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Studies of the Arroyo Toad and Coast Range Newt on the Upper San Diego River Watershed – Annual Report

Prepared for:

Helix Water District
7811 University Ave.
La Mesa, California 91941

March 1, 2002

TAIC
Technology Associates International Corporation

U.S. Department of the Interior
U.S. Geological Survey

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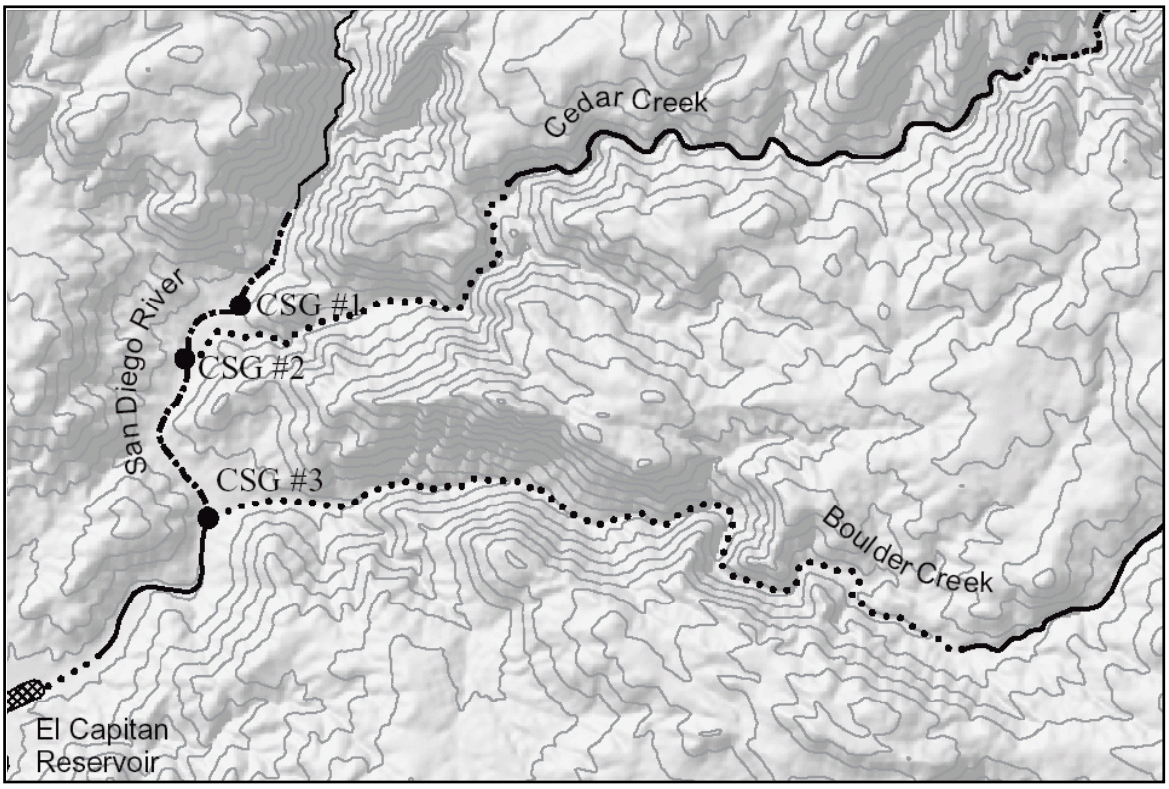

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STUDIES OF THE ARROYO TOAD AND COAST RANGE NEWT ON THE UPPER SAN DEIGO RIVER WATERSHED

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ANNUAL REPORT

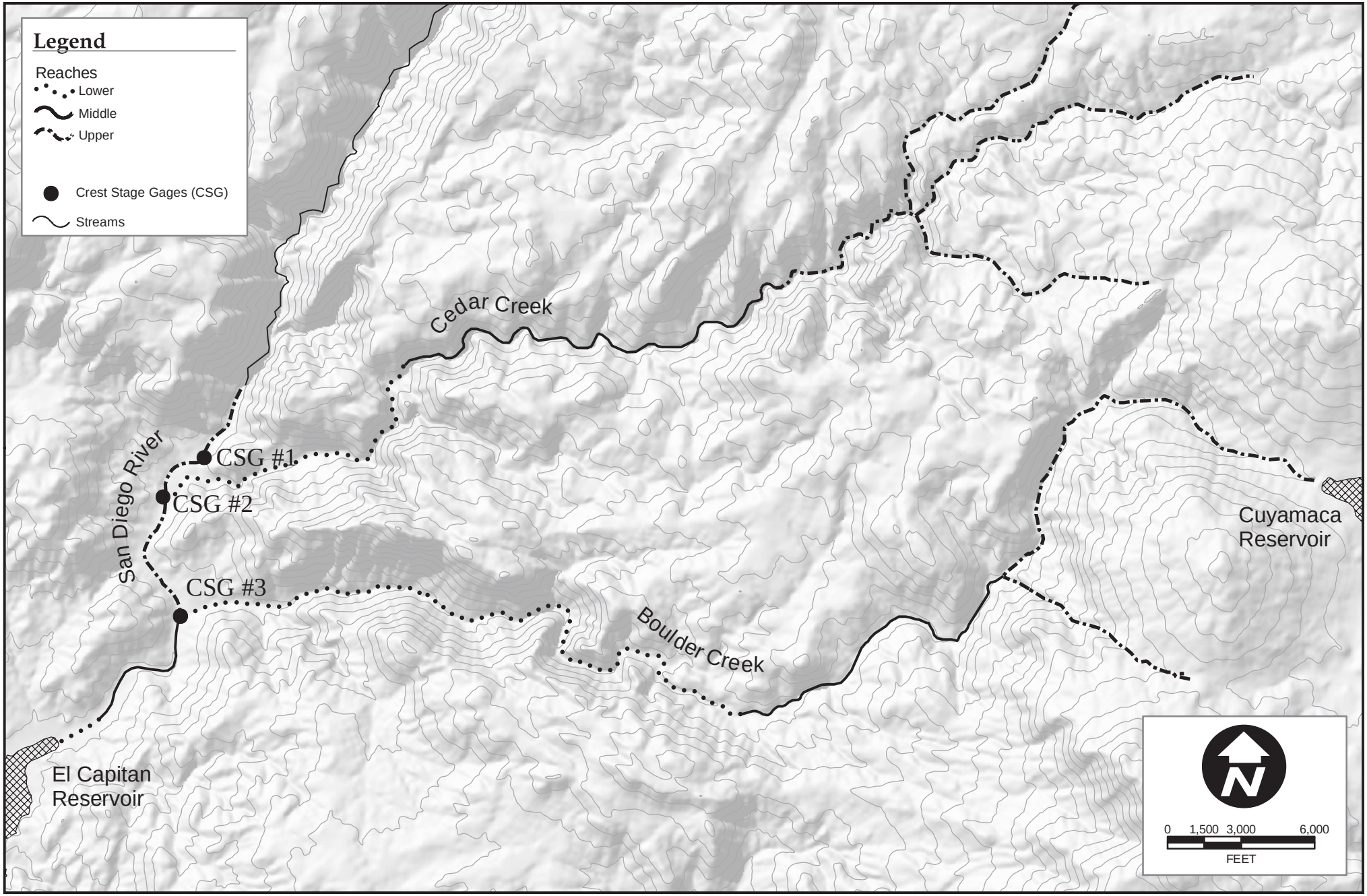
Studies of the Effects of Reservoir Releases on the Arroyo Toad and Coast Range Newt On the Upper San Diego River Watershed

