



Habitat Assessment and Surveys for the Arroyo Toad (*Bufo californicus*) in Cuyamaca Rancho State Park, 2002



Prepared for:

California State Parks

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
WESTERN ECOLOGICAL RESEARCH CENTER

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INTRODUCTION

In 1994, the arroyo toad (*Bufo californicus*) was listed as endangered by the U. S. Fish and Wildlife Service (hereafter USFWS) (Federal Register, 59 FR 241:64859-64866). The arroyo toad is considered to have the most specialized habitat requirements of any amphibian found in California (Jennings and Hayes, 1994). The arroyo toad is a terrestrial amphibian that occupies habitats with sandy or other friable soil types in relative close proximity to their aquatic breeding sites. Following adequate seasonal rainfall in late winter and/or early spring (March-May) they migrate from upland habitats down to quiet pools that form along low gradient drainages to breed. In 1999, adult arroyo toads were observed foraging along the Sweetwater River at the southwest border of Cuyamaca Rancho State Park. At that time, the extent of suitable habitat and the distribution of the arroyo toad within the park were unknown.

In 2002, California State Parks contracted with the U. S. Geological Survey - Biological Resource Discipline (USGS), to determine the potential for additional populations of the arroyo toad within the park and conduct surveys to identify occupied habitats.

For this study, our objectives were to: 1) select drainages that would likely contain suitable arroyo toad habitat by examining USGS topographic 7.5 minute maps, 2) survey (ground truth) the selected drainages, identify the areas of suitable arroyo toad habitat, and rate them in terms of habitat quality (e.g., *high quality*, *good quality*, *marginal quality*, or *poor quality* (see Methods for definitions of habitat rating terms)), 3) conduct nocturnal follow up presence (visual encounter) surveys for arroyo toads only at sites deemed *high quality* or *good quality* in search of calling males, egg strings, and larva as well as searching upland habitats for foraging juveniles and adults, and 4) record all non-native species observed during both daytime habitat assessment and presence/absence surveys.

STUDY SITE DESCRIPTION

Cuyamaca Rancho State Park is located in the Peninsular Ranges in San Diego County, California. The park currently consists of 9988 hectares (24,681 acres) and has an elevation range extending from 1055 m (3465 ft.) to 1985 m (6512 ft.). The creeks and river within the study site range from 1st to 3rd order drainages with the Sweetwater River as the main drainage. Collectively these drainages form a dendric pattern (resembling a branching tree) and compose the headwaters of the Sweetwater River watershed. Major plant communities include, conifer forests, chaparral, grasslands, oak woodlands, and willow riparian.

METHODS

The most efficient and effective way to determine arroyo toad presence is to survey potentially suitable breeding habitat during the breeding season. Therefore, to meet our

objectives we first examined topographic maps to make initial site selections of riparian corridors.

Daytime habitat assessment surveys

Seven of the parks largest riparian corridors (drainages) in the Sweetwater River watershed were surveyed during daylight hours (Table 1; Figure 1). Surveys consisted of hiking up riparian corridors and looking for habitat features known to be associated with suitable arroyo toad habitat (i.e., low gradient drainages, predominantly sandy substrate, adjacent banks and terraces composed of friable soil types). The physical habitat features used to characterize riparian habitats in terms of quality for arroyo toads included, 1) any given drainage, or portion thereof, with a gradient of (degree of slope) $\leq 2\%$, 2-3%, or $> 3\%$, 2) the channel substrate type being predominately composed of depositional sand and the presence of sandy banks, 3) the presence of flat sandy terraces immediately adjacent to channel, and 4) the degree of channel braiding. In combination, the occurrence of a low gradient reach ($\leq 2.0\%$) with a sandy depositional substrate result in conditions conducive to the formation of seasonal quiet backwater breeding pools (Sweet, 1992; Campbell et al., 1996). Assessments were based on physical features and channel morphology, and not necessarily on the presence of surface water (seasonal breeding pools). The following four habitat quality types are based on various conditions and combinations of upland (terrestrial) and stream channel (potential aquatic breeding pools) characteristics.

High Quality: Portion of drainage of low gradient ($\leq 2\%$), with predominantly sandy substrate and banks, adjacent terraces with friable soils, and often having a watercourse of braided channels.

Good Quality: Portion of drainage of relatively low gradient (2-3%) and having only one of the following characteristics; predominantly sandy substrate and banks, adjacent sandy terraces, and a watercourse of braided channels.

Marginal: Portion of drainage of relatively low gradient (2-3%) and lacking all three of the following characteristics; predominantly sandy substrate and banks, adjacent sandy terraces, and a watercourse of braided channels.

Poor: Portion of drainage with a gradient of $> 3\%$, and lacking all three of the following characteristics; predominantly sandy substrate and banks, adjacent sandy terraces.

Six 2nd-order streams were surveyed and included Stonewall Creek, Harper Creek, Japacha Creek, Juaquapin Creek, Descanso Creek, and Cold Stream (Figure 1). A 3rd-order river, the Sweetwater River, was also surveyed; habitat assessment surveys along this river were divided into three segments, including:

- Lower Sweetwater River – Hulburd Grove upstream to Green Valley Campground (Figure 1).

- Middle Sweetwater River – from Green Valley Campground upstream to State Park headquarters (Figure 1).
- Upper Sweetwater River – from the State Park Headquarters to the headwaters (Figure1).

Nocturnal presence surveys

Since no areas qualified as *good quality* arroyo toad habitat during the daytime assessment phase, follow-up nocturnal presence surveys were only conducted in reaches identified as *high quality* arroyo toad habitat (Table 2; Figure 2). Biologists experienced and familiar with the life history and ecology of the arroyo toad conducted all nocturnal presence surveys. Such experience included the ability to discern between the eggs and the larvae of the western toad (*Bufo boreas*) and the arroyo toad as well as the identification of the male arroyo toad advertisement call.

Nocturnal presence/absence surveys entailed walking along drainages in search of any of the various life history stages (i.e., calling males, egg strings, larvae, metamorphic individuals, and foraging juveniles and adults in upland habitats) using multiple cues (direct observation and calling males). Headlamps with 45,000-candle power were used to provide the required amount of illumination to maximize detection. Age-class, length (SUL = snout-urostyle length), and GPS coordinates were recorded for each arroyo toad observation. We followed a modified version of the USFWS arroyo toad survey guidelines (USFWS, 1999).

