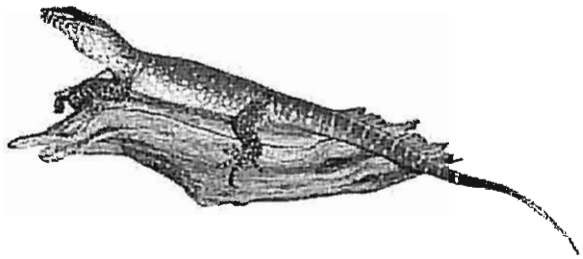
VARANUS MONITORING SERVICES



15 December 2005

Ms. Jeanne Krosch
Senior Planner
City of San Diego, Planning Department
202 C Street, MS 5A
San Diego, CA 9210

Subject: Spring 2005 Arroyo Toad Surveys in support of the MSCP Monitoring Program

Dear Jeanne:

In 1998, under contract to MEC Analytical Systems, Inc., Varanus conducted arroyo toad surveys in the San Pasqual Valley (MEC Analytical Systems 2000). We confined our surveys to lands owned by the city of San Diego along Santa Ysabel, Santa Maria, Guejito, and Cloverdale creeks and for a distance of approximately 1 km along the San Dieguito River, from its origin at the confluence of Santa Maria and Santa Ysabel creeks. We continued to monitor the San Pasqual Valley arroyo toad population through 1999, 2000 and 2001. During this period, virtually all of our work focused on arroyo toad occurrence and behaviors in the uplands surrounding the aforementioned creeks. During that period, breeding conditions never materialized, thus, no breeding surveys were conducted. In February of 2002, the city of San Diego awarded Varanus a contract to conduct breeding surveys for the arroyo toad (*Bufo californicus*) on city land in San Pasqual Valley. These surveys were designed and implemented to support the City's participation in the Multiple Species Conservation Program (MSCP). Survey conditions, which include suitable climatological conditions, appropriate time of year; and especially the presence of conditions suited to arroyo toad breeding - above-ground, low velocity flow along low-gradient stream beds of which sand and gravel comprise the substrate - did not materialize in 2002 within San Pasqual Valley. Nor did breeding conditions materialize in 2003 or 2004.

However, between 1 July 2004 and 30 June 2005, San Diego County received the third highest annual rainfall amount since records were first kept (1 July 1850 – 30 June 1851). San Pasqual Valley received approximately 24.2 inches through fall, winter and spring of the 2004-2005 accounting period. Sufficient rain had fallen by mid-February 2005 to create conditions suitable to arroyo toad breeding in the valley for the first time since 1998. The following is the report of our findings.

If you have any questions about its content or have additional data needs, please do not hesitate to call me.

Sincerely,

William E. Haas
President

Recommended citation: Haas, W. E. 2005. Status of the arroyo toad in San Pasqual Valley: Results of 2005 breeding season surveys. Report and field studies conducted under contract to the City of San Diego. 29pp.

STATUS OF THE ARROYO TOAD IN SAN PASQUAL VALLEY
RESULTS OF 2005 BREEDING SEASON SURVEYS

1.0 INTRODUCTION

1.1 MSCP Participation

By agreeing to implement the conservation, monitoring, and management measures specified in the San Diego MSCP, the city of San Diego (City) receives authorizations and permits from the U.S. Fish and Wildlife Service and the California Department of Fish and Game for loss of habitats and species due to development within the San Diego MSCP planning area. Participation in the MSCP requires involvement in a preserve management program that ensures maintenance of habitat quality that hopefully reduces threats to covered species and subscription to a biological monitoring program to assess the progress of the MSCP towards meeting its biological objectives.

The City has the responsibility to prepare and implement habitat management plans as well as management and biological monitoring of its MSCP lands. The MSCP has determined two processes to track MSCP implementation:

- Annual accounting of the acreage, type, and location of habitat conserved and destroyed (taken) by permitted land uses and other activities; and
- Biological monitoring to determine if the preserve system is meeting conservation goals for covered species (i.e., those species whose populations will be maintained or enhanced by MSCP actions).

There is a three-year response period, during which the City must prepare documentation in support of its MSCP participation, including

a. An MSCP status report,

b. A biological monitoring report prepared for the wildlife agencies, and

c. A report on preserve management activities and priorities.

Regular monitoring of plant and animal populations, therefore, is not only the primary means of determining overall health of biotic systems and observing population trends, but it has also been incorporated into the MSCP doctrine to ensure that participating agencies fulfill management responsibilities. These surveys were conducted in support of the city's MSCP monitoring responsibilities.

1.2 Species Description

One of the species for which the City, in accordance with its MSCP agreement, is responsible for monitoring is the federally endangered arroyo toad (*Bufo californicus*), a small (5–8 cm), stocky amphibian with an olive-green to gray, tan, or pinkish back, often with off-white or light-colored sacral and mid-dorsal patches; horizontal pupils; round to ovoid parotid glands; and a spotless cream-colored underside (Figure 1).