1.0 INTRODUCTION

This study was commissioned in 1999 to investigate the potential downstream effects of current and modified controlled water release regimes from Cuyamaca Reservoir into Boulder Creek on the resident populations of arroyo toad (*Bufo californicus*) and the coast range newt (*Taricha torosa torosa*). This study is intended to develop a scientific foundation upon which to base the issuance of United States Fish and Wildlife Service (USFWS) and California Department of Fish and Game (CDFG) endangered species take permits, as a part of the Helix Water District Natural Communities Conservation Plan (NCCP), pursuant to the State of California NCCP Act of 1991. Projects for which incidental take of sensitive species is sought are required to contribute to the recovery of the species through increased management and conservation, as required by state and federal environmental policy and legislation regarding take of endangered species. The development and study of alternative water release regimes is an important component of this project in that it will investigate means of reducing or avoiding adverse effects to these species, which is preferable to compensatory mitigation. The Implementing Agreement for the Helix Water District NCCP will include this research project as one of the conditions for "coverage" for the arroyo toad and Coast Range newt. This report summarizes the first two years of the research project.

The Helix Water District administers a 31,276-acre service area, including all or most of the Cities of Lemon Grove, La Mesa, and El Cajon, plus the community of Spring Valley and other adjacent territory. Helix WD owns and manages 2,994 acres of land, 1,569 acres of which are scattered within its service area. Cuyamaca Reservoir (elevation 4600') and El Capitan Reservoir (elevation 760') are two of the storage facilities used by Helix on the upper watershed of the San Diego River. Outflow from Cuyamaca Reservoir enters Boulder Creek, which flows about 10 miles to its confluence with the San Diego River, which is, in turn, approximately two miles above the head of El Capitan Reservoir (Figure 1-1). The upper San Diego River watershed is characterized by numerous deep canyons with rocky and sandy streams supporting discontinuous riparian vegetation. Although the capacity for water flow on the river and its tributaries is high, it is highly seasonal and quite variable among years.

Controlled water releases between the reservoirs are conducted periodically for the purpose of maintaining a suitable reservoir level and protecting sensitive biological



FIGURE

TAIC

Stream Reaches Surveyed for the Arroyo Toad & Coast Range Newt

1-1

resources above the reservoir. This is typically in the form of pulse releases, which, unlike natural flows, are abrupt and result in rapidly sequential, steep increases and decreases in flow rate (Lind et al. 1996). Figure 1-2 compares the shapes of the 10-year hydrographs (discharge units are cubic feet per second [cfs]) from the South Fork of Conejos Creek, an unregulated tributary of El Capitan Reservoir, and the Cuyamaca Reservoir outlet to Boulder Creek. Controlled releases occur most often in April and May, but may be as early as February (e.g., 1993) and as late as August (e.g., 1993 and 1998). The typical pattern of peak reservoir release events associated with normal reservoir operation corresponds with the latter half of the rainy season (spring).

The drainages of the upper San Diego River watershed support breeding populations of several native amphibian species. Among these are the federally endangered arroyo toad and the coast range newt, a California Species of Special Concern. These two species breed in different microhabitats of the streambeds, but both may be affected by the volume and timing of seasonal (natural and artificial) water flows. Suitable habitat for the arroyo toad includes low gradient, sandy reaches containing portions of braided river channels, whereas habitat for the coast range newt is characterized by steeper bedrock and boulder-lined drainages. The breeding season and period of larval development for these species can occur within the period between February and August, so controlled reservoir water releases have the potential to affect one or more life stages of these species (i.e., eggs, larvae, or adults) by creating or altering breeding habitat or by flushing individuals out of suitable habitat, resulting in decreased population sizes, reduced reproductive recruitment, and consequently, decreased population viability (Lind et al. 1996).

The first two seasons for this study, 1999-2000 and 2000-2001, were used to collect preliminary data to determine the presence and distribution of the arroyo toad and coast range newt and the feasibility of the study. Subsequent stages of this study will compare the effects of natural versus artificial flows and, as needed, the effects of modified water release regimes that may be developed as management recommendations for these two species. Depending on rainfall patterns, the study is expected to require four to six years for completion. Biologists at Technology Associates International Corporation (TAIC) worked in collaboration with biologists at the United States Geological Survey, Western Ecological Research Center – San Diego Field Station (USGS) to design this study. Biologists and hydrologists from the USGS conducted all field investigations. This report presents the results of the first two years of the study.