As a result of colder than normal winter temperatures and lower than normal rainfall during rain year 2001/2002 (July 1-June 30), we surveyed on nights that were less than optimal for detecting surface active adult arroyo toads. Nocturnal presence/absence surveys were delayed until April because of the absence of measurable precipitation and warmer nighttime temperatures. The USFWS arroyo toad survey guidelines recommends commencing nighttime surveys 60 minutes after sunset on nights with an ambient temperature of 15⁰ C (at sundown) in absence of wind, hard rains, and a full moon (USFWS, 1999b). Modifications made to the USFWS guidelines for our nocturnal presence surveys included commencing surveys at approximately 30 minutes after sunset (to take advantage of the darkness but prior to lower air temperatures) and on nights with an ambient air temperature as low as 14⁰ C at sunset, because of the extended unseasonable cold weather trend. No nocturnal presence surveys were conducted within four days of a full moon.

RESULTS

Because the arroyo toad is restricted to breeding in lotic habitats, with a range of hydroperiods (i.e., perennial, semi-permanent, seasonal, ephemeral), habitat assessment surveys were conducted along riparian corridors (Sweet, 1992; Campbell et al., 1996; USFWS, 1999), irrespective of the presence of surface water. In total, 34.5 km (21 mi.) of

riparian habitat was assessed for arroyo toad habitat quality. Only a relatively small amount of the habitat surveyed qualified for high quality habitat and was distributed as four discrete patches along the Sweetwater River (Figure 2). These 4 sites included: Upper Sweetwater River, South Boundary Fire Road crossing, Saddleback Trail crossing, and Park Boundary at Hulburd Grove.

- Site 1 (Upper Sweetwater River) – located within a portion of the Upper Sweetwater River and Middle Sweetwater River habitat assessment survey reach; ~ 3.2 km (1.99 mi.) in length.
- Site 2 (South Boundary Fire Road crossing) – located within the Lower Sweetwater River habitat assessment survey reach; ~ 490 m (1608 ft.) in length.
- Site 3 (Saddleback Trail crossing) - located within the Lower Sweetwater River habitat assessment survey reach; ~ 480 m (1575 ft.) in length.
- Site 4 (Park Boundary at Hulburd Grove) - located within the Lower Sweetwater River habitat assessment survey reach; ~ 280 m (919 ft.) in length.

No habitats surveyed qualified as *good quality*. The remaining stretches of the Sweetwater River not identified as *high quality* qualified as mostly *marginal quality* arroyo toad habitat (Figure 2). The other six drainages in the study (Stonewall Creek, Harper Creek, Japacha Creek, Juaquapin Creek, Descanso Creek, and Cold Stream) qualified as *poor* arroyo toad habitat (Table 1; Figure 2).

Daytime habitat assessment surveys

During our assessment surveys, we found that the majority of the drainages were dry by mid-June. Surface water was found, albeit discontinuous, in Harper Creek, Japacha Creek, Juaquapin Creek, and Descanso Creeks and along Sweetwater River from the park headquarters south to the park boundary at Hulburd Grove. No surface water was observed in Stonewall Creek or Cold Stream, or along the Sweetwater River upstream the State Park headquarters.

Non-sensitive herpetofauna species observed during these diurnal surveys included the larval phase of the western toad, Pacific treefrog (*Hyla regilla*), California treefrog (*Hyla cadaverina*), and one western yellow-bellied racer (*Coluber constrictor*) (Table 3). These aquatic-associated species were all observed along reaches where surface water was present. Two introduced fish species, the partially armored stickleback (*Gasterosteus aculeatus microcephalus*) and rainbow trout (*Oncorhynchus mykiss* var.) were restricted to the Sweetwater River (Table 3). The fishes were limited to the discontinuous wetted portions along the Sweetwater River from the confluence of Cold Stream southwest 5.3 km (~3.3 mi) to the South Boundary Fire Road crossing (Table 3).

Nocturnal presence surveys

A total of 14 focused nocturnal presence surveys were conducted across four sites rated as high quality during the assessment phase (Table 2.). Twelve surveys were conducted from May to July and two additional late-season surveys took place in early September.

Despite rigorous searching efforts, only two arroyo toads were detected during the 14 nocturnal surveys conducted from May through September (Table 2). On 20 June 2002 we located a female arroyo toad (55-mm, SUL) within Cuyamaca Rancho State Park along the Sweetwater River channel at the southwest boundary at Site 4 (Hulburd Grove) (Figures 2 and 4). On 11 September 2002 we located an adult female arroyo toad (63-mm, SUL) in the headwaters of Site 1 (Upper Sweetwater) River. (Figure 2). This individual serves as an elevation record (1182 m.; 4114 ft.) for the Sweetwater River watershed (Campbell et al., 1996).

Non-sensitive herpetofauna species observed during the nocturnal surveys included the adult and larval phase of western toads, Pacific treefrogs, California treefrogs, a California kingsnake (*Lampropeltis getula*), and two southern Pacific rattlesnakes (*Crotalus viridis*) (Table 3). In addition, one two-striped gartersnake (*Thamnophis hammondi*), which is listed by California Department of Fish and Game (CDFG) as a species of special concern, was also observed (Table 3).

DISCUSSION

In this section we elaborate on the significance and practical relevance of our findings and list additional research opportunities. In addition, we provide several management recommendations. The overall goals of the project were met.

Daytime habitat assessment surveys

Four discreet patches of *high quality* arroyo toad habitat were found along the Sweetwater River (Figure 1). All four of these patches qualified as *high quality* because the patch is a section of drainage of low gradient ($\leq 2\%$) with predominantly sandy substrate and banks, adjacent sandy terraces, and a watercourse of braided channels. Although the area of each of these sandy patches has not been calculated, the approximate lengths were estimated (Table 2). The remainder of the Sweetwater River qualified as *marginal* because the gradient was greater than 3% and characterized by narrow bedrock or rocky channels lacking adjacent banks and terraces composed of friable soils. Habitats rated as *poor* lack important arroyo toad habitat features (sandy banks, benches, and terraces; quiet shallow breeding pools) and presumably offer fewer essential resources (food, shelter, breeding opportunities). The lack of important resources is a possible reason why arroyo toads are seldom found in habitats lacking the important habitat features mentioned above (Sweet, 1992; Campbell et al., 1996; USFWS, 1999). All six of the 2nd order drainages assessed (Stonewall Creek, Harper Creek, Japacha Creek, Juaquapin Creek, and Descanso Creeks, and Cold Stream) were rated as *poor* because of the combination of slope (greater than 3%.) and incised channels. As a

consequence of the slope and the narrow channel, sand created by the natural weathering processes of the parent material (granite, schist) in these drainages does not accumulate, but is flushed out during high flow events and deposited on floor of broader valleys below. For example, the scouring of Stonewall Creek, Harper Creek, and Cold Stream has resulted in sand being deposited on the floor of upper Green Valley. A characteristic of braided channels is still to slow moving side-channel pools that are critical for arroyo toad spawning and the development and growth of larvae (Sweet, 1992; USFWS, 1999). Consequently, the portion of the Sweetwater River through upper Green valley (up stream of the SR-79 bridge) is highly braided and composed of a combination of deep sandy alluvium, gravel, cobble, and rock with the highly braided Sweetwater River channel draining it.

