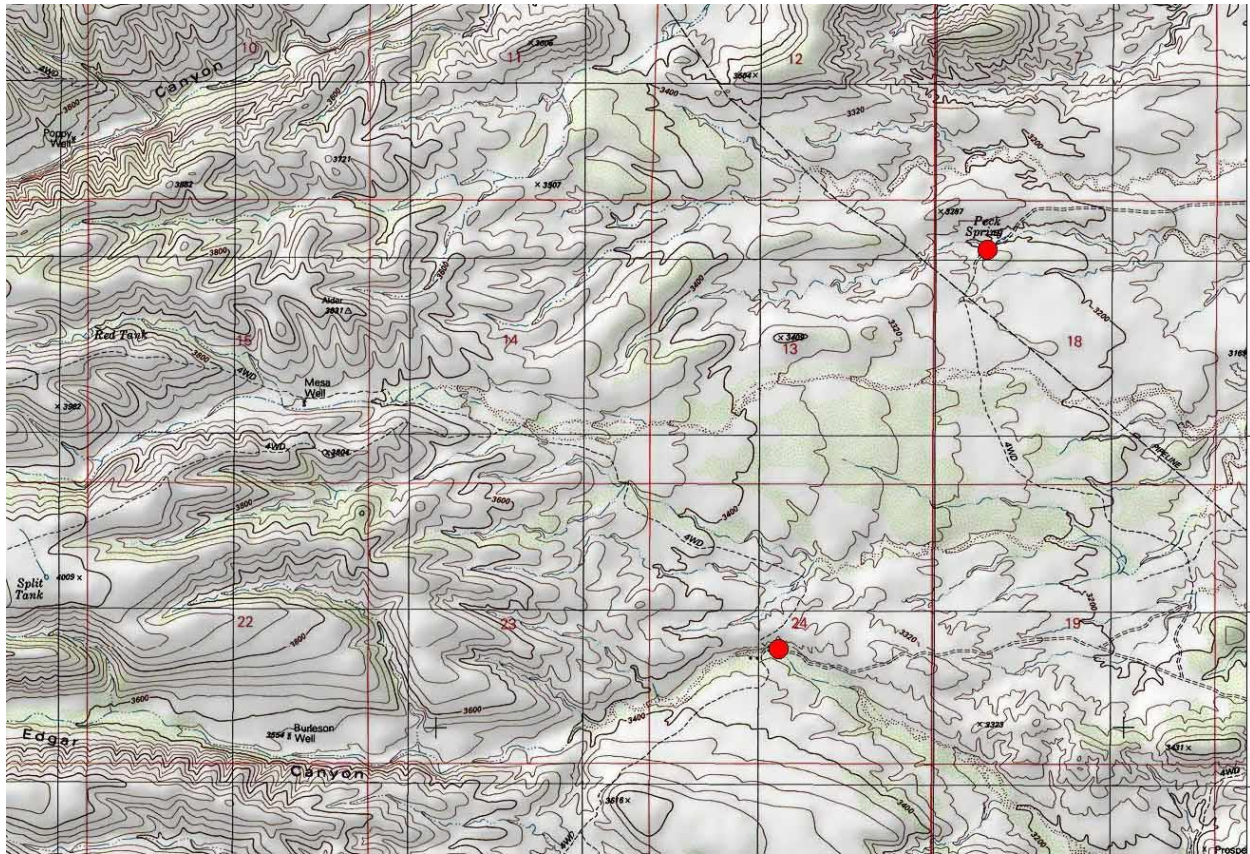


Figure Seven. Stream reach surveyed within Romero Canyon, indicated by the heavy red line. Frogs were found throughout this survey reach (see text).