2.0 METHODS

2.1 Study Area

Potential arroyo toad and coast range newt habitat was initially mapped from stream gradient characteristics through inspection of topographic maps. The majority of potential toad habitat occurs on the San Diego River, with a small amount of possible

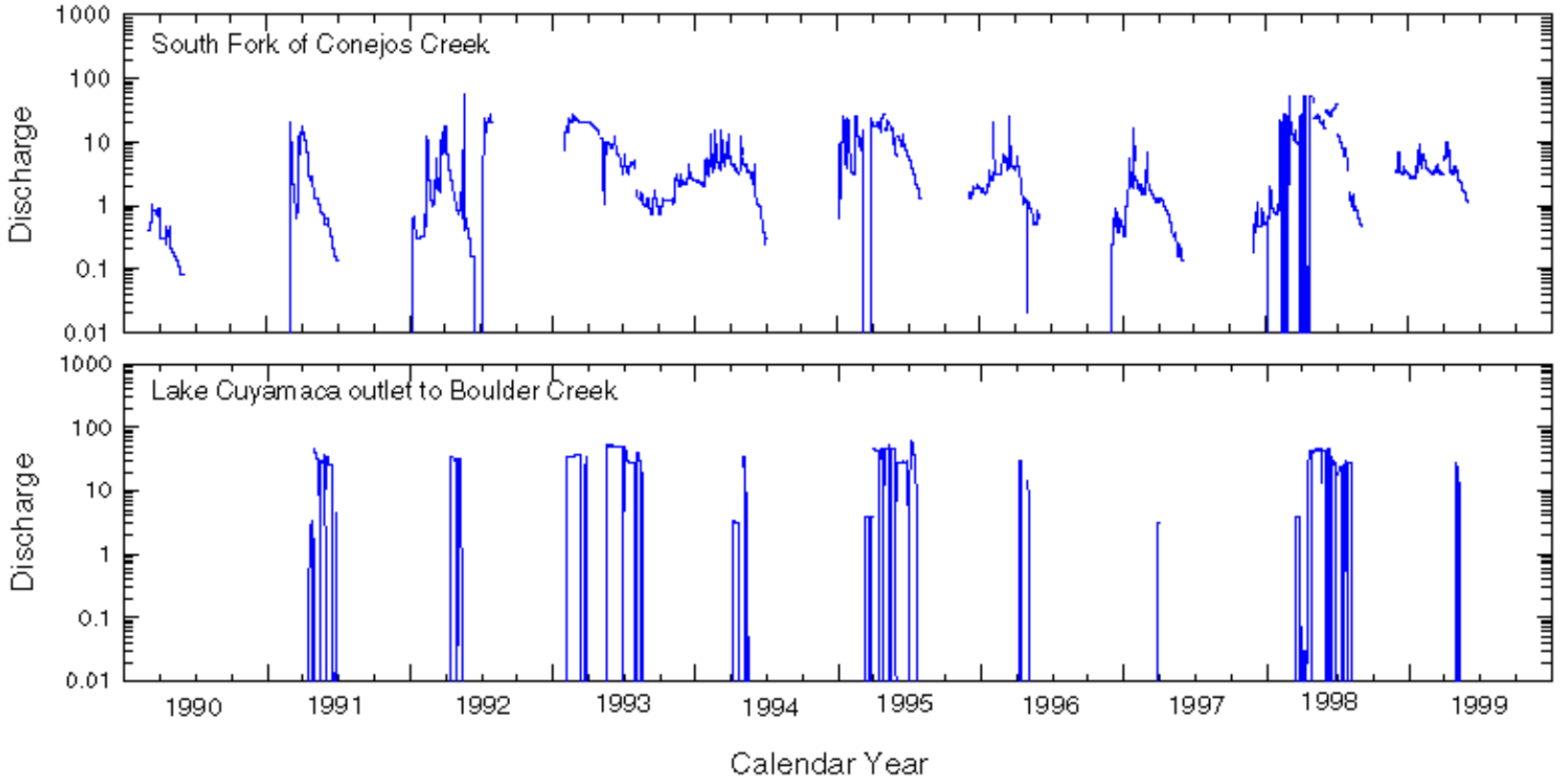


Figure 1-2. 10-year Hydrograph (discharge units are cfs) from South Fork Conejos Creek, an unregulated stream, and Cuyamaca Reservoir outlet to Boulder Creek. Unlike the natural hydrograph from Los Conejos Creek, pulse releases from the reservoir are flashy with steep increase and decrease. Releases occur most often in April and May but may be as early as February (e.g., 1993) and as late as August (e.g., 1993 and 1998). Data compiled by C. Burton, USGS.

toad habitat at the extreme lower portions of Boulder and Cedar Creeks (Figure 1-1). Potential coast range newt habitat was identified on Boulder and Cedar Creeks, where the stream gradient is steeper than on the San Diego River. Preliminary field investigations in 2000 refined locations of potential toad and newt habitat based on stream characteristics.

2.2 Study Sites

Sites are defined here as specific reaches of drainages in the upper San Diego River watershed between El Capitan and Cuyamaca Reservoirs. Reaches were delineated by stream characteristics and accessibility (Figure 1-1). Arroyo toad habitat occurs on all the San Diego River sites, a drainage where this species has been documented in the past. Suitable habitat for the coast range newt includes all reaches of Cedar and Boulder Creeks. Because of low rainfall received during the first two study seasons (i.e., 1999-2000 and 2000-2001), reaches were designated for preliminary assessment of current toad and newt distribution; therefore, not all reaches surveyed will be used in the final study. The study is being designed as a paired comparison between one "treatment" (subject to controlled water releases) and one "control" (natural flows) drainage for each species. In addition, a "before and after" analysis (e.g., using repeated measures statistics) of the data will be used to interpret observations of artificial and natural flows. For purposes of initial evaluation, each study drainage was divided into three reaches, as follows:

Site 1, Upper San Diego River (toad control site): This reach is 2.2 miles in length and is characterized by a low-gradient river channel bordered by sandy, sparsely vegetated upland terraces. Arroyo toads have been documented breeding in the quiet pools that form along this reach and on the adjacent terraces that provide potential foraging and aestivating habitat. This site is located above the confluence of Boulder Creek. The habitat within this site is considered marginal for Coast Range newts.

Site 2, Middle San Diego River (toad treatment site): This 1.3 mile study site is subject to reservoir releases via the confluence with Boulder Creek. This portion of the river has a low gradient and is bordered by sandy terraces, but has a slightly incised channel. Because the majority of the watercourse is confined to this channel, the flows tend to be deep and swift, providing fewer quiet pools for breeding arroyo toads. An exception to this is a section of suitable habitat below the diversion dam, where the unpaved road crosses the river channel. Arroyo toads are known to occur along this reach. The streambed along this reach is considered marginal to unsuitable habitat for coast range newts.