Confusion about the name of this small toad is common; frequently it is referred to as the southwestern toad or more commonly, the arroyo southwestern toad (AST in the literature). A review of its systematics helps clarify its current status and also helps explain the basis of the confusion. Originally described by C. L. Camp (1915) as *Bufo cognatus californicus*, a subspecies of the Great Plains toad, G. S. Myers recognized and named this "southern California toad" as a distinct species, *B. californicus* (Myers 1930). J. M. Linsdale described Nevada specimens of a physically similar population (now recognized as *B. microscaphus*) as subspecies of *Bufo compactilis*, the plateau toad (Linsdale 1940). F. A. Shannon's revision contradicted Linsdale's association and instead aligned the Nevada population with Woodhouse's toad (*B. woodhousii*) (Shannon 1949). However, R. C. Stebbins in his review of the taxonomic status of the Arizona (= southwestern) toad, *B. microscaphus* Cope 1866, including the Nevada specimens described by Linsdale, annulled previous associations of *microscaphus* with

the *cognatus*, *compactilis*, and *woodhousii* species groups (Stebbins 1951). He also included in its description two allopatric subspecies, the Mexican toad *B. m. mexicanus* Brocchi 1879, which occurs in the Sierra Madre Occidental of central Mexico south to Durango (Price and Sullivan 1988) and Myers' southern California toad, the historic range of which included the Salinas River Basin in Monterey and San Luis Obispo Counties to Arroyo San Simón in northern Baja California, México. This designation resulted in recognition of California populations as "arroyo southwestern toads" (*B. microscaphus californicus*). However, allozyme electrophoresis studies (that is, laboratory studies of protein migration rates in applied electronic fields) of the systematics of the *microscaphus* group by E. W. A. Gergus (1998) have established that the California and Mexican populations each represent distinct species, thus resurrecting to full species status the arroyo toad while establishing full species status to the Mexican toad (*B. mexicanus*).

Figure 1. Adult female arroyo toad on gravel road in San Pasqual Valley.

1.3 History of the Arroyo Toad Decline

Populations of this highly specialized, ecologically restricted amphibian have been in decline in since the early 20th century (Sweet 1989). Jennings and Hayes (1994) estimated that by the time of its listing (1994), the arroyo toad had been extirpated from 75% of its former range. Responding to the likelihood of its continued decline, the U. S. Fish and Wildlife Service listed the arroyo toad as an endangered species (U. S. Fish and Wildlife Service 1994). Recent field studies driven by its listing under the Endangered Species Act of 1973 indicate that the overall range of the arroyo toad is mostly intact; however, its distribution within that range has been greatly reduced.

Numerous factors have contributed to its decline. Damming of watercourses, which leads to the disruption of a hydrologic regime of sedimentation and scour; drawdown of water tables in the vicinity of breeding sites; and loss and fragmentation of upland habitats are among the leading causes (Campbell et al. 1996). In addition to changes in hydrologic regime, numerous other factors contribute to the continuing decline of the arroyo toad including the harmful effects of exotic plants and animals. Overlapping the range of the arroyo toad are numerous species that pose threats to the arroyo toad including red swamp crayfish (*Procambarus clarkii*), which may eat and disrupt the development of arroyo toad eggs and larvae, and bullfrogs (*Rana catesbeiana*), which may devour arroyo toads of any stage of development (W. Haas personal observation). Proliferation of exotic plants, for example tamarisk (*Tamarix* spp.) and giant reed (*Arundo donax*), which occur extensively along riparian corridors, may lead to reduced arroyo toad breeding success (Haas 2006).

Finally, eggs and larvae of the arroyo toad are highly susceptible to sedimentation (Sweet 1992). Disturbances to creeks when surface flows are present may disrupt arroyo toad breeding and cause deposition of sediments in the vicinity of breeding pools; these may reduce or eliminate arroyo toad fecundity (Campbell et al. 1996). Disturbances that occur between the disappearance of aboveground flows and the drying of surface substrates may be equally devastating by directly causing

mortality of adults and young. This period is especially important to recently metamorphosed young of the arroyo toad, which are restricted to moist streambed environs until they are strong enough to bury themselves into daytime hibernacula.

2.0 DESCRIPTION OF THE SURVEY AREA

The City's San Pasqual Valley properties include approximately 14,000 acres that are owned for the most part by the City's Water Utilities Department. The valley is located in the northernmost portion of the City. The city of Escondido forms its northern boundary; unincorporated lands of San Diego County border the valley on the east and west; and on the south, its boundary is formed by the city of Poway and the San Diego community of Rancho Bernardo.

Agriculture dominates the valley's landscape; crops are grown in orchards (e.g., avocado) and groves (e.g., citrus); on vines (e.g., grapes); and in fields (e.g., corn and ornamental flowers). Several dairies persist in the valley along with many acres of pasture land. Native riparian habitats are distributed along its major drainages, including Santa Ysabel Creek, Santa Maria Creek, a small segment of Guejiito Creek, and along the San Dieguito River. Upper terraces along its major drainages and hillsides are dominated by sage scrubs, chaparrals, and oak woodlands.

Habitats in the vicinity of our surveys can be described by the following Oberbauer (1996) vegetation communities:

Uplands: Eucalyptus Woodland (11100), Disturbed Habitat (11300), and Non-native Grassland (42200).

Wetlands: Disturbed Wetland (11200), Emergent Wetland (52440), Southern Arroyo Willow Riparian Forest (61320), Mule Fat Scrub (63310), Southern Willow Scrub (63320), Tamarisk Scrub (63810), and, lacking Oberbauer designations, open water and unvegetated sandbar.

Riparian habitats within the study area (including habitats identified as Southern Arroyo Willow Riparian Forest, Southern Willow Scrub, Disturbed Wetland,

and Tamarisk Scrub) are very widely distributed and vary in physical structure, stand age, and composition. Widths of the valley's riparian corridors vary from single shrubs to more than 400 feet wide. The most abundant vegetation within these corridors are Goodding's black willow (*Salix gooddingii*), red willow (*S. laevigata*), narrow-leaved willow (*S. exigua*), tamarisk (E), giant reed (E), mulefat (*Baccharis salicifolia*), and rabbit's-foot grass (*Polypogon monspeliensis*) (E). Several large gum tree (*Eucalyptus* spp.) (E) windrows are present in or immediately adjacent to riparian habitats. Another four species were found to be common in the riparian corridors: Arroyo willow (*S. lasiolepis*), Emory's baccharis (*B. pilularis*), salt heliotrope (*Heliotropium curassavicum*), and salt grass (*Distichlis spicata*). Four of the dominant riparian plant species are exotic invasive species (designated with an "E" following their listing). Native species comprise the preponderance of the total plant cover within the (riparian) project area but non-natives, especially tamarisk and giant reed, may over time threaten their dominance.