Typical of streams in Mediterranean regions, the extent of inundation and amount of flow vary considerably inter- and intra-annually (Gasith and Resh, 1999) and the drainages of Cuyamaca Rancho State Park are no exception. Currently, the dynamic nature of the riparian systems (hydrologic regime) upon which the arroyo toad populations relies for reproduction, development, and survival is still intact within the park. This is a critical aspect of maintaining arroyo toad populations.

Nocturnal presence surveys

The total number of arroyo toad observations was very low during our 2002 surveys despite the amount of habitat identified as *high quality* for the toad during the habitat assessment phase. For the months of March through August only one adult arroyo toad was observed. The limited number of observations is suspected to be related to the unfavorable environmental conditions (cold/dry) this year. The first arroyo toad we observed was on 20 June 2002 along the Sweetwater River channel at the southwest boundary at Site 4 (Hulburt Grove) (Figure 2). Late-summer rains received on 10 September provided measurable rainfall in Cuyamaca Rancho State Park 1.5 cm (0.6 in.). While this is outside the optimal time of year to detect toads we took advantage of this opportunity and conducted a single late-season survey for arroyo toads. A single arroyo toad was observed approximately 150 m (~ 492 ft.) away from the river channel on a dry paved road in oak woodland habitat (Figure 2).

Detectability of arroyo toads

Four consecutive years of below normal rainfall resulted in severe drought conditions in our region. In addition, during rain year 2001-2002 we received the lowest rainfall on record (R. Minnich, pers. comm.). Consequently, surface activity by native amphibian species this year was limited, resulting in a significant reduction in their detectability. Because of the unfavorable environmental conditions (cold/dry) (Campbell et al., 1996), it is unlikely that the arroyo toad bred within the Cuyamaca Rancho State Park during the 2002 breeding season (est. March-June). If they had bred, it is unlikely that calling males, egg strings, larvae, and/or metamorphs, would have gone undetected during both the daytime habitat assessment and the focused nocturnal presence survey phases.

Records of arroyo toads in Cuyamaca Rancho State Park

The first report of arroyo toads within the Cuyamaca Rancho State Park appeared in Wright & Wright (1933) as an excerpt of a natural history journal entry dated 5 May 1930. The excerpt is as follows: "Collected at Green Valley Falls Public Campground on Sweetwater River (creek) [sic]. Just above water crossing, found two fresh compliments of *Bufo*. They are more or less in double arrangement. Files or strings with a continuous gelatinous encasing. One [vitelline] envelop present. We both suspect they are *Bufo californicus*, the form we so often sought in vain". Subsequently, this egg string from Green Valley Falls Campground location was included in a more detailed account and became the reference 'type' used to describe the spawn of *Bufo californicus* (Livezey and Wright, 1947). This original description is still recognized as the standard reference (Stebbins, 1985).

A more recent observation of the arroyo toad occurring within the Cuyamaca Rancho State Park is noted in the Recovery Plan for the arroyo southwestern toad (USFWS, 1994, pg.29). However, no details were provided regarding the specific location or the date this observation was made. Arroyo toads were also observed along the Sweetwater River in the spring of 1982, approximately 3/4 mile downstream from Green Valley Falls, in the area we are calling South Boundary Fire Road crossing (M. Mills, pers. comm.). On 23 September 1999, Edward L. Ervin (USGS) and John R. Stephenson (USFWS) observed 32 adult arroyo toads along the Sweetwater River channel at the southwest park boundary at Hulburt Grove (USFWS database, Carlsbad Field Office).

Impacts potentially affecting the arroyo toad

Human impacts

Many human-related activities have resulted in the loss or degradation of seasonal breeding and upland arroyo toad habitat, including urbanization, agriculture within and adjacent to riparian habitats, dam building and the resulting reservoirs, water diversions, sand and gravel mining, road placement across and within stream terraces, livestock grazing, introduction of non-native species, off-highway vehicle use, and the use of stream channels and terraces for recreational activities (USFWS, 1999). Direct habitat loss in conjunction with hydrological alterations and the introduction of nonnative predatory aquatic species have caused arroyo toads to disappear from about 75% of the previously occupied habitat in within the United States (Jennings and Hayes, 1994).

Cuyamaca Rancho State Park contains the headwaters of the approximately 80 km (~50 mi.) long Sweetwater River. Approximately half of the parks 9988 hectares are managed as wilderness areas where vehicles, including bicycles, are prohibited. Consequently, the upper watershed of the Sweetwater River is currently free from the majority of causes that have resulted in habitat degradation of arroyo toad riparian and upland habitats across its geographical range. Historically, cattle were grazed in Green Valley along the Sweetwater River from the mid-1800's but were removed soon after 1933 when the original 160 acre

homestead was purchased by the State of California for the creation of the new park (J. Burke, pers. comm.; Anon, 2000).

Recreational impacts

Horseback and mountain bike riding, hiking, and fishing, all popular forms of recreation within Cuyamaca Rancho State Park. Horseback riding and mountain bike riding both require the participants to remain on an established trail system, whereas hikers and fishermen are allowed to walk along the riparian corridors where, for the most part, there is no maintained trail. These activities may lead to inadvertent trampling or crushing of burrowed adults, juveniles, and recent metamorphic individuals and if activities are concentrated in the breeding pools, activities by equestrians, mountain bikers, hikers, and fishermen can also have serious adverse effects on eggs and larvae.

Occasionally, horse droppings and hoof prints were observed off established riding trails along the sandy reaches of the Sweetwater River. However, this practice does not seem to be typical of the majority of horseback riders. In any case, it is possible that horses, bicycles, hikers, and fishermen may be disturbing or crushing arroyo toads while traversing the sandy terraces and banks (burrowing habitat) and sandy bottom pools (breeding habitat) (Griffin et al., 1999; Ross et al., 1999; USFWS, 1994).