Site 3, Lower San Diego River (toad treatment site): This site is 0.8 miles in length and consists of a low-gradient river channel dominated by a willow-riparian woodland. Arroyo toads have bred on this reach, although it did not carry surface water during the initial two years of this study. The riverbed within this site is considered marginal to unsuitable habitat for coast range newts.

Site 4, Lower Boulder Creek (newt treatment site): This reach is 5.5 miles in length and is subject to artificial flows from controlled water releases. The entire reach contains suitable breeding habitat for the newt and these animals are known to occur here. Although the reach is too steep to contain any high quality arroyo toad breeding habitat, the lowest 500-foot segment is marginally suitable for this species because of its linkage to suitable toad habitat on the river. The coast range newts that are known to occur in this reach occur mostly on private property in the upper portion of this reach.

Site 5, Middle Boulder Creek (newt treatment site): This reach is 2.75 miles in length and supports a steep, rocky creek channel. No suitable arroyo toad habitat occurs within this site.

Site 6, Upper Boulder Creek (newt treatment site): The main channel of this reach is 3.75 miles in length and includes a one-mile long tributary from La Puerta Springs. No suitable arroyo toad habitat occurs within this site. This relatively short reach is remote and difficult to reach.

Site 7, Lower Cedar Creek (newt control site): This 3.7 mile reach experiences only natural water flows and newt breeding was documented within this reach during the 2001 surveys.

Site 8, Middle Cedar Creek (newt control site): This 3.0 mile reach contains many bedrock pools and is therefore potentially suitable newt habitat. However, there is no suitable arroyo toad habitat within this reach. Despite several surveys, no newts were observed. The majority of pools along this reach were occupied by the introduced green sunfish, which is known to prey on native amphibian larva.

Site 9, Upper Cedar Creek (newt control site): This reach is 3.0 miles in length and includes two 1.5-mile tributaries (from Dehr and Sandy Creeks). The steep rocky creek channel is suitable habitat for coast range newts. No suitable arroyo toad habitat occurs within this site. Part of this reach is on the Inaja Indian reservation. This relatively short reach is remote and difficult to reach.

2.3 Hydrology and Other Stream Characteristics

The following proposed hydrologic methods were designed for years with normal to high rainfall and resultant streamflow. Flow velocities are to be measured with hand-held digital meters at fixed, regular intervals throughout the study area. Hydraulic cross sections will be drawn at each measurement station and flow volumes will be calculated from a combination of flow velocity, cross-sectional profile, and stream depth. Stream flow measurements will be taken at each station during weekly surveys and during scheduled releases or natural storm events, to the extent possible. Additional stream flow measurement sites will be established near breeding toad and newt pools. Microflow measurements will be taken with Marsh-McBurney flow meters in toad and newt breeding pools. During the rainy season and periods of reservoir releases, more than one

survey per week may be required to better approximate the hydrologic dynamics in the habitat. Other stream characteristics of relevance to amphibians will be measured with instruments at each breeding pool on each visit. These will include water temperature, dissolved oxygen, weather conditions, stream or pool depth, width, and flow velocity. Turbidity, bottom substrate condition (organic accumulation) and silt deposition on eggs or larvae will be qualitatively described at each location. Microflow rates at egg and larval localities will also be measured.

Peak flow events will be measured at permanent Crest Stage Gages (CSG's) installed at select sites on the main drainages. The CSG's record maximum stream stage since the time the gauge was reset for comparison of natural peak water levels with artificially induced peak water levels associated with water releases into Boulder Creek. Gages consist of closed pieces of two-inch diameter steel pipe bolted vertically to rocks or other stable substrate within a particular streambed. The pipes are perforated to allow water to enter as stream levels rise. A vertically mounted wooden stick and a quantity of cork dust are enclosed within each pipe. Peak or crest water height is determined by the measurement from the stream bottom to the height of the cork dust deposited on the stick.

The majority of the measurements described above were precluded in 2000 and 2001 by below-normal low rainfall and resultant stream flows. These methods and measurements are described below and will be implemented in future years with normal to high rainfall conditions. Three CSG's were installed and will be maintained at strategic locations on the main drainages (Figure 1-1).

2.4 Biology

The proposed field protocol was designed for reproductive surveys under normal to high rainfall conditions. Weekly surveys are conducted by teams of two USGS personnel on foot and consist of systematic searching and mapping of adult toads and newts and assessment and quantification of their reproduction. A qualified biologist that is experienced with the identification of amphibian egg masses and larvae has been and will continue to be present for all aquatic habitat surveys.

Weekly surveys are coordinated to maximize field time and minimize travel time. Daylight breeding habitat mapping and egg mass surveys are conducted in the late afternoon, followed by evening auditory toad surveys, additional toad larvae and toadlet surveys, and adult and larval newt surveys. The general survey schedule as originally proposed is shown in Figure 2-1. Given the extended dry period that may continue through 2002, the period for studying the current water release regime may have to be extended beyond 2002.

Although the methods for both species are basically observational, the details vary by species:

> **Arroyo Toad**: Weekly toad surveys are based on nocturnal counts of foraging adults and calling males during the period of adult reproductive activity (March through late April or May). More frequent surveys may be conducted if