Our 2005 breeding survey study area included portions of Santa Ysabel Creek, Santa Maria Creek, Guejito Creek, and the San Dieguito River. We divided the survey area into seven sections (Figures 2 and 3).

1. Santa Maria Creek from Bandy Canyon Road to Ysabel Creek Road (1.4 km) – this section was accessed from Bandy Canyon Road where it crosses the creek.
2. Santa Maria Creek from Ysabel Creek Road to the Santa Ysabel Creek/Santa Maria Creek confluence (1.4 km) – this section was accessed from the south via Ysabel Creek Road.
3. Santa Ysabel Creek from the east side of Cranes Peak to SR-78 (2.0 km) – this section was accessed from SR-78 via a dirt road that passes through citrus groves along the northern edge of the creek.

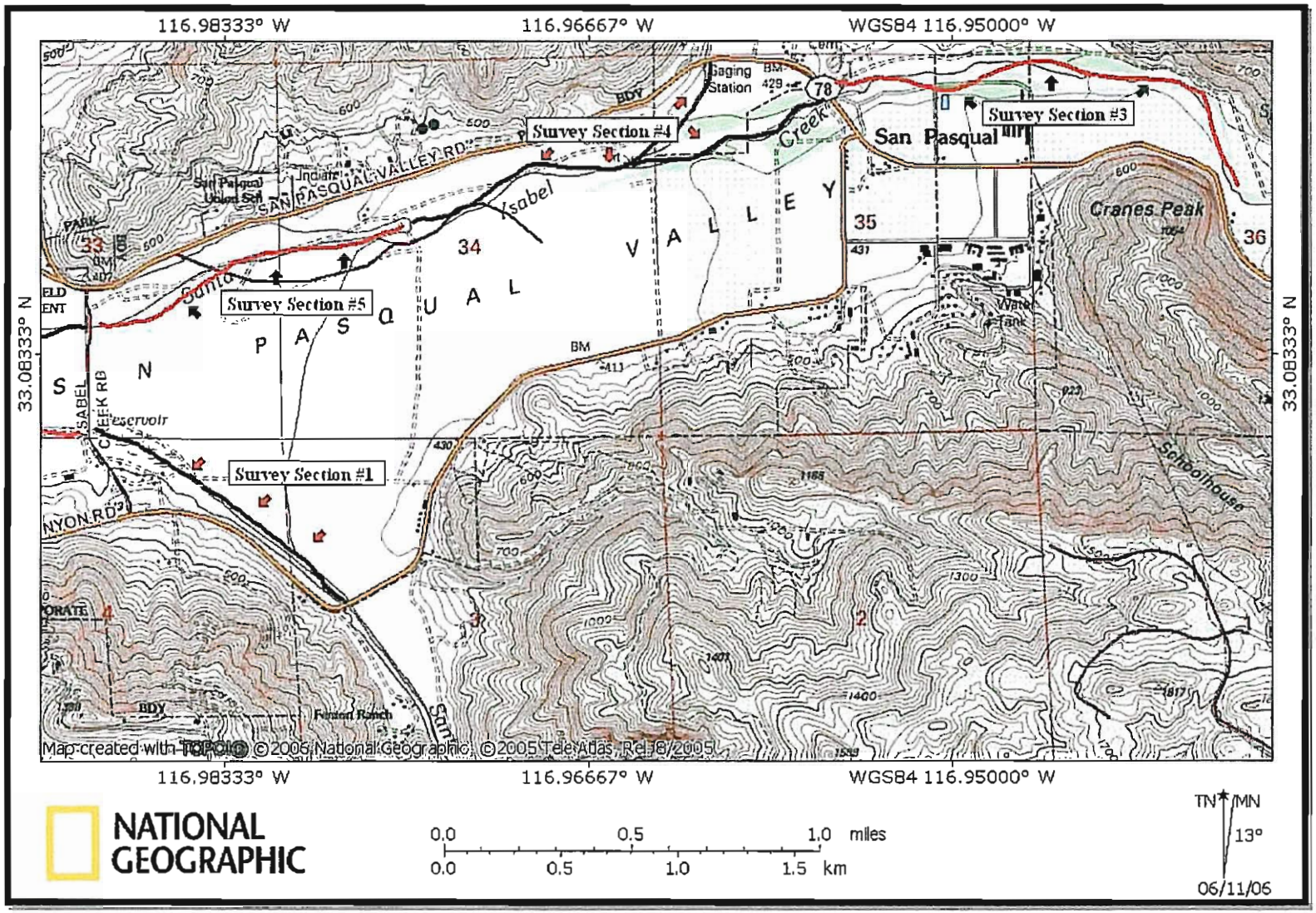


Figure 3. San Pasqual Valley arroyo toad survey routes, Sections 1, 3, 4, and 5.