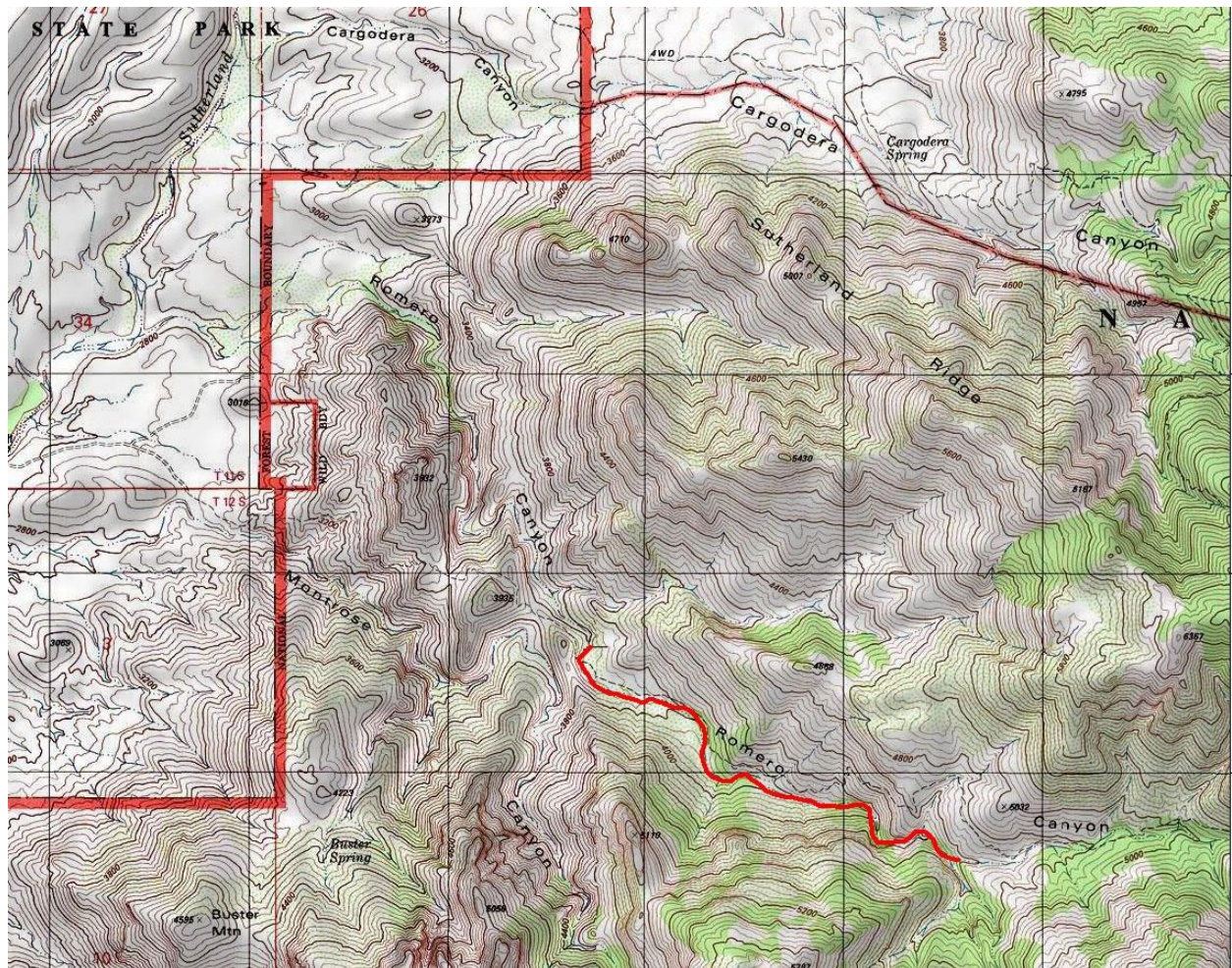
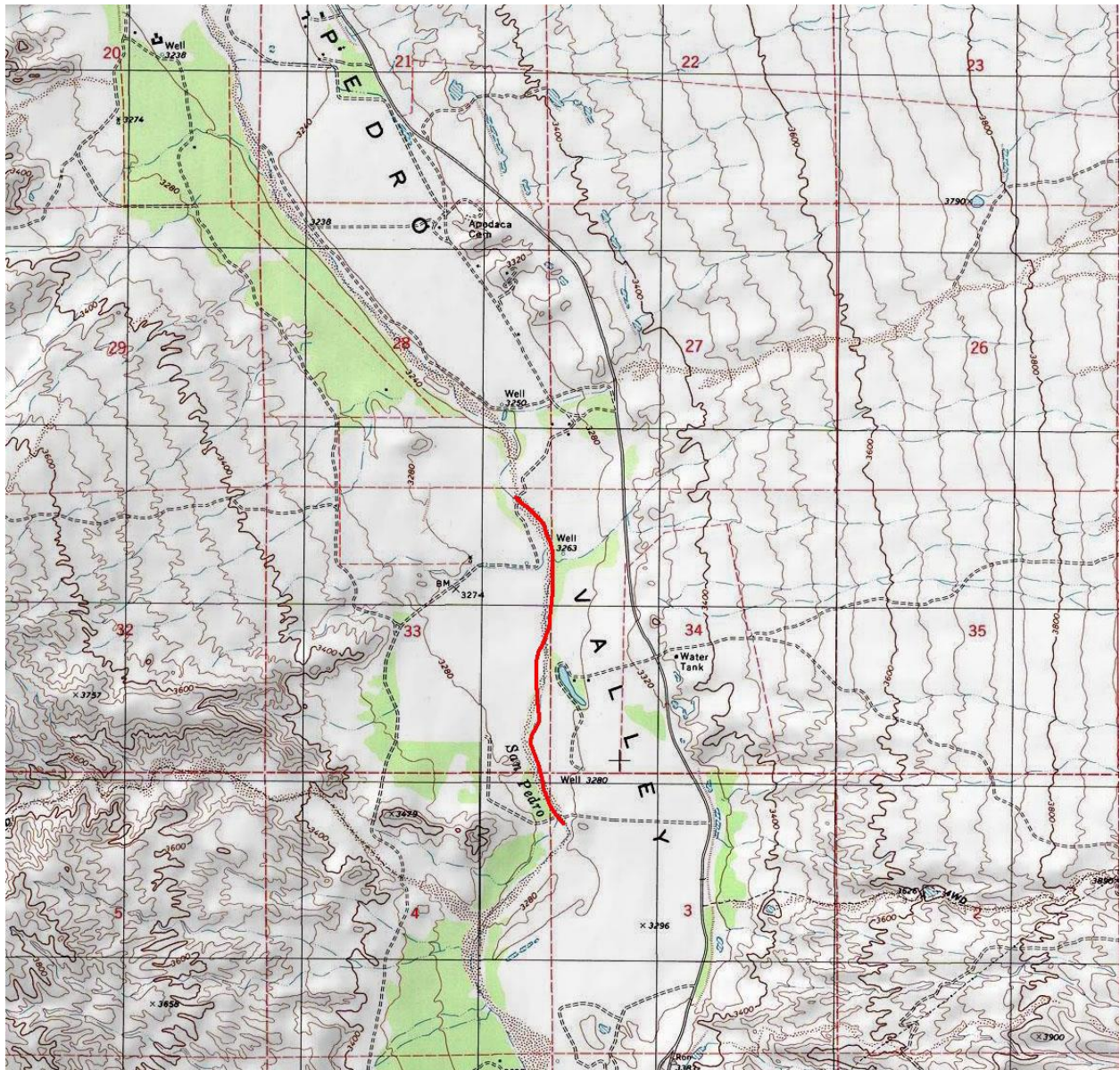


Figure Eight. Section of the San Pedro River that was surveyed. Entire survey reach was occupied by Lowland Leopard Frogs and tadpoles. The start of this reach is approximately 9 miles south of Cascabel AZ, or 14 miles North of Bensen, AZ (both distances straight-line).



[illegible]

Figure Ten. Sections of Cañada Del Oro and Peppersauce canyons that were surveyed. Black lines indicate survey reaches, whereas black dots represent springs or tanks that were surveyed. No frogs were found in these surveys (see text).