Introduced species impacts

It should be noted that many of the introduced invasive species commonly found in coastal southern California wetlands, and that are known to have deleterious effects on native amphibian species (i.e., crayfish (*Procambarus clarki*), bullfrogs (*Rana catesbeiana*), and warm water game fish (e.g., mosquitofish (*Gambusia affinis*) and green sunfish (*Lepomis cyanellus*)), were not detected during the course of our field surveys and are considered not to currently occur within the Sweetwater River system within Cuyamaca Rancho State Park. However, established breeding populations of introduced partially armored stickleback (*Gasterosteus aculeatus microcephalus*), rainbow trout (*Oncorhynchus mykiss* var.) and the Rio Grande turkey (*Meleagris gallopavo intermedia*) do occur in the Sweetwater River within the Cuyamaca Rancho State Park. All three of these introduced species were observed on numerous occasions during our 2002 surveys (Table 4; Figure 3). Individual accounts, which include brief discussions on potential impacts to native fauna, are provided for these three species.

Lake Cuyamaca, on the northern border of the park (owned by Helix Water District and operated by Lake Cuyamaca Recreation and Park District), is managed as a recreational fishery and is stocked with warm-water game fish on a regular basis (CDFG, 1994-1998). A community of introduced species, having presumably washed over the spillway, has become established in Boulder Creek, which traverses Cuyamaca Rancho State Park. These species include crayfish, bullfrogs, black bullhead (*Ameiurus melas*), rainbow trout, and green sunfish (E. Ervin, pers. observ.). There is no suitable arroyo toad habitat along Boulder Creek within Cuyamaca Rancho State Park (USGS & TAIC, 2002).

Partially Armored Stickleback

The partially armored stickleback is a diminutive fish (3-5 cm TL) native to coastal southern California. The population in Cuyamaca Rancho State Park, in the Sweetwater River, is considered to be an introduced population (Swift et al., 1993) and presumably incidental with the planting of hatchery trout. The partially armored stickleback specializes in feeding on a rather limited number of organisms (e.g., chironomid larvae, ostracods) (Moyle, 2002). Currently, there is no evidence that indicates the diet of the partially armored stickleback include amphibian eggs and or tadpoles.

Since the 2002 surveys were conducted during a below-normal rainfall rain year (July 1st – June 30th), and the fourth consecutive year of drought conditions, it is likely that the distribution of the partially armored stickleback would expand under higher flow conditions.

Rainbow Trout

Hatchery stock trout are being introduced into the upper Sweetwater River within the Cuyamaca Rancho State Park by the CDFG as part of an ongoing program to create additional recreational fishing opportunities. CDFG has described the location of their trout stocking as occurring in the general area of Green Valley Falls Campground and at the SR-79 highway overpass (CDFG, 2002). The most recent trout plants have taken place in 1994 (n= 870), 1995 (n= 760 & 1510), 1996 (n= 1720), 1997 (n= 1880), and 1998 (n= 2370) (CDFG, 1994-1998). Subsequent trout stocking was halted with the onset of the current four-year drought that began in rain year 1998-1999. Since the 2002 surveys were conducted during a below-normal rainfall rain year (July 1st – June 30th), and the fourth consecutive year of drought conditions, it is likely that the distribution of the rainbow trout would expand under higher flow conditions.

Trout are known to prey on native amphibian larvae and have the ability to completely eliminate them from small pools (Cooper et al., 1996). The placement of trout into streams and rivers that were previously fishless has been shown to negatively affect native amphibians at the population level (Backlin et al., 2002, Bradford et al., 1993; Fisher and Shaffer, 1996). Tadpoles are particularly vulnerable to predatory fish when they do not possess effective anti-predatory mechanisms (Bradford, 1989; Hecnar and Closkey, 1997; Sexton and Phillips, 1986) and this has been demonstrated to be the case with arroyo toad larvae (Sweet, 1992). Consequently, successful recruitment could be significantly reduced in the presence of trout, thus resulting in artificially lowering the abundance of local populations of arroyo toads and the other aquatic breeding amphibian species (i.e., western toad, Pacific treefrog, California treefrog).

An additional concern is the health of the introduced trout originating from hatcheries. Fish raised in environmentally constant conditions are more susceptible to diseases and may act as a vector of them upon liberation into wild habitats. Infections include, but are not limited to, iridoviruses and the protozoan commonly referred to as white spot disease, or 'Ich'

(*Ichthyophthirius multiliis*) (Mao et al., 1999; Scholz, 1999). As part of a separate research project investigating parasites in the fish fauna in southern California, 10 introduced fish (5 stickleback and 5 trout) were collected by USGS from the Sweetwater River at the SR79 bridge on 5 October 2001 and transported live to San Diego State University for analysis. One of the 5 stickleback collected was found to be infected with a mature trophont (free-living cyst under the epithelium) of the exotic parasite *I. multiliis* and one of the five trout collected contained *Crepidostomum farionis*, a native fish parasite (Warburton et al., 2002). The presence of white spot disease on wild stickleback is troubling because amphibians and fish are not as immune from one another's pathogens as previously thought. Recent studies have demonstrated that iridoviruses and the protozoan *Ichthyophthirius multiliis* can be transmitted between different taxonomic classes [i.e., fish ↔ amphibians] (Mao et al., 1999; Moody and Owens, 1994; Gleeson, 1999).

A recent study of fish communities in the wild has shown a strong correlation between the occurrence of hatchery-stock trout and *I. multiliis* infections in native fish species (Warburton et al., 2002). In light of *I. multiliis* outbreaks being a common occurrence in fish hatcheries, hatchery-stock trout planted in the Sweetwater River in Cuyamaca Rancho State Park may not only be infected with *I. multiliis* but may in fact be acting as a vector to the other fish and amphibian species. Although outbreaks of *I. multiliis* infections have been reported in wild fish and amphibian larva in the past, it is currently unknown what the effect of this infection has at the population level (Scholz, 1999; Gleeson, 1999).

Since the 2002 surveys were conducted during a below-normal rainfall rain year (July 1st – June 30th), and the fourth consecutive year of drought conditions, it is likely that the distribution of the rainbow trout would expand under higher flow conditions.

Wild Turkey

Since the 1930's, translocated turkeys have been periodically released into oak woodlands and associated habitats on private ranches and on National Forest lands of San Diego County extending from the foothills to the mountains (CDFG, 1995). As a result of introductions close to Cuyamaca Rancho State Park, turkeys have migrated into the park and have become a common sight day or night (pers. observ.). In terms of diet, turkeys have been shown to consume a great variety of food types such as hard mast (acorns, seeds from grasses and forbs), soft mast (grasses, sedges, and various forbs), and a variety of invertebrate and vertebrates, including insects, snails, crayfish, salamanders, frogs, tadpoles, and lizards (Hurst, 1992; CDFG, 1995). However, vegetation comprises the majority of their diet for all four seasons. Turkeys do not provide a recreational opportunity for hunters within Cuyamaca Rancho State Park because hunting is not permitted within California State Parks.