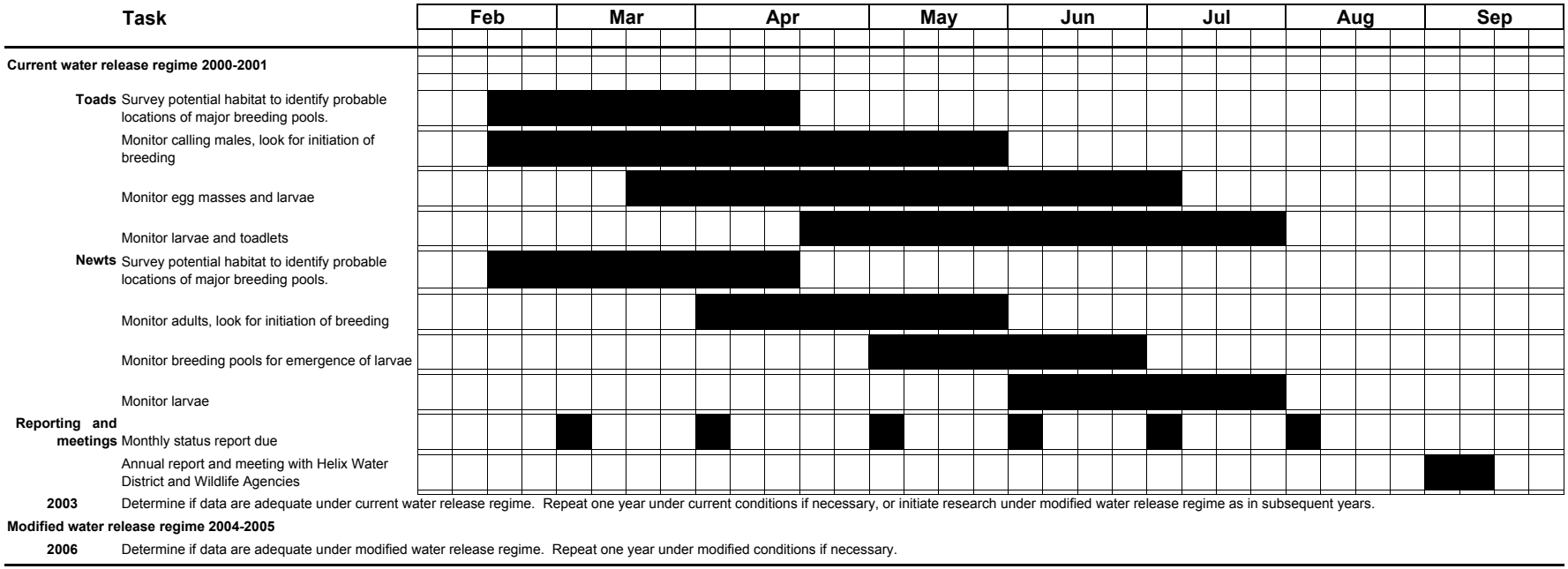


Figure 2-1. Arroyo toad and coast range newt research schedule.

additional visits are required for hydrological measurements. Temperature and other weather measurements will be used as a covariate in the data analysis to account for variation in male vocalization. Individuals are not captured and marked, so as to minimize disturbance to the toads.

Daylight (late afternoon) surveys begin during the period in which eggs are normally laid (March through May). Arroyo toad egg masses are readily observed in breeding pools and can be distinguish from those of the western toad (*Bufo boreas*) upon close examination by an experienced observer. The development and survivorship of egg masses will be monitored: egg strings will be counted and the number of eggs per mass will be visually estimated. The abundance of larvae within each breeding pool will be visually estimated at each visit. During this period the sections of stream between breeding pools will also be surveyed to locate larvae that may have dispersed or have been washed beyond the breeding pools. Some eggs may hatch before they are detected due to the short length of the egg stage (4 to 6 days), but they will still be monitored in the larval phase. Once egg strings or larvae are located, the species' identities will be confirmed by a qualified biologist who is experienced with the identification of amphibian egg masses and larvae.

Larvae continue to grow and develop for another 65 to 85 days (Sweet 1989) before they begin to metamorphose. Larvae are diurnal throughout this period; therefore, daylight surveys will also be used to continue weekly monitoring. Monitoring of the juveniles will continue until toads have moved beyond the high waterline of maximum expected reservoir release.

Coast range newt: It is reported that the coast range newt breeds from December to April (Jennings and Hayes, 1994). However, our findings indicate that the Boulder and Cedar Creek populations, the southern-most populations of this species, breed from April through June. The eggs take from 4-6 weeks to hatch and the larvae take from 3-6 months to emerge from the pools as juveniles. (Jennings and Hayes, 1994). During the breeding season (April through June) and the majority of the larval growth period (May through July), newt surveys will be conducted on a flexible weekly basis and will be coordinated with the arroyo toad surveys (i.e., the same field personnel will monitor toads and newts on the same field visits, if possible). Adult newts and egg masses are easily detected by visual encounter surveys while larvae surveys will require a dip net. Once adult newts begin arriving in the breeding areas, all adult newts found will be counted, measured, and sexed.

The number of adult males and females present will be quantified during each survey. Marking of individual newts is not anticipated. If initial results indicate that individual marking is necessary to better interpret observations, this decision will be re-evaluated. Surveys will also attempt to locate egg masses. Pools and slower-moving segments of the stream will be monitored during the season for the emergence of newt larvae from the pool habitat. The number of newt larvae per

pool will be quantified once newt larvae have emerged. Although the larvae may not metamorphose until late summer or early fall, newt surveys will be terminated by the end of July to coincide with the end of the arroyo toad survey season. Historical stream flow data (Figure 1-2) indicate that the necessity for significant water releases is very low by mid- to late summer; therefore, the risk to larval newts is also low by this time.

Analyses of controlled water release effects will consist of simple correlations between flow rates and toad and newt presence/absence or abundance, as well as differences in the same parameters between measurements before and after water releases or storm events on treatment drainages. Control sites will be used to compare toad and newt abundance and persistence on the reaches not affected by water releases. Substantial changes in toad or newt reproduction between control and treatment drainage reaches will be assumed to be attributable to the change in flow unless other factors are identified (e.g., predation). The influence on data of shifting exotic predator distributions from high flow events will be controlled by predator removal to the greatest extent possible (E. Ervin pers. comm.). If substantial negative effects of reservoir releases are detected in toad and newt reproductive success, an adaptive management strategy that would minimize or eliminate those effects will be proposed.

Thirty surveys on the study drainages were conducted between 20 December, 1999 and 26 September, 2001. Table 2-1 documents the dates, times, and conditions of each survey. Only the lowest reach of the San Diego River (immediately above El Capitan Reservoir) was not surveyed due to a consistently dry channel. Two consecutive years of low rainfall resulted in stream conditions generally unsuitable for widespread amphibian reproduction. However, active and foraging adult toads and newts, and to a limited extent their eggs and larvae, were found and used as indicators of suitable breeding habitat.