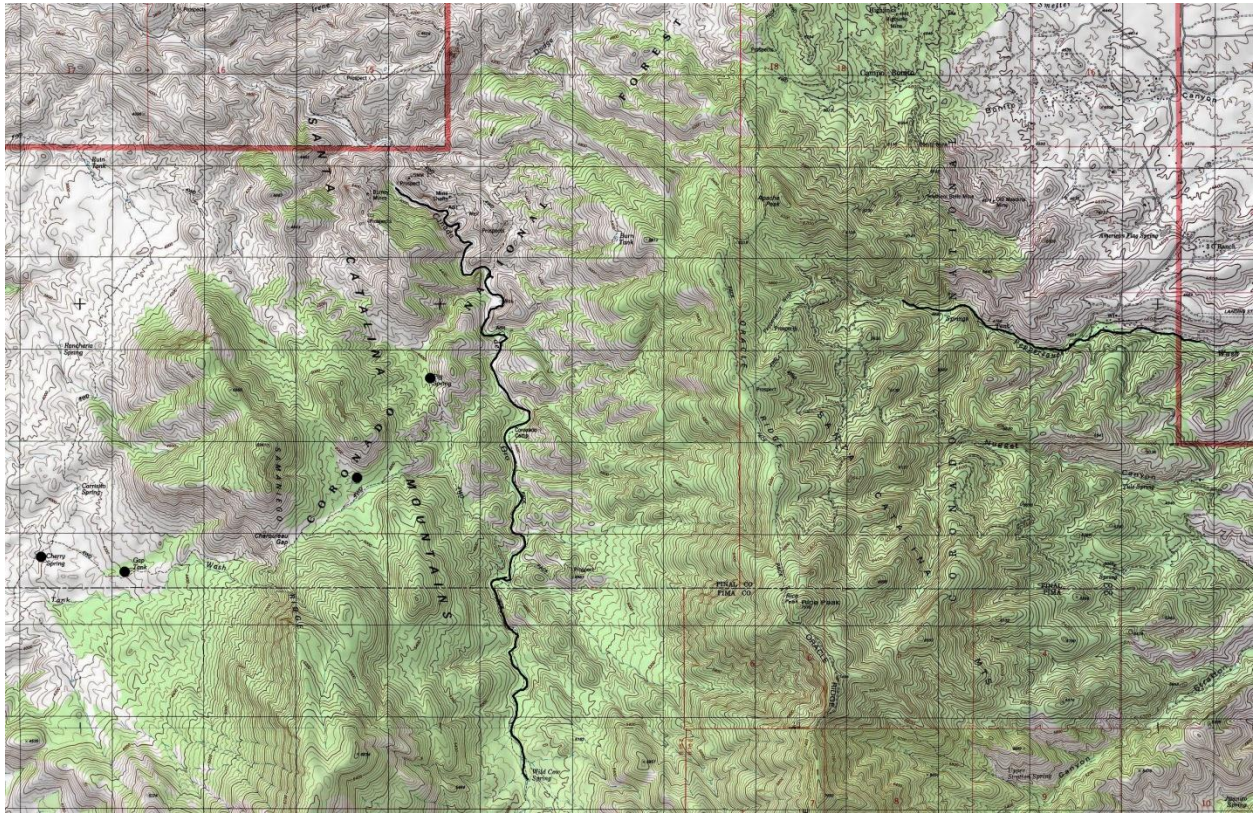


Figure Eleven. Stream reaches surveyed in Geesaman, Gibb, Juanito and Stratton Canyons. No frogs and very little water was found in any of these sites despite extensive Interior Riparian Deciduous Forests lining the stream beds in all of the canyons. Both Geesaman and Gibb canyons were totally dry in fall 2012.