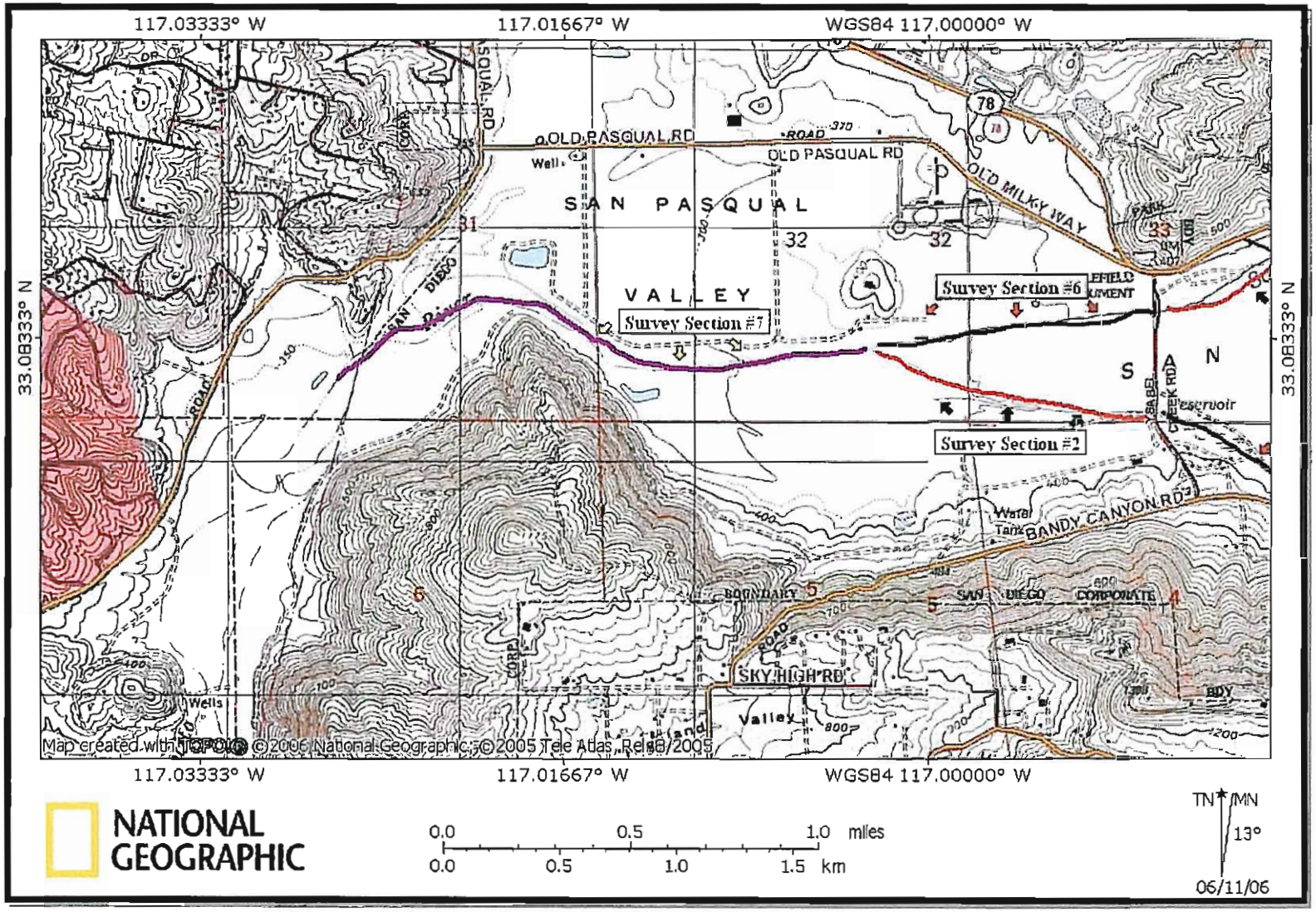


Figure 3. San Pasqual Valley arroyo toad survey routes, Sections 2, 6, and 7.

4. Santa Ysabel Creek from SR-78 to the Whitman Ranch road (a dirt farm road) (2.0 km) – this section was accessed directly from SR-78;
5. Santa Ysabel Creek from Whitman Ranch road to Ysabel Creek Road (1.4 km) – this section was accessed from the north off SR-78; entry was obtained through a gated entryway through the Whitman Ranch.
6. Santa Ysabel Creek from Ysabel Creek Road to the Santa Ysabel Creek/Santa Maria Creek confluence (1.2 km) – this section was accessed from SR-78 via Ysabel Creek Road.
7. San Dieguito River from its origin at the Santa Ysabel Creek/Santa Maria Creek confluence to Cloverdale Creek (2.4 km) – this section was accessed from the north off Old Pasqual Road via a dirt farm road.

3.0 METHODS

Following the 2002 season during which breeding conditions failed to materialize, we established four monitoring stations in the valley (Figure 4). We used these monitoring stations to determine if and when breeding conditions along Santa Ysabel and Santa Maria creeks materialized. These stations augmented our study at 16 other San Diego County sites at which we were monitoring arroyo toad breeding cycles. The San Pasqual Valley monitoring locations were the following:

1. Santa Ysabel Creek at SR-78.
2. Santa Ysabel Creek at Ysabel Creek Road
3. Santa Maria Creek at Ysabel Creek Road, and
4. Santa Maria Creek at Bandy Canyon Road.

From these stations we monitored stream flow and arroyo toad advertising.

When breeding conditions are present, arroyo toads may be heard from each of these sites and stream flow at these observation points is indicative of conditions throughout the valley. We observed that breeding conditions persisted for extremely