As a result of the below-normal precipitation during the first year of work (1999-2000), the survey effort was modified from the original proposal: aquatic breeding surveys were replaced by a refinement of the predicted breeding locations based on locations of adults and inspection of stream morphology. USGS biologists and hydrologists surveyed the reaches with the greatest potential for suitable breeding habitat and identified all locations having high quality breeding habitat for either the arroyo toad or coast range newt.

The potential breeding locations identified during the first year, in combination with the limited observed reproduction during the second year (2000-2001), were sufficient to allow specific selection of the sites for this comparative study.

3.0 RESULTS

3.1 Weather and Hydrology

During the first two survey seasons (1999/2000, 2000/2001) below-normal rainfall fell in the region of the study area, resulting in early season drying of the river and streambeds.

Table 2-1. Arroyo toad and coast range newt survey dates, locations, and conditions, 1999 - 2001.

	Study Site #	Survey reach	Date	Hydrological conditions	Methods	Personnel
Toad Control Sites	Site 1	Upper San Diego River (above Cedar Creek confluence)	February 9, 2000	creek bed dry, occasional quiet pools	visual, dipnet	Ed Ervin, Manna Warburton, Carmen Burton
		Upper San Diego River (above Boulder Creek confluence)	May 16, 2000	creek bed dry	visual	Ed Ervin, Manna Warburton, Carmen Burton
		Upper San Diego River (above Boulder Creek confluence)	March 8, 2001	continuous wetted channel entire reach	visual, dipnet, aural	Ed Ervin, Manna Warburton
		Upper San Diego River (above Boulder Creek confluence)	March 22, 2001	continuous wetted channel entire reach	visual, dipnet, aural	Manna Warburton, Allan Hebbert
		Upper San Diego River (above Boulder Creek confluence)	April 12, 2001	continuous wetted channel, entire reach	visual, dipnet, aural	Ed Ervin, Manna Warburton, Steve Carrol, Chris Peregrine
		Upper San Diego River (above Boulder Creek confluence)	May 15, 2001	continuous wetted channel, entire reach	visual, dipnet	Ed Ervin, Steve Carroll
Toad Treatment Sites	Site 2	Middle San Diego River (above Diversion Dam, below Cedar Creek)	February 15, 2000	creek bed dry, occasional quiet pools	visual, dipnet	Ed Ervin, Manna Warburton, John Stephenson
		Middle San Diego River (between Cedar Ck. & Diversion dam).	April 20, 2001	continuous wetted channel, entire reach	visual, dipnet	Ed Ervin, Manna Warburton, Chris Peregrine
		Middle San Diego River (below Boulder Creek confluence)	May 15, 2001	continuous wetted channel, entire reach	visual, dipnet	Manna Warburton
	Site 3	Lower San Diego River	this reach not sampled	dry channel		

Table 2-1 (cont.). Arroyo toad and coast range newt survey dates, locations, and conditions, 1999 - 2001.

	Study Site #	Survey reach	Date	Hydrological conditions	Methods	Personnel
Newt Treatment Sites	Site 4	Lower Boulder Creek	December 20, 1999	creek bed dry	visual	Ed Ervin, Manna Warburton, Carmen Burton, Robert Kent, Bill McGilton
		Lower Boulder Creek (Three Sisters Falls, below Boulder Creek Road))	June 23, 2000	generally dry creek bed, 5 deep bedrock pools filled at falls	visual, dipnet	Ed Ervin, Gina Castro
	Site 5	Middle Boulder Creek (above Boulder Creek Road)	March 14, 2000	low flow, wetted channel	visual, dipnet	Ed Ervin, Kalie Matten,
		Middle Boulder Creek (above Boulder Creek Road)	March 17, 2000	low flow, wetted channel	visual, dipnet	Ed Ervin, Drew Stokes
		Middle Boulder Creek (above Boulder Creek Road)	May 30, 2001	continuous wetted channel, entire reach	visual, dipnet	Ed Ervin, Manna Warburton
		Middle Boulder Creek (Lake Cuyamaca dam down to Boulder Creek Road)	September 26, 2001	creek bed dry	visual, dipnet	Ed Ervin, Peter Tang
	Site 6	Upper Boulder Creek (Lake Cuyamaca dam down to Boulder Creek Road)	September 26, 2000	mostly continual wetted channel	visual, dipnet	Ed Ervin, Peter Tang
		Upper Boulder Creek (La Puerta Springs drainage)	June 12, 2001	low flow mostly riffles, ~8 pools with still waters	visual, dipnet	Ed Ervin
Newt Control Sites	Site 7	Lower Cedar Creek (below falls)	December 20, 1999	creek bed dry	visual	Ed Ervin, Manna Warburton, Carmen Burton, Robert Kent, Bill McGilton
		Lower Cedar Creek (below falls)	March 8, 2001	continuous wetted channel entire reach	visual, dipnet, aural	Ed Ervin, Manna Warburton
		Lower Cedar Creek (below Cedar Creek Rd)	June 7, 2001	low flow, few dry reaches, pools with still water common	visual, dipnet	Ed Ervin

Table 2-1 (cont.). Arroyo toad and coast range newt survey dates, locations, and conditions, 1999 - 2001.

	Study Site #	Survey reach	Date	Hydrological conditions	Methods	Personnel
Newt Control Sites	Site 8	Middle Cedar Creek (above Cedar Creek Road)	March 14, 2000	low flow, wetted channel	visual, dipnet	Ed Ervin, Kalie Matten,
		Middle Cedar Creek (above Cedar Creek Road)	March 25, 2000	low flow, wetted channel	visual, dipnet	Ed Ervin, Rob Petit
		Middle Cedar Creek (above Cedar Creek Road)	April 12, 2001	continuous wetted channel, entire reach	visual, dipnet, aural	Ed Ervin, Manna Warburton, Steve Carrol, Chris Peregrine
		Middle Cedar Creek (above Cedar Creek Road)	May 19, 2000	low flow connecting pools	visual, dipnet	Ed Ervin, Gina Castro
		Middle Cedar Creek (above Cedar Creek Rd)	May 25, 2001	isolated pools, mostly dry bed	visual, dipnet	Ed Ervin
	Site 9	Upper Cedar Creek (Dehr Creek)	May 19, 2000	low flow connecting pools	visual, dipnet	Ed Ervin, Gina Castro
		Upper Cedar Creek (headwaters)	June 2, 2000	upper mostly dry, low trickle	visual, dipnet	Ed Ervin, Leah Tibbles
		Upper Cedar Creek (Dehr Creek)	May 25, 2001	creek bed mostly dry, 5 bedrock pools	visual, dipnet	Ed Ervin
		Upper Cedar Creek (Sandy Creek)	June 19, 2001	mostly dry, 5 pools	visual, dipnet	Ed Ervin, Dino Barhoum
		Upper Cedar Creek (main drainage)	June 19, 2001	low flow connecting a series of boulder and bedrock pools	visual, dipnet	Ed Ervin, Dino Barhoum

There was no opportunity to collect flow data and few data were collected on water quality parameters. No controlled water releases were issued from Cuyamaca Reservoir.