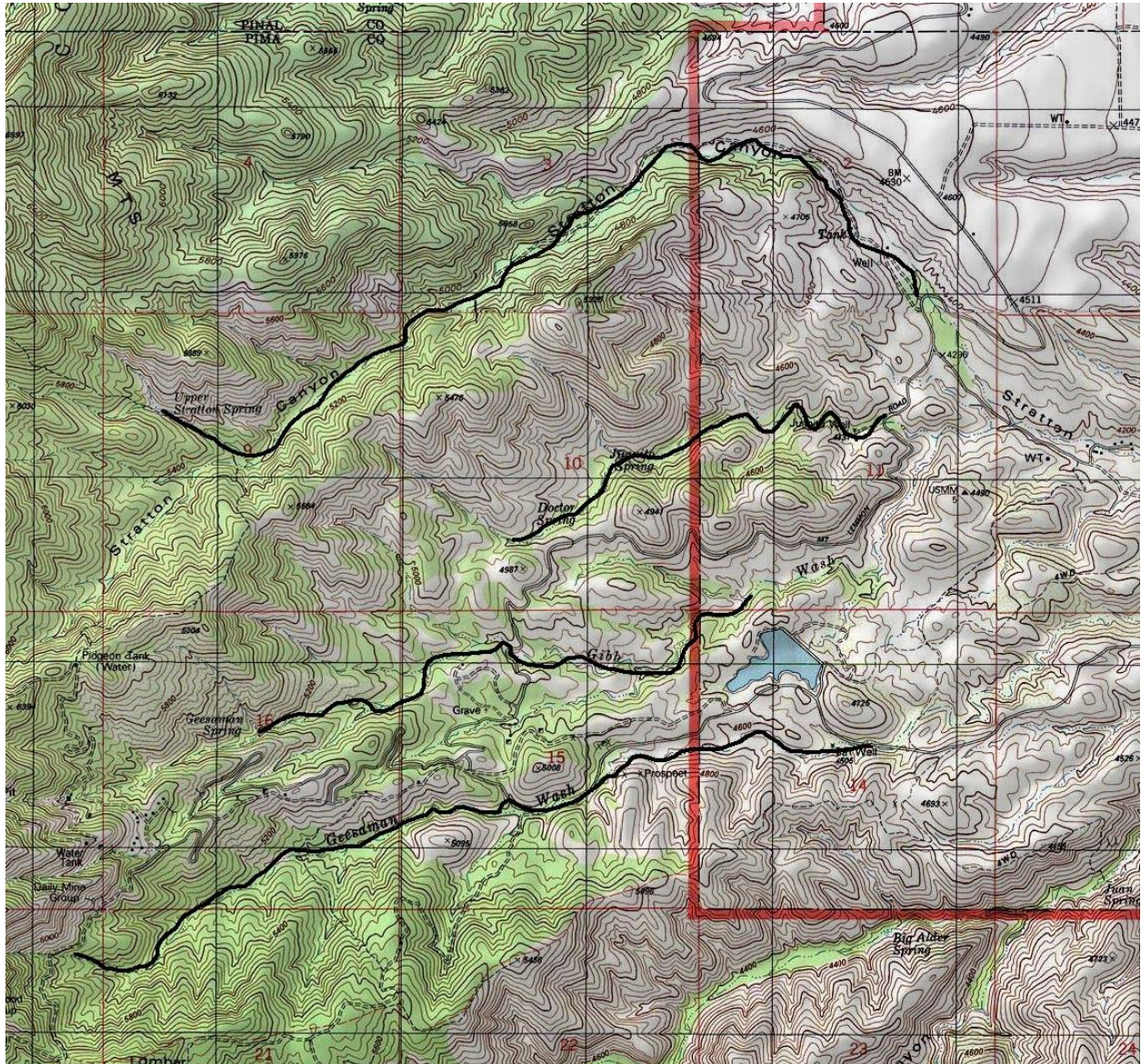


Figure Twelve. Sections of Espiritu Canyon (and surrounding areas) that were surveyed. Black lines indicate reaches that were surveyed, black dots indicate springs or tanks that were surveyed. No frogs were found during the surveys (see text).

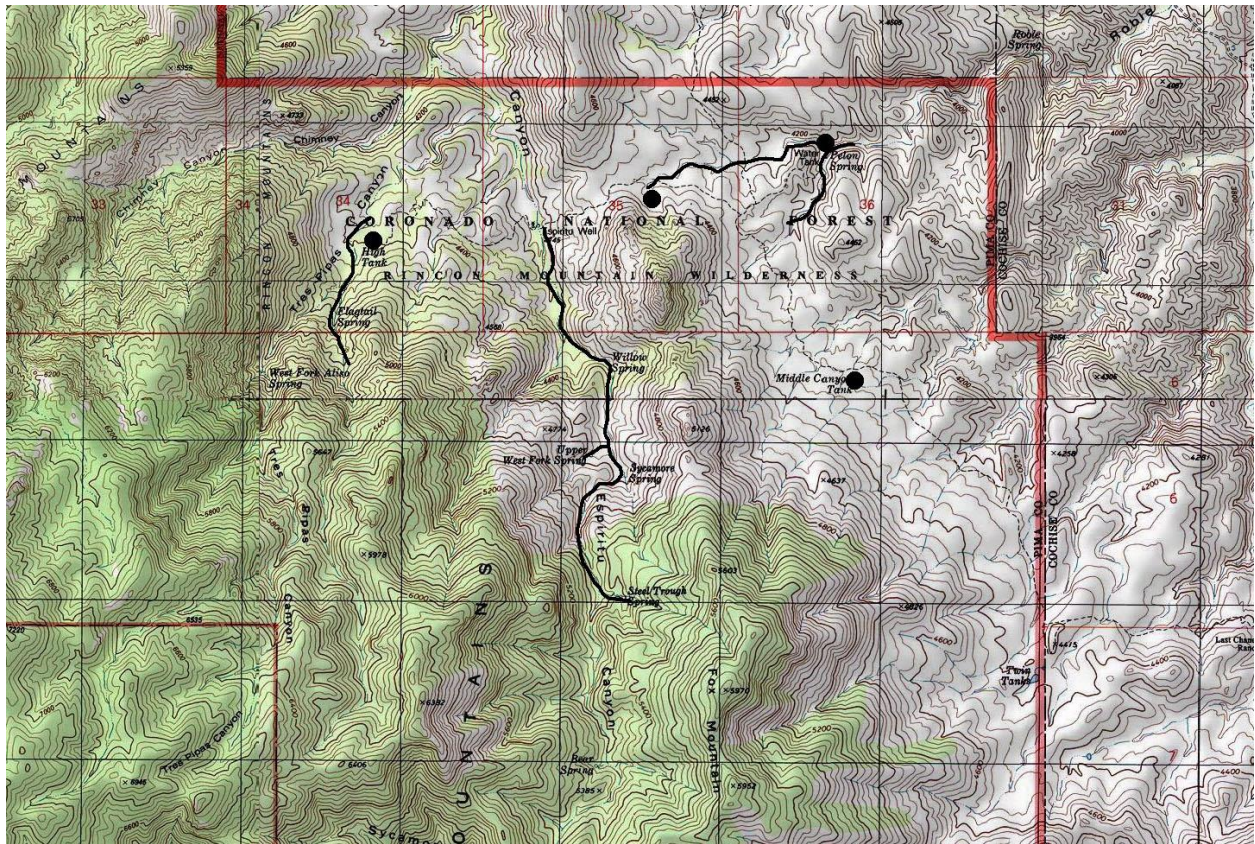


Figure Thirteen. Espiritu Canyon reach surveyed by Pima County personnel (2011-2012). Red dot represents single likely Lowland Leopard frog adult found in a tinaja at this location (UTM: 348299/3573655). See text for details.