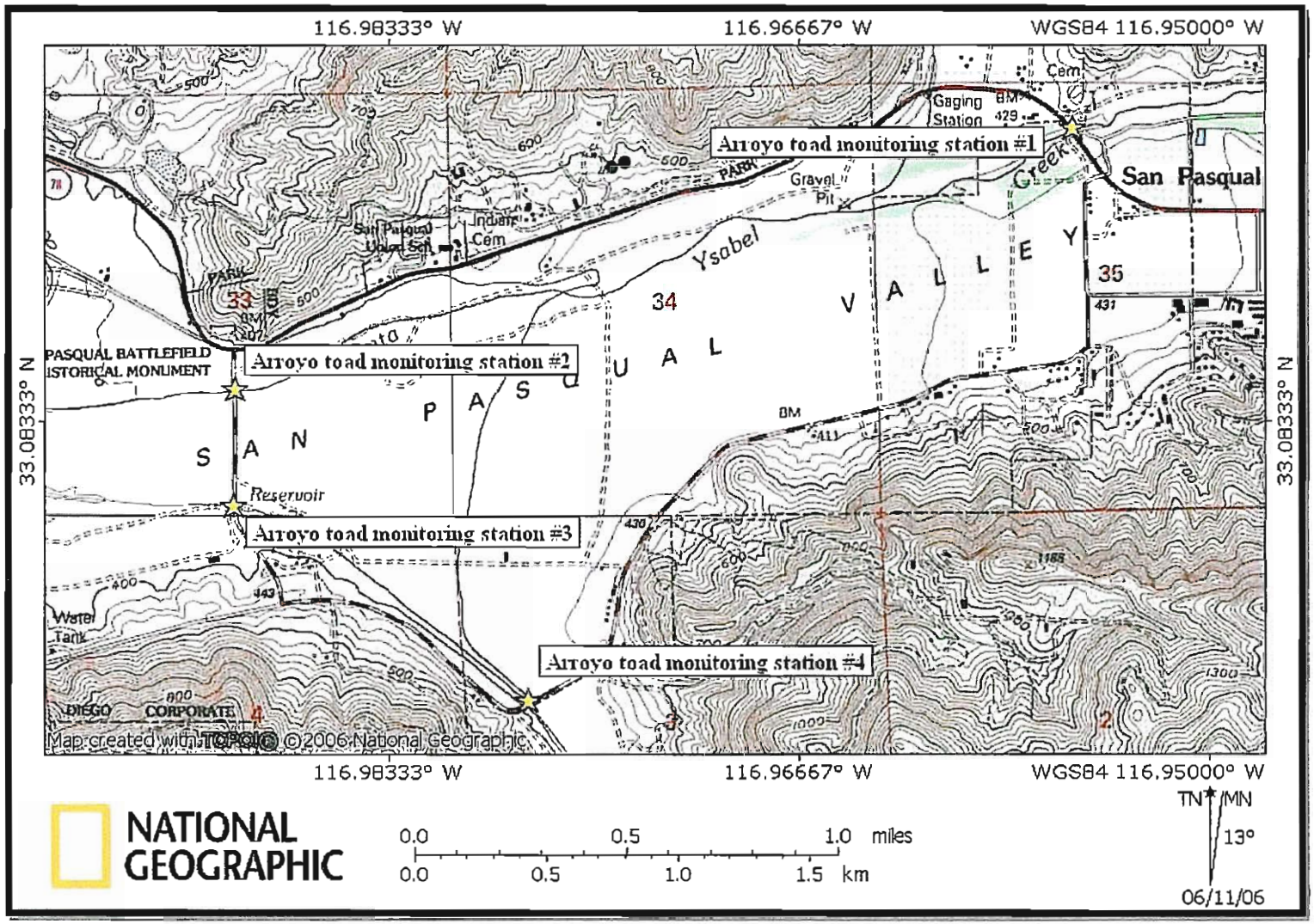


Figure 4. San Pasqual Valley arroyo toad monitoring sites.

short periods in 2003 and 2004 and from 1999 through 2004 there was no arroyo toad recruitment in San Pasqual Valley (Varanus field notes).

Using a survey crew of four persons each night, each survey required two nights to address the entire length of the study area. We arrived at the study area prior to sunset. Our surveys were timed to begin approximately ½-hour after sunset although onset of advertisement by arroyo toads was frequently used to determine start time.

Start and end times were collected for each survey along with ambient, water, and dry sand temperatures, wind speeds, cloud covers and moon phases. Survey routes were document with handheld GPS units (accuracy ± 3m) as field observers walked along the river. GPS waypoints and observation times were collected for individual arroyo toads; arroyo toads that were clustered (e.g., around the edge of a sand bar) were enumerated and one location reference was recorded for the group. Arroyo toad locations were annotated by number of individuals observed, sex of the individuals, and presence of larvae and/or egg strands (Table 1).

Arroyo toads were searched for using aural and visual cues. Aural detection involved listening for the trill of advertising adult male arroyo toads. Visual detection involved a search for eye shine (tapetal response to high intensity headlamps) and/or direct observation of moving and motionless individuals, especially by scanning the edges of sandbars and of the river's edge. Care was taken to periodically look and listen back toward the area already surveyed to detect toads that might not have been detected (for example, because the toad was facing away from the observer and thus presented no eye shine) or that might have emerged after the surveyor had passed. Once an individual, small group, egg strand or larvae had been identified, the location and time was logged onto a handheld GPS unit and the data recorded in field notes.
Bullfrogs (*Rana catesbeiana*) were also located by the same methods. The bullfrog, an exotic-invasive introduced to California in the 19th Century, is a potential predator of the arroyo toad. When possible, we hand-captured and euthanized bullfrogs during

our arroyo toad surveys. Euthanized bullfrogs were gutted and their stomach and intestinal contents recorded.

Biologists conducting the arroyo toad surveys included the study's Principal Investigator W. Haas and field biologists J. Konecny, K. Skrivseth, K. Alberts, A. Zych, and K. Bender.

4. 0 RESULTS

4.1 Summary of Survey Results, 2002 - 2004

In 2002, the first year of this contract, we recorded no above ground flow within Santa Ysabel, Santa Maria, or Guejito creeks, or along the San Dieguito River east of Lake Hodges. The period from 1 July 2001 to 30 June 2002 was the driest on record for coastal San Diego County; records for the County date back to the period 1 July 1850 to 30 June 1851. Because of the lack of suitable conditions in which to conduct protocol surveys, we did not visit the site other than to document stream flow, or rather, the lack thereof.