Crest Stage Gages (CSG's) were installed just prior to the only significant rainfall event (February 2001) experienced in the watershed above El Capitan reservoir during the first two years of study. The gages on Boulder and Cedar Creeks were installed while the reaches were dry, while the gage on the San Diego River was installed in a pool holding water. Readings show maximum height attained by rain-induced flows (Table 3-1). Water levels at all sites declined gradually after the rain event, showing a natural pattern of decrease in flow with no additional input, artificial or natural, into the system (as in Figure 1-1). These data represent natural water heights within the study area and, when coupled with cross-sectional profiles of the downstream control feature within the channel and absolute height as measured by the CSG, can provide a baseline for flows from future artificial water releases. The second and third measurements for each gage represent baseline water height at the gage and can be subtracted from the first measurement to arrive at the increase caused by the single storm event experienced in the system while gages have been installed. Differences in water heights between peaks and baselines were fairly similar for all gages (ranging from 12 - 16 cm decreases in water height), representing fairly similar inputs at all locations.

Table 3-1. Crest stage gage data collected after the February 2001 rain event.

CSG #	Date	Survey site	Peak gage measurement (cm)
1	March 2, 2001	San Diego River	54
1	April 12, 2001	San Diego River	41
1	May 15, 2001	San Diego River	40
2	March 2, 2001	Cedar Creek	62
2	April 12, 2001	Cedar Creek	50
2	May 15, 2001	Cedar Creek	50
3	March 2, 2001	Boulder Creek	48
3	April 12, 2001	Boulder Creek	32
3	May 15, 2001	Boulder Creek	32

3.2 Biology

The below-normal rainfall between late 1999 and early 2001 resulted in unfavorable stream breeding conditions that precluded successful recruitment for both the arroyo toad and the coast range newt during the first year (2000) and greatly limited recruitment in the second year (2001). The limited recruitment in 2001 was attributable to a series of storms in February that resulted in the resumption of flow in the river channel. Consequently, data gathered over the last two survey years from San Diego River, Cedar Creek, and Boulder Creek provided limited information on breeding locations and recruitment success for both amphibian species.

The general distribution of the arroyo toad, coast range newt, and other species of interest is summarized by site in Table 3-2. A narrative describing the details of the extensive surveys in both years is as follows:

Site 1, Upper San Diego River (toad control site): In survey year 2000, adult arroyo toads were observed foraging on a sandy terrace approximately 150 feet above the river channel on 9 February. No toads were found in the river channel during this period. Two adult arroyo toads were found alive on dirt access road that closely parallels the main river channel. The riverbed contained some isolated pools and short reaches that were in the process of drying (February - March). These small wetted portions were remnants from the previous year's flow. By March, the onset of the arroyo toad breeding season, all the pools in the riverbed had dried. Consequently, there was no arroyo toad reproduction year 2000 within this site. No newts were found at this site. Other native amphibian species observed within the Upper San Diego River include California treefrogs (*Hyla cadaverina*), Pacific treefrogs (*Hyla regilla*), and western toads (*Bufo boreas*). Exotic species observed were crayfish (*Procambarus clarki*), bullfrogs (*Rana catesbeiana*) and green sunfish (*Lepomis cyanellus*).

Although the total rainfall received for year 2001 was below average for the region, a series of storms in February resulted in the resumption of flow in the river channel and initiation of amphibian reproduction. Arroyo toad egg masses were observed in this reach on one visit and larvae were observed on two subsequent visits. Yet later visits found significantly fewer larvae and several metamorphosed individuals (toadlets) along the moist margins of the pool, indicating successful recruitment. No newts were found at this site. Other native amphibian species observed within the Upper San Diego River include California treefrogs, Pacific treefrogs, and western toads. Exotic species observed were crayfish, bullfrogs and green sunfish.

Site 2, Middle San Diego River (toad treatment site): No arroyo toads were detected within this reach during surveys. However, toads have been observed at the road crossing in past years. It is likely that arroyo toads successfully breed closer to the road crossing at the bottom of this reach under optimal conditions. Native species observed include the Pacific treefrog, California treefrog, and the two-striped garter snake. Several pools greater than 0.25 meters deep persisted throughout the period of the field surveys along the upper portion. Consequently, this section of the reach supported the greatest number of exotic species (i.e., crayfish, bullfrogs, green sunfish, largemouth bass (*Micropterus salmoides*), and mosquitofish [*Gambusia affinis*]), which have been shown to have negative effects on native aquatic-breeding amphibians.

Site 3, Lower San Diego River (toad treatment site): This reach was not surveyed due to the limited period with surface flow, although it is suitable for

Table 3-2. Native and non-native aquatic vertebrate species observed during stream surveys in the study area in 2000 and 2001.

Site number	Survey site name	Native Species							Nonnative Species						
		Arroyo Toad	Coast Range Newt	California Treefrog	Pacific Treefrog	Western Toad	Two-striped Garter Snake	Pacific Pond Turtle	Crayfish	Bullfrog	Green Sunfish	Largemouth Bass	Trout	Black Bullhead	Mosquitofish
1	UPPER SAN DIEGO RIVER (toad control)	EGG STRINGS, LARVAE, ADULTS		X	X	X			X	X	X				
2	MIDDLE SAN DIEGO RIVER (toad treatment)			X	X		X		X	X	X	X			X
3	LOWER SAN DIEGO RIVER (not surveyed)														
4	LOWER BOULDER CREEK (newt treatment)										X				
5	MIDDLE BOULDER CREEK (newt treatment)		ADULTS	X	X	X	X						X		
6	UPPER BOULDER CREEK (newt treatment)		EGG MASSES, ADULTS	X							X		X	X	
7	LOWER CEDAR CREEK (newt control)	ADULTS	LARVA, ADULTS	X	X		X	X	X	X	X				
8	MIDDLE CEDAR CREEK (newt control)			X	X		X	X	X	X	X				
9	UPPER CEDAR CREEK (newt control)		ADULTS	X	X	X	X			X	X	X	X		

arroyo toads under conditions of adequate surface water. The habitat within this site is marginal or unsuitable for coast range newts.