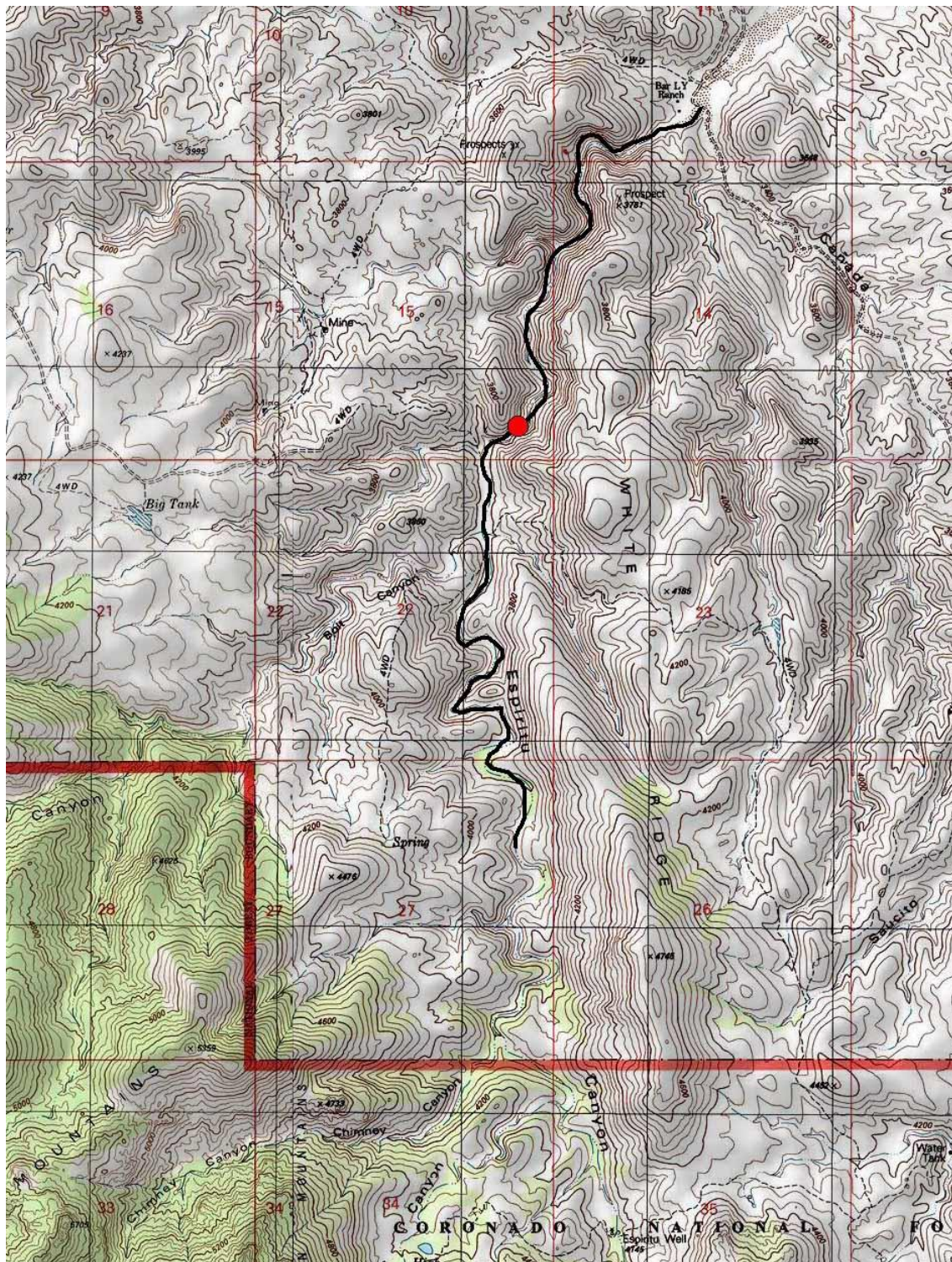


Figure Fourteen. Sections of Paige Creek (and surrounding areas) that we surveyed. Black lines indicate reaches surveyed, whereas black dots indicate springs or tanks surveyed. No frogs were found during these surveys (see text).