In 2003 we again monitored stream flow (and calling activity) from our four San Pasqual Valley monitoring sites hoping to document the timing (initiation and duration) of arroyo toad breeding activity following the three-year drought. We visited the San Pasqual Valley sites weekly from 25 February through 18 April. Although we continued to monitor breeding populations at other San Diego County study sites through mid-June, we discontinued our visits to the San Pasqual Valley sites in mid-April because of the lack of above ground flow. Despite a season of slightly above average rainfall, the Santa Ysabel Creek and the San Dieguito River experienced no above ground flow, while Santa Maria and Guejito creeks experienced limited flows for a few days only on two occasions (in mid-March and again in mid-April). On 19 March 2003, biologist Kylie Fischer detected a single calling adult male arroyo toad in Santa Maria Creek, approximately 75 meters north of Bandy Canyon Road. Attempts to survey in 2004 resulted in similar findings: Other than brief periods of male

advertisement along Santa Maria Creek, we found no other evidence of breeding activity.

4.2 2005 Survey Summary

We re-initiated annual monitoring at the San Pasqual Valley sites in mid-February of 2005. During our first monitoring visit (on 15 February) we found stream flows that presaged valley breeding conditions for the first time since 1998. We continued to monitor conditions weekly and found advertising adult male arroyo toads near all four monitoring sites in early March (8 March was the date of the first detection). However, a storm that brought approximately 1.13 inches of rain to the valley between 18 and 24 March (along with augmented surface flows emanating from the watershed at higher elevations) caused Santa Ysabel and Santa Maria creeks to swell eliminating most of the emergent arroyo toad breeding sites. Beginning one week after that late March storm (on 1 April), we conducted a cursory survey to determine the extent of breeding activity. At that time male advertising behaviors had been re-initiated; however, conditions were not ideal for breeding as the creeks in many areas continued to exhibit bank to bank flows that limited the amount of suitable arroyo toad breeding habitat. Since we had as our focus the determination of maximal numbers and distribution through the valley of the arroyo toad, we again postponed surveys in anticipation of overall more suitable breeding conditions.

We again initiated surveys on 14 April when surface flows had subsided sufficiently to provide breeding conditions throughout the study area. Results of those surveys yielded arroyo toad numbers far less than we had documented in 1998. We scheduled our next survey for two weeks hence. In anticipation of a storm predicted for 27 April, which ultimately persisted through 29 April, we conducted surveys on the night of the 26th. Breeding conditions were absent from most of Santa Ysabel Creek between SR-78 and the San Dieguito River. Breeding conditions persisted along Santa Maria Creek and east of SR-78 along Santa Ysabel Creek. Immediately following our 26

April survey, the area was again beset by rainfall; during this period the valley amassed approximately 1.2 inches of precipitation. Following the storm, Santa Ysabel Creek exhibited its greatest surface flow of our entire sampling period. This late April storm also appeared to stimulate adult male arroyo toad migration to breeding sites and commencing on 2 May we conducted weekly surveys through 2 June at which time surface water along all survey routes was absent or discontinuous and advertising toads were restricted to small, scattered breeding sites. Based on our detection of neonate arroyo toads in mid-May (on the 17th and 18th) it is apparent that successful breeding had been initiated in the period between late February and mid-March. However, the peak of breeding activity occurred within the month of May.

4.3 Results of 2005 Surveys

In 2005, we first documented arroyo toad breeding behavior (specifically, male advertisement) at various locations in the vicinity of our monitoring sites between 14 and 17 March. The valley is sufficiently large that we suspected breeding had commenced even earlier in the year; however, elevated flows rendered unusable much of the breeding area that we documented in 1998. The discovery of several clusters of neonate arroyo toads during our mid-May surveys indicate that recruitment resulted from breeding events of early to mid-March and possibly late February. Maximal breeding conditions did not materialize until late-April through mid-May. Since the goal of our surveys was to attempt to enumerate and determine extent of breeding habitat, we focused our surveys during the latter period.

During the peak of the breeding season we found the maximum number of advertising males and amplexing pairs between 2 and 4 May. This followed closely the

TABLE 1. 2005 ARROYO TOAD SURVEY RESULTS SAN PASQUAL VALLEY, SAN DIEGO, CALIFORNIA						
SURVEY AREA	**26-27 April**	**2-4 May**	**9-10 May**	**17-18 May**	**25-26 May**	**1-2 June**
Santa Maria Creek (SMC)						
Bandy Canyon Rd. to Ysabel Creek Rd.	16 AM/2AA LP	21AM LP	27AM/2F/2AA LP	34AM/3AF LP	13AM/2AF/28N LP	7AM/1AF/71N LP
Ysabel Creek Rd. to Confluence	18AM/3AF/2AA LP	36AM/3AF/3AA LP	11AM/1AF LP	41AM/2AF/3A A	17AM/	2AM/20N LP
Santa Ysabel Creek (SYC)						
Cranes Peak to SR-78	23AM/1AF LP	67AM/2AA LP	68AM/2AA LP	41AM/2AF/14N LP	31AM/136N LP	14AM/2F/148N NLP
SR-78 to Whitman Farm Road	5AM NLP	56AM LP	8AM/1AF LP	6AM/2AF/6N NLP	7AM/30N NLP	2AM/1AF/16N NLP
Whitman Farm Road to Ysabel Creek Road	1AM/2AF NLP	26AM/7AF/2AA NLP	11AM/2AA LP	3AM/2AF NLP	4AM NLP	1AM/1AF NLP
Ysabel Creek Road to Confluence	3AM/1AF NLP	8AM/1AF NLP	7AM/2AF LP	1AM NLP	1AM/1AF NLP	3AM/1AF/3N NLP
San Dieguito River						
SYC/SMC Confluence to Cloverdale Creek	12 AM/3AF/4AA LP	56AM/6AF/2AA LP	53AM/3AF/2A A LP	46AM/3AF/1A A LP	38AM/4AF/35N LP	25AM/2F/31N NLP