In this study, both the turkey (through observations of footprints and droppings) and the arroyo toad co-occur on open sandy stream benches and terraces along the Sweetwater River. The presence of turkeys in these areas adjacent to arroyo toad breeding habitat may increase vulnerability to predation. These toads are naturally subject to predation specific to various stages of their development, including egg masses, tadpoles, juveniles, and adults. It is during

the juvenile phase in which the arroyo toad would become most vulnerable to predation by turkeys. One of the most distinctive characteristics of the arroyo toad is the tendency for metamorphic individuals to remain on the open sand benches at the margins of the natal pool (rather than dispersing). The metamorphs may occupy the sandy benches and bars, if conditions permit, for up to 4 months (from late June well into October) and grow to 30-35 mm (Sweet, 1992). They make themselves more vulnerable to predation that may be offset by the opportunity for rapid growth afforded by abundant insect prey and elevated body temperatures (Sweet, 1992). It is also possible that predation by turkeys and introduced trout may be having an additive effect on the reduction of arroyo toad populations.

RECOMMENDATIONS

To understand the ecology and life history the arroyo toad population within Cuyamaca Rancho State Park, we make the following recommendations. Further clarification of the following issues would enable California State Parks to develop specific policies (seasonal, spatial) to manage and conserve the federally endangered arroyo toad within Cuyamaca Rancho State Park and make informed management decisions regarding compatible recreational programs and activities.

- Conduct additional nocturnal presence surveys for arroyo toads in areas identified as potential habitat under more favorable environmental conditions to confirm their presence or increase confidence in their 'absence'.
- Determine the distribution of arroyo toads within occupied areas.
- Use the environmental data collected to develop a phenologic profile for this high elevation population.

As a result of our findings we recommend the following actions and guidelines for the protection and conservation of the arroyo toad within Cuyamaca Rancho State Park.

- Move established recreation trails (riding, biking, hiking) away from sandy areas along the Sweetwater River in areas identified as *high quality* arroyo toad habitat.
- Restrict access to patches identified as *high quality* arroyo toad habitat. (breeding and upland areas). Install unobtrusive information signs informing public of restrictions.
- Study the stock trout-arroyo toad tadpole interaction to assess the risk of predation and level of risk for disease transfer. Modify the seasonal recreational fisheries program if trout are shown to be preying on arroyo toad tadpole or carrying diseases the larvae may acquire.

- Study the risk of wild turkey predation on arroyo toad metamorphs. If wild turkeys are found to have detrimental impact on the arroyo toad population, state park officials may consider having the turkeys removed from Cuyamaca Rancho State Park.

LITERATURE CITED

- Anonymous. 2002. Cuyamaca Rancho State Park. Map. Cuyamaca Rancho State Park Interpretive Association.
- Backlin, A., C. Haas and R. Fisher. 2002. Angeles and San Bernardino National Forest, Mountain Yellow-legged Frog (*Rana muscosa*) surveys, 2001. Prepared for Angeles National Forest, San Bernardino National Forest.
- Bradford, D.F. 1989. Allopatric distribution of native frogs and introduced fishes in high Sierra Nevada lakes of California: Implication of the negative effect of fish introductions. *Copeia*. 1989:775-778.
- Bradford, D.F., F. Tabatabal and D.M. Graber. 1993. Isolation of remaining populations of the native frog, *Rana muscosa*, by introduced fishes in Sequoia and Kings Canyon National parks, California. *Conservation Biology*. 7(4):882-888.
- California Department of Fish and Game. 1994. Mojave River hatchery calendar year report. Unpublished report.
- California Department of Fish and Game. 1995. Draft mitigated negative declaration for the release of the wild turkeys on the Descanso Ranger District of the Cleveland National Forest. 84pp.
- California Department of Fish and Game. 1995. Mojave River hatchery calendar year report. Unpublished report.
- California Department of Fish and Game. 1996. Mojave River hatchery calendar year report. Unpublished report.
- California Department of Fish and Game. 1997. Mojave River hatchery calendar year report. Unpublished report.
- California Department of Fish and Game. 1998. Mojave River hatchery calendar year report. Unpublished report.
- California Department of Fish and Game. 2002. Department Fish and Game, South Coast Region, Fisheries Planting Page, San Diego.
Website:<http://www.dfg.ca.gov/fishplant/reg5a.html#SAN%20D>.
- Campbell, L.A., T.B. Graham, L.P. Thibault, and P.A. Stine. 1996. The arroyo toad (*Bufo microscaphus californicus*), ecology, threats, recovery actions and research needs. U.S. Dept. of the Interior, National Biological Service, California Science Center, Technical report (NBS/CSC-96-01) ii + 46 pp.

- Cooper, S.D., T.L. Dudley, and N. Hemphill. 1986. The biology of chaparral streams in southern California, Pages 139-152 in J. DeVries, editor. Proceedings of the Chaparral Ecosystem Research Conference. Report Number 62, California Water Resource Center, Davis, California, USA.
- Federal Register. 1994. Endangered and threatened wildlife and plants; determination of endangered status for the arroyo southwestern toad. Federal Register 59(241):64859-64866.
- Fisher, R.N. and H.B. Shaffer. 1996. The decline of amphibians in California's Great Central Valley. Conservation Biology, 65:177-181.
- Gasith, A. and V.H. Resh. 1999. Streams in Mediterranean climate regions: abiotic influences and biotic responses to predictable seasonal events. Annual Review of Ecological Systems. 30:51-81.
- Gleeson, D.J. 1999. Experimental infection of Striped Marshfrog tadpoles (*Limnodynastes peronii*) by *Ichthyophthirius multiliis*. Journal of Parasitology, 85(3):568-570.
- Griffin, P.C., T.J. Case and R.N. Fisher. 1999. Radio telemetry study of (*Bufo californicus*), arroyo toad movement patterns and habitat preferences. V + 66 pp.
- Hecnar, S.J. and R.T. Closkey. 1997. The effects of predatory fish on amphibian species richness and distribution. Biological Conservation. 79(1997) 123-131.
- Hurst, G.A. 1992. Foods and Feeding. In: The wild turkey: biology and management. (ed.) J.G. Dickson. Stackpole Books, Harrisburg, Pennsylvania. pp. 66-83.
- Jennings, M.R. and M.P. Hayes. 1994. Amphibian and reptile species of special concern in California. Department of Fish and Game, Rancho Cordova, California.
- Livezey, R.L. and A.H. Wright. 1947. A synoptic key to the salientian eggs of the United States. The American Naturalist. 37:179-222.
- Mao, J., D.E. Green, G.M. Fellers, and V.G. Chinchar. 1999. Molecular characterization of iridoviruses isolated from sympatric amphibians and fish. Virus Research. 63(1999): 45-52.
- Mills, M. 22 Feb. 2003. Personal communication-phone. Jamul, California.
- Minnich, R. 24 Feb. 2003. Personal communication-phone. Professor of Geography, University of California, Riverside, California.
- Moody, N.J.G. and L. Owens. 1994. Experimental demonstrations of the pathogenicity of a frog virus, *Bohle iridovirus*, for a fish species, barramundi *Lates calcarifer*. Disease of Aquatic Organisms, 18: 95-102.