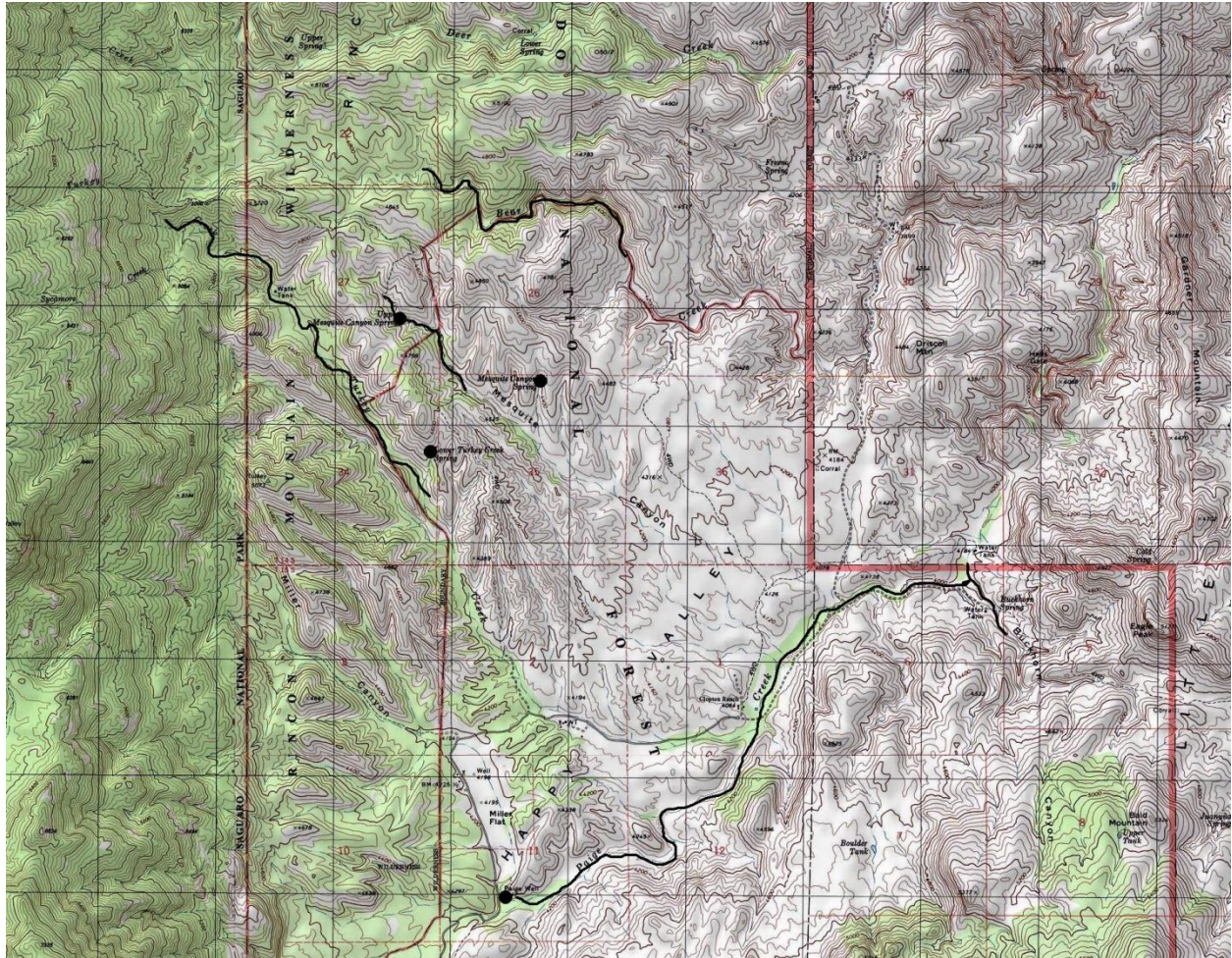


Table One. Lentic sites data.

DATE	SITE	EAST.	NORTH.	COND.	PHOTOS	START	END	LIYA PRES.	#FROG	#TADS.	AIR (°C)	RH (%)	WIND (mph)	WATER (°C)	Ph	TDS	COND. (µS)	DO (ppm)
3/27/12	unnamed tank	530359	3603742	DRY	1	1150	1150	0	0	0								
3/27/12	Twin Tank I	525359	3604343	WET	3	1340	1343	0	0	0	22.8	22.4	4-7					
3/27/12	Twin Tank 2	525359	3604343	WET	3	1343	1346	0	0	0	22.8	22.4	4-7					
3/27/12	3C Tank	527747	3601071	DRY	1	1415		0	0	0								
3/27/12	Nugget Tank	528248	359872	WET	1	1725	1728	0	0	0			0-7					
3/27/12	Kitty Tank	531897	3597147	DRY	1	1820		0	0	0								
3/27/12	Catalina Tank	531646	3597667	WET	1	1835	1840	0	0	0	21.3	21.9	0-3					
3/28/12	unnamed tank	529426	3596327	DRY	1	1045		0	0	0								
3/28/12	Fence Tank	530761	3596902	WET	1	1010	1013	0	0	0	20.7	23.5	0-7					
3/28/12	unnamed tank	529071	3594039	DRY	1	1700		0	0	0								
3/28/12	Ventana Tank	534177	3594446	WET	1	1725	1730	0	0	0	25.1	16.8	4-7	24.4	9.13	120	37.17	24.4
3/28/12	Pabasco Tank	535768	3595123	DRY	1	1745		0	0	0								
3/28/12	unnamed tank	526798	3593303	WET	1	1625	1635	0	0	0	26.8	18.2	0-3	25.4	9.4	207	29.9	25.4
3/29/12	unnamed tank	526029	3593151	WET	4	1220	1240	1	0	5	22	20	0-3	18.7	10.3	128	23.8	18.7
4/3/12	Pink Tank	544720	3588424	DRY	1	1220	1220	0	0	0								
4/3/12	Cocklebur Tank	543442	3587850	DRY	0	1300	1300	0	0	0								
4/3/12	Lonehill Tank	536895	3586355	DRY	0	1545		0	0	0								
4/25/12	6Bar drinker	541158	3591738	WET	1	1115	1130	1	2	0	25	23	0-7	21.2	8.73	127	67.3	21.2
4/26/12	Mesa Well	538408	3593187	WET	1	835	840	0	0	0	27.5	19	4-7	19	9.53	76		19
4/26/12	Red Tank	537172	3593562	DRY	0	850		0	0	0								
4/26/12	unnamed tank	534771	3593256	WET	1	905	925	0	0	0	23.6	27.4	8-10	24	9.28	65		24
4/26/12	Split Tank	536933	3592174	WET	1	740	800	0	0	0	20.1	22	4-7	20	8.5	57		20
5/7/12	unnamed tank	549562	3569546	WET	1	1115	1120	0	0	0	28	12.4	4-7	24.1	7.7	182	370	24.1
5/7/12	High Tank	547810	3569286	DRY	0	1300	1300	0	0	0								
5/8/12	Pelon Spring	550649	3569863	WET	1	805		0	0	0								
5/8/12	Middle Canyon Tank	550835	3568380	DRY	0	910		0	0	0								
5/8/12	Sycamore Spring	549395	3567814	WET	1	1045		0	0	0								
5/8/12	Upper West Fork Spring	549194	3567927	WET	0	1110		0	0	0								
5/8/12	Willow Spring	549289	3568513	WET	0	1120		0	0	0								
6/27/12	Paige Tank	549491	3555966	DRY	0	835		0	0	0								
6/27/12	Lower Turkey Ck. spring	548815	3559755	DRY	0	900		0	0	0								
6/27/12	Upper Mesquite spring	548553	3560903	DRY	1	945		0	0	0	30	29.3	0-3					
6/27/12	unnamed spring	549664	3561831	WET	1	1040	1100	0	0	0	35.1	27.7	0-3	26	7.6		307	26
6/27/12	Mesquite Cyn Spring	549726	3560380	DRY	0	1215		0	0	0								
10/11/12	Peck Spring	542277	3594086	WET	4	0930	1045	1	100+	0	24.0	40	0-10	18	8.3	357	453	
09/19/12	Ridgeline #1	526124	3593262	WET	0	1605	1625	1	24	2	25.0	18.0	4-7	25.0	9.7			
09/19/12	Ridgeline #2	526780	3593293	WET	1	1530	1600	1	16	0	32.2	19.7	0-7	26	8.7			