Key: AM: Adult male arroyo toad AF: Adult female arroyo toad AA: Adult male/female in amplexus J: Juvenile arroyo toad
L: Larval arroyo toad (LP = larvae present; NLP = no larvae present)

rainfall event of 27 -29 April when conditions in the valley were optimal for arroyo toad breeding. Earlier in the season portions of the study area were appropriate for breeding while other areas (especially along Santa Ysabel Creek) lacked surface water while in other areas (especially along Santa Maria Creek) surface flows covered the creek bed from edge to edge providing little arroyo toad breeding habitat. Between 2 and 4 May we documented in our seven study areas a total of 270 adult males and nine amplexing pairs (Table 1). We found amplexing pairs through surveys of 17-18 May but by the time we conducted our early June surveys (1-2 June), most of our observations were of individuals (adult males, adult females, and neonates) within or along moist, sandy soils of the creeks and river. We documented advertising males only along Santa Ysabel Creek east of SR-78. Much of the remainder of Santa Ysabel Creek exhibited dry, sandy substrate from which arroyo toads were virtually absent (we found 9 adults along an approximately 4 kilometer distance, most of which were observed near the confluence with Santa Maria Creek, where surface water was present but patchily distributed) or in the short distance between SR-78 and where the Santa Ysabel meets Guejito Creek, an area is immediately adjacent to the area that harbors the densest population of arroyo toads in San Pasqual Valley, that is, the area between Crane's Peak and SR-78

4.4 Results of Bullfrog Stomach Content Analysis

We euthanized a total of 26 bullfrogs during our arroyo toad surveys: Twelve adult females, nine adult males and five sub-adult/juveniles (Table 2). Seven of these were found to have empty stomachs; three of five sub-adult/juveniles (60%) lacked discernable stomach contents while only two of 12 adult females (17%) and two of nine adult males (22%) were so disposed. Food items recovered from the remainder of the captured bullfrogs included bullfrog (1), chorus frog (7), crayfish (8), and insects (12). Bees and wasps comprised the greatest proportion of the insect fauna. Plant

material/detritus was found in more than 50% of the stomachs we examined but we considered its ingestion was incidental to feeding.

Table 2. Demographics and Diet of the Bullfrog in San Pasqual Valley
Results collected during 2005 Arroyo Toad Surveys

Data from Santa Ysabel Creek, Santa Maria Creek, and the San Dieguito River

Age	Adult	Adult	Juvenile	
Sex	Female	Male	U/K	Total[1]
Number captured	12	9	5	26
Stomach Contents[2]				
empty	2	2	3	7
bullfrog	0	1	0	1
chorus frog	3	4	0	7
crayfish	2	4	2	8
wasps/bees	3	4	0	7
insect larvae	2	2	1	5

Key
bullfrog - *Rana catesbeiana*
chorus frog - *Pseudacris regilla; P. cadaverina also* occurs in area but none were found in stomach contents
crayfish - *Procambarus clarkii* (red swamp crayfish)
[1]Content totals do not equal 100%
[2]Plant material/detritus found in numerous stomachs but considered incidental to feeding

5.0 DISCUSSION

5.1 Activity Cycle of the Adult Arroyo Toad in San Pasqual Valley

Adult arroyo toads are almost exclusively nocturnal. In San Pasqual Valley, as in other coastal locations, we found arroyo toads active during all months of the year, irrespective of whether or not breeding had occurred during the previous breeding 12-month period. Non-breeding season activity was strongly correlated with rainfall. We did not correlate breeding season upland activity with any one factor; however, hot days and reduced soil moisture was correlated with cessation of activity - we documented very few observations of the arroyo toad in August and September, except in the vicinity of irrigated agricultural land. We recorded the earliest male advertising in February (26 February 1998) and in March of several other years (e.g., 2003 and 2005). Thus the onset of breeding matches what has been reported for near coastal sites in Orange and San Diego counties. Abnormal weather patterns may trigger earlier or later breeding of the arroyo toad; for example, breeding may be initiated as early as January (Holland and Goodman 1998b). In San Pasqual Valley, breeding may persist into early summer; in July of 1998 we documented egg deposition along Santa Maria Creek as late as 7 July (MEC Analytical 2000) when breeding conditions resulting from a winter El Nino and several previous above-average rainfall years persisted beyond what might be expected in an average rainfall year.

Because of surface water levels (that is, its presence in 2005 and absence from 2002 to 2004), breeding activity resulted in recruitment during this study only in 2005, the first recruitment in San Pasqual Valley since 1998. This means that breeding adults censused in 2005 were minimally seven years of age; that is, if only individuals from 1998 recruitment (when larvae hatched emerged in late February through early July) comprised the breeding cohort. Although it is possible that some of the 2005 breeding cohort was derived from upstream meta-populations (especially from Santa Ysabel Creek, but it is far less likely to have come from the Santa Maria Creek cohort in Santa Maria Valley, which is separated from San Pasqual Valley by an abrupt elevation

change through a narrow gorge), the number of individuals found and their distribution throughout the valley belie any possible explanation beyond longevity. Therefore the predominant age of the breeding cohort in 2005 was minimally seven.

Breeding of the arroyo toad in San Pasqual Valley is restricted to Santa Ysabel, Santa Maria, and Guejito creeks and along the upper portion of the San Dieguito River. All of these areas possess characteristics of typical arroyo toad breeding habitat - low gradient, sandy-bottomed channels – adjacent to sandy terraces of varying degrees openness and cover. Deposition of eggs and growth of larvae usually occur in shallows along the edges of sandy pools, within ox-bows, and along sandbars within stream channels with little or no current or emergent vegetation. In 1998 we found that arroyo toads used ponded water for breeding sites where Santa Maria Creek and Santa Ysabel Creek intercepted Ysabel Creek Road; during emergency road construction, an accumulation of native soils had been placed to span each creek along with several metal culverts to allow creek flow to pass beneath. As a result, once surface flows began to wane, ponded water developed immediately upstream of Ysabel Creek Road at both sites and immediately downstream along Santa Maria Creek. Recruitment was documented from pooled water along Santa Maria Creek on both sides of the road but not from Santa Ysabel Creek.