- Moyle, P.B. 2002. Inland Fishes of California. Berkeley, University of California Press.
- Ross, D.A., J.K. Reaser, P. Kleeman, and D.L. Drake. 1999. *Rana luteiventris* (Columbia Spotted Frog). Mortality and Site Fidelity. Herpetological Review, 30(3): 163.
- Scholz, T. 1999. Parasites in cultured fish. Veterinary Parasitology, 84 (1999): 317-335.
- Sexton, O. J., and C. Phillips. 1986. A qualitative study of the fish-amphibian interactions in the three Missouri ponds. Transactions of the Missouri Academy of Science, 20:25-35.
- Stebbins, R.C. 1985. A field guide to western reptiles and amphibians. Second edition, revised. Houghton Mifflin Company, Boston, Massachusetts.
- Sweet, S.S. 1992. Ecology and status of the arroyo toad (*Bufo microscaphus californicus*), on the Los Padres National Forest of southern California, with management recommendations. Report to United States Department of Agriculture, Forest Service, Los Padres National Forest, Goleta, California. Ii + 198 pp.
- Swift, C.C., T.R. Haglund, M. Ruiz, and R.N. Fisher. 1993. The status and distribution of freshwater fishes of southern California. Bulletin of Southern California Academy of Science, 92(3):101-167.
- U.S. Fish and Wildlife Service. Locality records for arroyo toads from GIS database, Unpub. data. Carlsbad Field Office, Carlsbad, California.
- U.S. Fish and Wildlife Service. 1999a. Arroyo southwestern toad (*Bufo microscaphus californicus*) recovery plan. U.S. Fish and Wildlife Service. Portland, Oregon. vi + 119 pp.
- U. S. Fish and Wildlife Service. 1999b. Survey protocol for the arroyo toad (*Bufo microscaphus californicus*). (Dated 19th, 1999) 3pp.
- U. S. Geological Survey and Technology Associates International Corporation. 2002. Studies of the Arroyo Toad and Coast Range Newt on the Upper San Diego River Watershed – Annual Report. Prepared for Helix Water District, La Mesa, California.
- Warburton, M., B. Kuperman, V. Matey, and R. Fisher. 2002. Parasite analysis of native and non-native fish in the Angeles National Forest. Prepared for Angeles National Forest, San Bernardino National Forest. Arcadia, California.
- Wright, A.H. and A.A. Wright. 1933. Handbook of frogs and toads of the United States and Canada. Comstock Publishing Company, Inc., Ithaca, New York.

Table 1. Daytime habitat assessment surveys for suitable arroyo toad habitat.

Survey Reach Name	Arroyo Toad Habitat Quality	Water Present (✓=YES)	Arroyo Toads Observed ¹ (✓=YES)	Survey Reach Length (km)	Date(s) of Survey	Personnel
Upper Sweetwater River (headwaters to Park Headquarters)	High	✓		3	4/16/02 5/21/02 5/31/02	E. Ervin, C. Brehme, A. Hebbert
Stonewall Creek	Poor			2.6	05/21/02	E. Ervin
Harper Creek	Poor	✓		2.2	04/16/02	E. Ervin, C. Brehme
Middle Sweetwater River (Park Headquarters to Green Valley Falls Campground)	Marginal / High	✓		2.6	4/4/02 6/13/02	E. Ervin, A. Hebbert, C. Brehme
Cold Stream	Poor			3.7	05/21/02	E. Ervin
Japacha Creek	Poor	✓		4.7	05/03/02	E. Ervin, M. Mitrovich
Juaquapin Creek	Poor	✓		3.5	04/26/02	E. Ervin
Lower Sweetwater River (Hulburd Grove to Green Valley Falls Campground)	Marginal / High	✓		6.6	04/09/02	E. Ervin, A. Hebbert
Descanso Creek	Poor	✓		3.3	05/31/02	E. Ervin, A. Hebbert
Reaches resurveyed for surface water.						
Sweetwater River (above 79 bridge)	Poor	✓		1.5	09/03/02	E. Ervin, D. Clark
Sweetwater River (at Green Valley Falls Campground)	Poor	✓		0.75	09/03/02	E. Ervin, D. Clark

¹ Includes all life history stages (egg strings, larvae, metamorphs, adults)

Table 2. Nocturnal presence surveys conducted in areas identified as *high quality* arroyo toad habitat. See Figure 2 for site locations 1-4.

Site #	Site Name	Presence of Suitable Breeding Pools (✓=YES)		# Arroyo Toads Observed ¹	Date	Personnel
		✓				
Site 1	Upper Sweetwater River	✓			04/04/02	E. Ervin, C. Brehme
		✓			06/28/02	E. Ervin, J. Burke (CRSP)
		✓			07/10/02	E. Ervin, D. Clark
					07/16/02	E. Ervin, D. Clark
					07/18/02	E. Ervin
Site 2	South Boundary Fire Road crossing			(1) adult ♀	09/12/02	E. Ervin, A. Herring
		✓			05/31/02	E. Ervin, A. Hebbert
		✓			06/13/02	E. Ervin, A. Hebbert
Site 3	Saddleback Trail crossing	✓			07/10/02	E. Ervin, D. Clark
					07/16/02	E. Ervin, D. Clark
Site 4	Park Boundary at Hulburd Grove				07/18/02	E. Ervin
		✓			05/21/02	E. Ervin
		✓			06/13/02	E. Ervin, A. Hebbert
		✓		(1) adult ♀	06/20/02	E. Ervin, A. Hebbert
					09/03/02	E. Ervin, D. Clark

¹ Includes all life history stages (egg strings, larvae, metamorphs, adults)

Table 3. All fish, amphibian, and reptile species observed by drainage.