Table headings: **EAST.** = UTM easting coordinate, WGS 84, **NORTH.** = UTM northing coordinate WGS 84, **COND.** = whether site was wetted or not, **PHOTOS** = number of site photographs taken, **START** = survey start time, **END** = survey end time, **LIYA PRES.** = whether Lowland Leopard frogs were present, **#FROG** = numbers of frogs observed, **#TADS.** = number of tadpoles observed or dip netted, **AIR (°C)** = air temperature at 1.5 m start of survey, **RH** = relative humidity at start of survey, **WIND** = wind speed, **WATER (°C)** = water temperature 5mm depth, **Ph** = water acidity, **TDS** = total dissolved solids, **COND.** = water conductivity, **DO** = water dissolved oxygen content.

Table Two. Lotic sites data.

DATE	SITE	EAST.	NORTH.	TYPE	PHOTOS	START	END	PRES.	#FROG	#TADS.	AIR (°C)	RH (%)	WIND (mph)	WATER (°C)	Ph	TDS	COND. (µS)	DO (ppm)
03/27/12	Campo Bonito Creek	525070	3602846	EPHEM	3	1250	1310	0	0	0	24	0-3	0					
03/27/12	Peppersauce Cyn (up)	525065	3600422	INTER	1	1510	1550	0	0	0			0					
03/27/12	Peppersauce Cyn (Low)	526813	3600298	PEREN	1	1510	1555	0	0	0	19.2	0-3	0	17.6	7.5	248		7.77
03/27/12	American Flag Spring	527393	3601342	PEREN	2	1400	1405	0	0	0	19.2	0-3	0					
03/27/12	Nugget Canyon	527611	3598581	INTER	1	1720	1755	0	0	0			0					
03/28/12	Stratton Canyon (low)	529844	3595996	EPHEM	1	1020	1145	0	0	0			0					
03/28/12	Stratton Canyon (up)	527380	3595969	INTER	2	1145	1315	0	0	0	20.5	0-3	0	22	7.8	168		
03/29/12	Juanito Creek	527556	3594668	INTER	5	935	1050	0	0	0	21.5	0-3	0					
04/03/12	Middle Buehman Cyn	542606	3584788	INTER	4	1410	1505	0	0	0	16.8	0-3	0					
04/04/12	Lower Buehman Cyn	545964	3586986	PEREN	3	1445	1610	1	1	0	15	0-3	1	18	8.4	214		
04/04/12	Upper Buehman Cyn	538718	3583507	EPHEM	2	1000	1240	0	0	0			0					
04/04/12	Cedar Spring	536895	3586355	EPHEM	0	1315	1315	0	0	0			0					
04/04/12	Mesquite Flat Spring	535480	3586150	EPHEM	0	1040	1040	0	0	0			0					
04/04/12	Brush Corral Spring	536722	3584854	EPHEM	0	1010	1010	0	0	0			0					
04/04/12	Georges Spring	536409	3585799	EPHEM	0	1035	1035	0	0	0			0					
04/04/12	Finley Spring	534709	3586369	EPHEM	0	1240	1240	0	0	0			0					
04/20/12	Novio Spring/Falls	526288	3587886	INTER	2	1200	1240	0	0	0	25	0-3	0	10.1	8.1	50		5.39
04/25/12	Davis Spring	533706	3591139	PEREN	3	1300	1320	0	0	0			0					
04/25/12	Upper Edgar Cyn	533943	3590853	INTER	3	1325	1530	1	0	1000+	15.9	0-3	1	20.4	7.4	128		
05/07/12	Tres Pipas Canyon	547793	3569397	INTER	2	1320	1425	0	0	0	15	0-10	0					
05/07/12	Espiritu Canyon	548827	3569360	INTER	1	1545	1615	0	0	0	13	0-3	0	28.2	7.7	282		
09/18/12	Youtcy Spring	545554	3578154	PEREN	1	1215	1330	1	27	0			1	26.5	10		337	
09/19/12	Buehman Cyn	545782	3587015	INTER	2	830	1230	1	65	10	24	0-3	1	20.3	7.1		550	
09/19/12	Gibb Wash, Gees. Sp.	525338	3593292	EPHEM	0	1605	1730	0	0	0			0					
09/20/12	Alder Canyon	529622	3592548	INTER	3	900	1345	1	55	egg mass	22	0-3	1	19	7.5	103		
10/09/12	Beuhman Cyn	542150	3583033	INTER	0	1730	2000	1	100's	100's	24	0-3	1	18	7.7	259	453	
10/10/12	Davis Spring	533732	3591128	INTER	1	1250	1300	0	0	0			0					
10/10/12	Edgar Cyn	533945	3590902	INTER	4	1300	1630	1	60	20	27	0-7	1	21	7.9	195		
10/11/12	Peppersauce cyn	526810	3600291	INTER	0	1815	1840	0	0	0	29	0-3	0	20	7.6	279		
10/16/12	Youtcy Spring	545554	3578154	PEREN	0	1900	1945	1	30	0	30	1-3	1	23	9.7		350	
10/17/12	Beuhman Cyn	544473	3586929	PEREN	4	1030	1430	1	1000's	100's	28	0-3	1	16.6	7.5	241	482	
10/17/12	Alder Canyon	529617	3592562	INTER	0	1700	2130	1	60	0	8.5	0-3	1	15.1	8.5	278	555	
10/22/12	Canada Del Oro	520170	3597464	INTER	2	1600	1945	0	0	0	28	0-3	0	15.2	7.8	185	296	
10/23/12	Canada Del Oro	520170	3597466	INTER	4	1000	1400	0	0	0	43	0-7	0	16.2	8.1	151	303	
10/30/12	Romero Cyn	511645	3586751	PEREN	2	950	1305	1	44	6	20	0-3	1	15.7	8.5	43	88	