Site 4, Lower Boulder Creek (newt treatment site): This creek bed was dry during the 2000 surveys, which is likely the reason that no newts were observed. Observations of coast range newts have been reported on this reach in the last several years by U.S. Forest Service personnel (John Stephenson, USFS, pers. comm.). The only aquatic species observed at this site was the exotic predatory green sunfish that occupied deep granite perennial bedrock pools at Three Sisters Falls. During the single 2001 survey in the upper portion of this reach no newts were observed.

Site 5, Middle Boulder Creek (newt treatment site): One juvenile introduced trout was observed prior to the entire site drying out in 2000. Adult and larva of the coast range newts were observed during the 2001 surveys. Other native species observed include California treefrogs, Pacific treefrogs, western toad, and two-striped garter snakes.

Site 6, Upper Boulder Creek (newt treatment site): Coast range newts were observed only in a tributary to the main channel in 2001. The native California treefrog was observed in 2000 and 2001. The exotic species observed in the main drainage were green sunfish, trout, and black bullhead (*Ameiurus melas*).

Site 7, Lower Cedar Creek (newt control site): The only arroyo toads observed within this site were 0.5 miles from the confluence of the San Diego River, where past records for this species exist. This site was dry for the majority of time during the last two years. However, adults and the larva of coast range newts were observed on one occasion in 2001. Other native species observed include California treefrogs, Pacific treefrogs, two-striped garter snakes, and a pond turtle. Exotic species observed include crayfish, bullfrogs, and green sunfish.

Site 8, Middle Cedar Creek (newt control site): Suitable breeding habitat (i.e., bedrock pools) for the newt is common throughout the main drainage, but the newt was not observed in either year. The exotic species observed in the main drainage were crayfish, bullfrogs, and the predatory green sunfish. The latter was observed in all these pools. It is quite possible that the sunfish is having a significant negative effect on the coast range newt along the reach. Additional exotic species observed in the main drainage were bullfrogs, largemouth bass, and trout. Native species observed include California treefrogs, Pacific treefrogs, two-striped garter snakes, and pond turtles.

Site 9, Upper Cedar Creek (newt control site): Adult newts were observed in rocky pools that persisted through June in the main drainage and in two tributaries during the 2000 and 2001 surveys. Other native species observed in both years include the California treefrog, Pacific treefrog, western toad, and two-striped

garter snake. The exotic species observed in the main drainage in both years were bullfrogs, green sunfish, largemouth bass, and trout.

The only arroyo toad reproduction found in the watershed in either 2000 or 2001 was on the upper San Diego River. Quantitative data for the limited arroyo toad reproduction in 2001 are presented in Table 3-3. Pool 1-1 may have been the source of egg masses for surrounding pools, including 1-2. Pools 1-1 and 1-2 were newly formed after rains in March 2001, which appears to explain the lack of predatory sunfish and crayfish. Water in the main pool was very clear, but a discontinuous benthic layer of organic detritus was present (toad larvae avoided areas of detritus, selecting clear sand substrate). Higher numbers of observed larvae on subsequent visits probably reflected the preference of metamorphosing larvae for shallow water, where they are more readily observed.

Table 3-3. Arroyo toad survey observations on upper San Diego River watershed, 2001 season.

Site # (Reach)	Pool # (Lat./Long.)	Date	Observations
1	1-1 (32.99291N, 116.73585W)	3-22-01	One egg string. Pool 15 X 4m; 1m deep. Dry prior to recent rain. No crayfish or fish. One bullfrog destroyed.
1	1-1	4-12-01	150 to 200 larvae, 10-15 mm TL[1], distributed over open sandy substrate. No other spp.
1	1-2 (32.99154N, 116.73671W)	4-12-01	Two larvae 10-15mm TL. Pool 5X4m; 0.25m deep. One bullfrog destroyed.
1	1-1	5-15-01	2000 larvae, 25-30mm TL, w/ hind legs. One toadlet 12mm SV[2]. Another 50+ larvae in 2 small pools (1X0.5m; 8 cm deep) 3m from main pool. One bullfrog not captured.
1	1-2	5-15-01	15 larvae of same stage as in pool 1-1. No other spp.

[1] TL = total length.
[2] SV = snout-vent length.

4.0 WORK PLAN FOR 2002

Results of predictive modeling by Scripps Institute of Oceanography, La Jolla, CA, suggests that rainfall for southern California for rain year (July-June) 2001/2002 will likely be below average, with the usual high degree of uncertainty (M. Dettinger, pers. comm.). If close to normal rainfall is received as predicted, it should provide the necessary conditions for both target amphibian species to breed within our study are enabling the USGS to track the developmental progress of the eggs and larva. However,

the opportunity for quantification and comparison of the effects of episodic natural flows against controlled flows is contingent upon water releases from Cuyamaca Reservoir.

Despite promising rainfall in November and December of 2001, subsequent winter rainfall has been below normal. As of early March, 2002, measurable precipitation for the season has been the lowest on record and there is no surface water on the upper San Diego River (E. Ervin, pers. comm.).

5.0 CONTRIBUTORS

Biological field studies were coordinated and conducted by Robert Fisher, Edward Ervin, and Manna Warburton of the U.S. Geological Survey, Biological Resources Discipline. Hydrological studies were conducted by Manna Warburton (BRD), Carmen Burton and Scott Patterson of the USGS, Water Resources Discipline. This report was prepared by John Lovio and Scott Fleury of Technology Associates International Corporation, and Edward Ervin, Manna Warburton, and Stacie Hathaway of U.S. Geological Survey.

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