SPECIES	Sweetwater River	Stonewall Creek	Harper Creek	Cold Stream	Japacha Creek	Juaquapin Creek	Descanso Creek
Fish:							
Rainbow Trout ¹ <i>Oncorhynchus mykiss</i> var.	✓						
Partially Armored Stickleback ² <i>Gasterosteus aculeatus microcephalus</i>	✓						
Amphibians:							
Western Toad <i>Bufo boreas</i>	✓						
Arroyo Toad ³ <i>Bufo californicus</i>	✓						
Pacific Treefrog , <i>Hyla regilla</i>	✓				✓		
California Treefrog <i>Hyla cadaverina</i>					✓		
Reptiles:							
Two-striped Garter Snake ⁴ <i>Thamnophis hammondi</i>	✓						
California Kingsnake <i>Lampropeltis getula</i>	✓						
Western Yellow-bellied Racer <i>Coluber constrictor</i>	✓						
Southern Pacific Rattlesnake <i>Crotalus viridis</i>	✓						

¹ Introduced stock-trout

² Native fish to southern California, introduced into upper Sweetwater River

³ Endangered species (U.S. Fish and Wildlife Service)

⁴ Species of special concern (California Department of Fish and Game)

Table 4. Introduced species detected at each of the four areas identified as *high quality* arroyo toad habitat.

Site #	Site Name	Trout	Stickleback	Turkey
Site 1	Upper Sweetwater River	✓	✓	✓
Site 2	South Boundary Fire Road crossing	✓	✓	✓
Site 3	Saddleback Trail crossing			✓
Site 4	Park Boundary at Hulburd Grove			

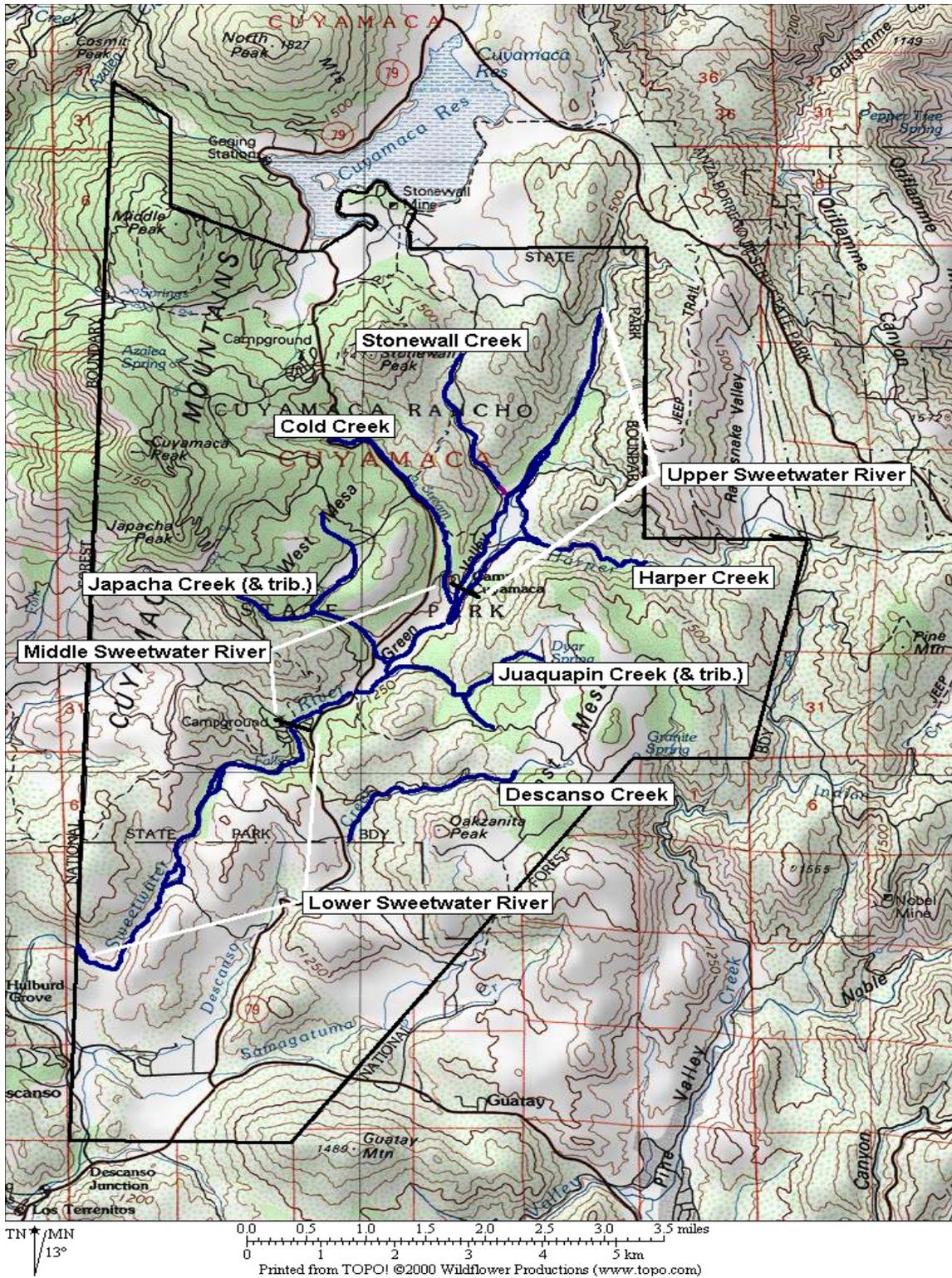


Figure 1. Drainages surveyed for arroyo toad habitat suitability during the year 2002 (indicated by blue lines), including the approximate boundary of Cuyamaca Rancho State Park (black line).