Table headings: **EAST.** = UTM easting coordinate, WGS 84, **NORTH.** = UTM northing coordinate WGS 84, **TYPE.** = whether site was ephemeral (**EPHEM**), intermittent (**INTER**), or perennial (**PEREN**), **PHOTOS** = number of site photographs taken, **START** = survey start time, **END** = survey end time, **LIYA PRES.** = whether Lowland Leopard frogs were present, **#FROG** = numbers of frogs observed, **#TADS.** = number of tadpoles observed or dip netted, **AIR (°C)** = air temperature at 1.5 m start of survey, **RH** = relative humidity at start of survey, **WIND** = wind speed, **WATER (°C)** = water temperature 5mm depth, **Ph** = water acidity, **TDS** = total dissolved solids, **COND.** = water conductivity, **DO** = water dissolved oxygen content.

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Acknowledgements

Thanks to Don Carter, Brian Powell, Phillip Rosen, Don Swann and Eric Wallace and for helping to organize the surveys. Special thanks to Brian Powell, Phillip Rosen and Don Swann for editing this manuscript and providing his expertise to the project. Thanks to Adam Barkalow, Lee Borzick and Brian Powell for help in doing surveys and to Brian Powell and Don Swann for sharing their survey data.

Appendix I. Site Photographs.

Photograph 1. Alder Canyon pool near Alder Box Spring. Lowland Leopard Frog adults, tadpoles and a single egg mass were found in this fairly typical pool in the upper section of this canyon. Note that the riparian canopy in this section is not as well developed as in the lower section of the canyon (see text).



Photograph 2. Typical Lowland Leopard Frog from Alder Canyon.



Photograph 3. Alder Canyon just below Big Alder Spring. Adult Lowland Leopard Frogs were found throughout this area.



Photograph 4. Buehman Canyon. Beginning of spring reach where thousands of leopard frogs were observed, at approximately 3100 ft elevation. Green vegetation in photograph consists of ferns that cover the seep emerging from the canyon side at this point.



Photograph 5. The canyon of Cañada del Oro below Coronado Camp. Typical canyon reach.



Photograph 6. Wild Cow Spring in Cañada del Oro.



Photograph 7. Edgar Canyon Pool. at approximately 4100 ft elevation. Adult Lowland Leopard Frogs and tadpoles were common in this pool.



Photograph 8. Edgar Canyon pool. Note small seep on cliff face. Adult Lowland Leopard frogs occupied this pool.



Photograph 9. Peck Spring drinker; in background is Peck Canyon channel (dry).



Photograph 10. Second drinker at Peck Spring.



Photograph 11. Adult male Lowland Leopard Frog from Peck Spring.



Photograph 12. Perennial reach within Peppersauce Canyon at Sycamore Academy. This location is near the spring head. The vines covering the stream sides is near 100% nonnative *Vinca sp.*



Photograph 13. San Pedro River (with beaver dam in background); adult Lowland Leopard Frogs and tadpoles were found here.



Photograph 14. Six-Bar Drinker, Edgar Canyon. Adult Lowland Leopard Frogs occupied this small site.



Photograph 15. "Ridgeline Tank No. 1". Adult Lowland Leopard Frogs and tadpoles were abundant at this site.



Photograph 16. "Ridgeline Tank No. 2". Adult Lowland Leopard frogs were found here in the fall when it was much larger than shown in this springtime photo.



Photograph 17. Lowland Leopard Frog tadpoles from "Ridgeline Tank No. 1", spring 2012.



Appendix II. Data sheets used in surveys, templates (see below).

<u>LENTIC</u> SITE SURVEY FORM		DATE:		SITE NAME:	
LOCATION:		EASTING:			NORTHING:
PERSONEL:		TYPE (circle one): stock tank drinker storage tank other:			
photos: yes no	# photos:	Ta 1.5m:	RH:		WS (mph): 0-3 4-7 8-10 11-15 >16
CLOUD COVER (circle one): 0-20% 21-40% 41-60% 61-80% 81-100%					Precip: none light steady heavy
Tw 5cm:	Ph:	TDS (ppm):	Tw @ O ² :		DO:
SURVEY START TIME:		SURVEY END TIME:			SEARCH TIME:
SURVEY NOTES: _____					

**SPECIES
OBSERVED (use back of sheet if necessary)**

SPECIES	LIFE STAGE	# Obs.	NOTES

<u>LOTIC</u> SITE SURVEY FORM		DATE:		SITE NAME:	
LOCATION:		START EASTING:			START NORTHING:
SURVEY START TIME:		SURVEY END TIME:			PERENNIAL INTERMITTANT EPHEMERAL
ENDING EASTING:		ENDING NORTHING:			TOTAL SURVEY TIME:
PERSONEL:		TYPE (circle one): spring run stream tinajas other:			
photos: yes no	# photos:	Ta 1.5m:	RH:		WS (mph): 0-3 4-7 8-10 11-15 >16
CLOUD COVER (circle one): 0-20% 21-40% 41-60% 61-80% 81-100%					Precip: none light steady heavy
Tw 5cm:	Ph:	TDS (ppm):		Tw @ O ² :	DO:
SURVEY NOTES: _____					

SPECIES OBSERVED (use back of form if needed)

SPECIES	LIFE STAGE	# Obs.	NOTES