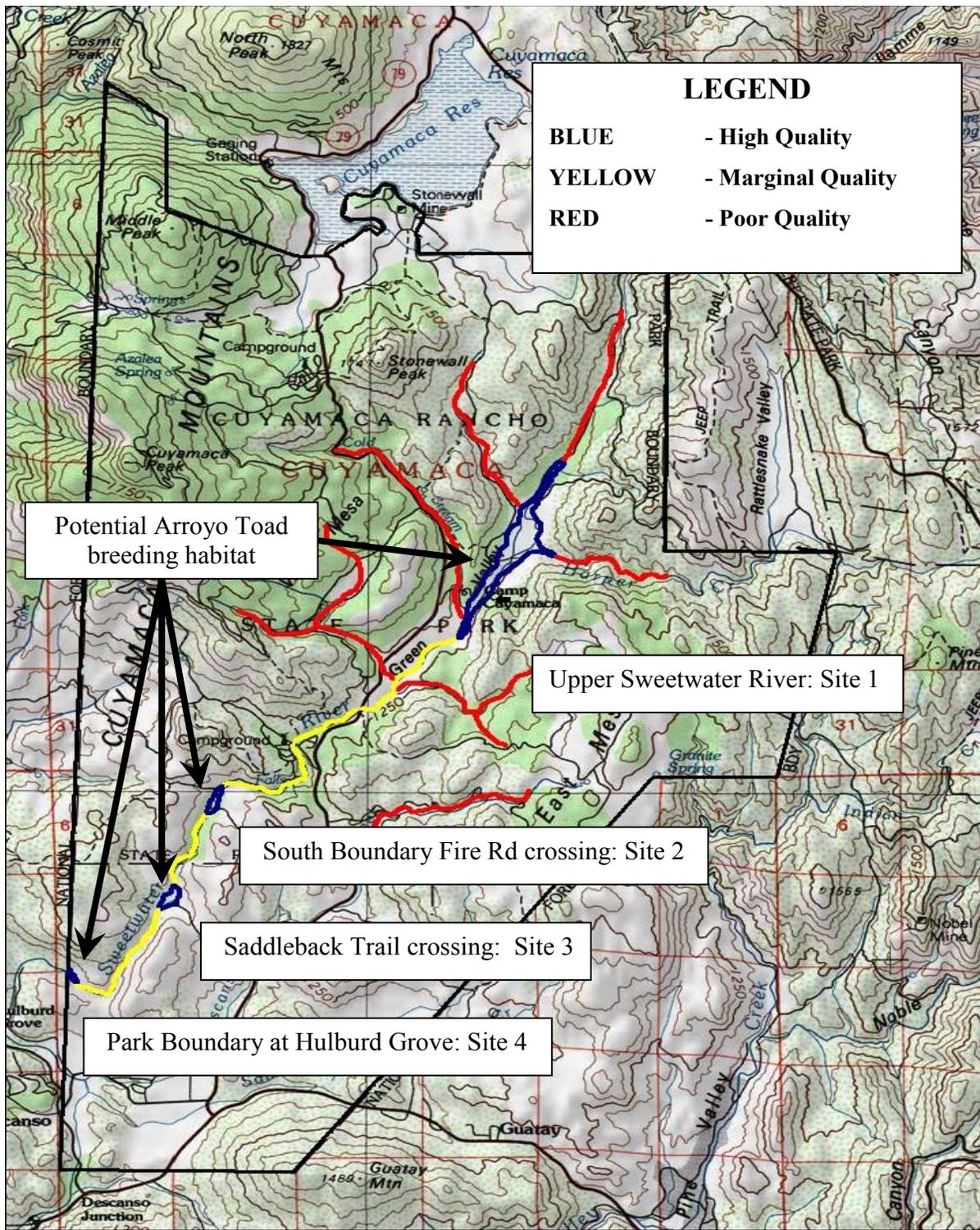


Figure 2. The location and relative size of four habitat patches identified as *high quality* arroyo toad habitat along the Sweetwater River (indicated by blue polygons).

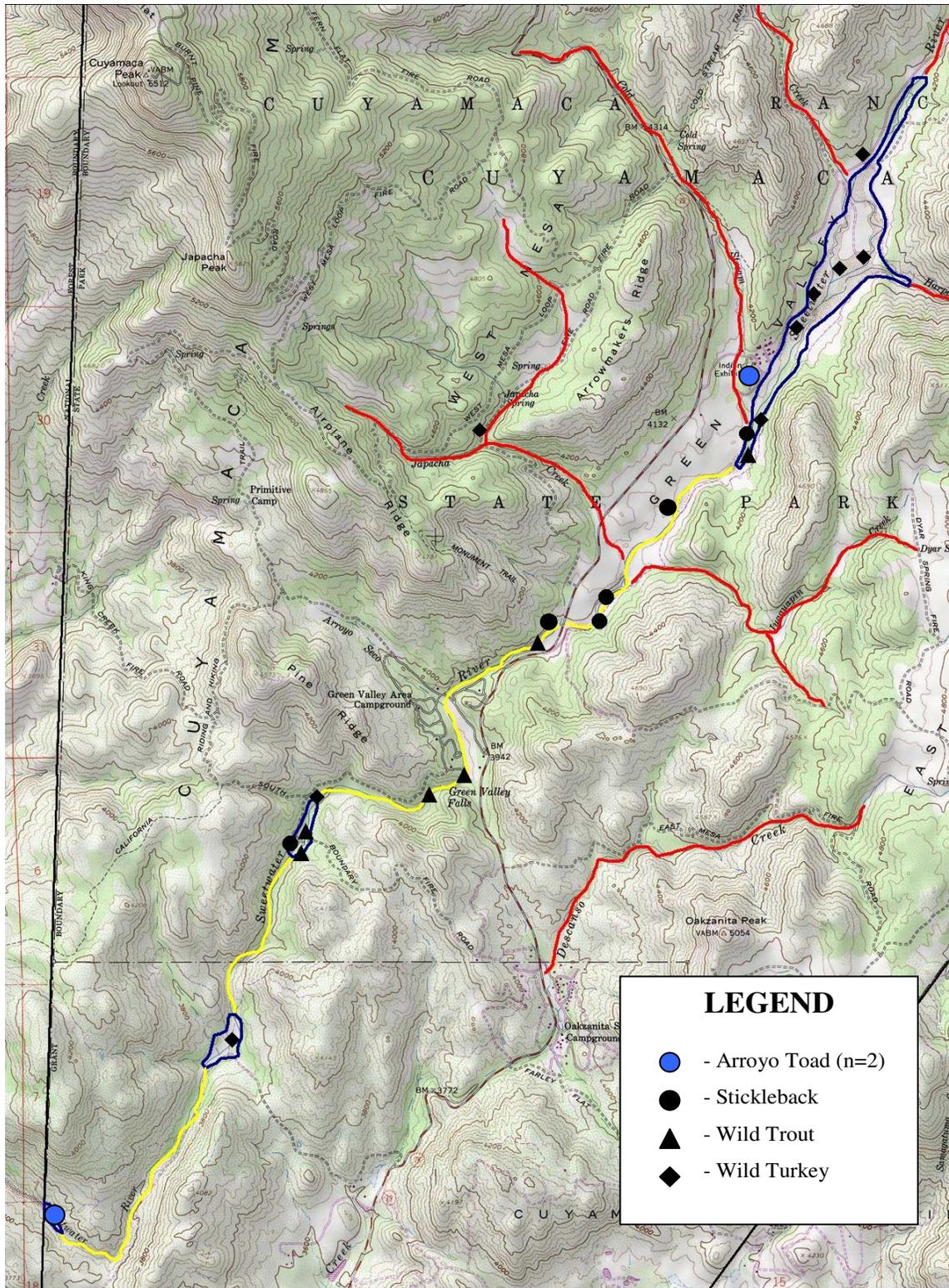


Figure 3. Locations where arroyo toads and introduced species were documented during our surveys.



Figure 4. Small female arroyo toad (55-mm, snout-urostyle length) observed on 20 June 2002 along the Sweetwater River at park boundary at Hulburd Grove (Site-4).