All breeding sites in San Pasqual Valley have been adjacent to sandy terraces where, typically, arroyo toads spend the greater part of their lives (W. Haas field data). Areas of open sand surrounded by patches of riparian vegetation of which mule fat and arroyo willow were typical components of terrace vegetation describes the situation where we most frequently found adult and juvenile arroyo toads during fall and winter rains. Beyond these terraces, arroyo toads invaded other upland associations including sage scrubs, agricultural field edges (but they rarely migrated into cultivated ag fields), citrus groves, and coast live oak woodlands. During the breeding season adult male arroyo toads were observed moving to and from breeding sites over relatively short distances (avg. = 5.2 m; n=112). Adult male arroyo toads retreated from breeding pools

to burrow into sandy substrate after prolonged nights of calling. Cooler nights were associated with earlier departures from breeding sites than were warmer nights, which were typical later in the breeding season.

Adult male toads constitute the preponderance of individuals detected during breeding surveys including our surveys in San Pasqual Valley. Visual searches of sandy terraces adjacent to breeding sites during the breeding season usually revealed adult females and, to a lesser extent, (unsexed) juveniles and sub-adults. During non-breeding season surveys we typically encountered similar numbers of adult males and females, which is true also at all of our other study sites (e.g., Sloan Canyon along the Sweetwater River and in Santa Maria Valley along Santa Maria Creek). Except to breed, adult females typically remain on terraces and in nearby upland habitats where they forage and secure daily refuge; females may move to breeding sites when sufficiently nourished and their eggs fully developed. When a female arroyo toad does visit a breeding site, it is typically in response to one or more calling males. Thus her success in finding a male is quite high. Adult females usually deposit eggs no more than once per breeding season (Sweet 1992) and in some years not at all in spite of the presence of breeding habitat and advertising males. Only rarely do female arroyo toads move to streams and creeks and their breeding sites other than to breed. Near the end of and following the breeding season, adult male arroyo toads may hydrate in quiet pools or meanders (D. Holland personal communication). Females hydrate more commonly during fall, winter, and spring rains by emerging periodically from burrows. Their sensitivity to potential desiccation is demonstrated by their rapid retreat into the ground once rainfall has ceased (personal observation).

Males may advertise at night for extended periods (weeks to months); however, brief periods of calling activity (days to weeks) may be more typical following periods of low annual rainfall or other stress factors. Occasionally amplexing (mating activity in which sexual clasping of the female by the male stimulates the external release of eggs

and sperm for fertilization) adults may remain at a breeding site well into daylight; however this is atypical.

Once seasonal calling behavior has ceased, adult male arroyo toads return to upland areas to forage and secure daily refuge. Until conditions become unsuitably hot and dry, adult and sub-adult arroyo toads spend daytime hours sequestered in shallow burrows and emerge at night to forage. Adult arroyo toads feed on a variety of insects and mollusks (crickets, beetles, ants, snails); juvenile arroyo toads feed on small insects, especially small beetles and ladybugs (W. Haas personal observation). Neonate arroyo toads are voracious predators and actively pursue a variety of small beetles and bugs that occur on drying but still moist creek bed soils. Although ants reportedly constitute a major food source for neonates in some populations, we never observed this behavior in more than 20 hours of observations of San Pasqual neonates.

From mid-August to early October, which is typically the hottest, driest period in southern California, arroyo toads are rarely abroad. At this time they typically aestivate by burrowing into friable soils. Long distance movements (on the order of a kilometer or more) are rare at this time. However, some individuals may emerge and move about at night during periods of high humidity; we found arroyo toads active in San Pasqual Valley as early as late October (2003, 2004) when relative humidity exceeded 60% and temperatures exceeded 12° C (55° F). In the southern part of their range arroyo toads can be active at any time when favorable conditions prevail (W. Haas *in prep*). Moreover, a large percentage of an area's population may be active during periods of moderate to heavy rains when temperatures exceed 10° C. All age groups may use these periods to forage, however hydration and dispersal appear to be the primary benefits from these excursions. Unlike the predominantly male occurrence of arroyo toads at breeding sites, similar numbers of males and females are typically abroad when conditions are favorable outside of the breeding season. Conversely, outside of the breeding season arroyo toads are rarely active when temperatures fall below 9° C. (48.2° F.) and become inactive when body temperature falls below 8° C.

(46° F.) (W. Haas unpublished data). We found this to be true as well in San Pasqual Valley through six years of monitoring.

Following the end of the breeding season, the distance that arroyo toads move from breeding sites is related to rainfall amount; arroyo toads remain close to breeding sites during the driest years and wander farthest abroad when rainfall is distributed throughout the non-breeding season (W. Haas *in prep.*). Elevated levels of soil moisture apparently favor a broader spectrum of usable substrates while frequent rains allow and probably encourage more frequent and random movements. Most individuals, however, remain on the sandy terraces that adjoin breeding sites; fewer individuals move into and forage in nearby upland habitats (W. Haas *in prep.*). Although female and male arroyo toads appear to be active in equal numbers during rain events, males were typically found at greater distances from breeding sites; on average, juvenile/sub-adult males moved the greatest distances from breeding sites and were the most commonly detected age group during winter surveys on Bandy Canyon Road (W. Haas *in prep*).

5.2 Distribution of Arroyo Toads in San Pasqual Valley

Surveys conducted during April, May, June, and July of 1998 documented the presence of the arroyo toad within and along Santa Ysabel, Santa Maria, and Guejito creeks and along portions of the San Dieguito River (MEC Analytical Systems 2000). Their distribution was relatively uniform along each of the three creeks; greatest densities were found along Santa Maria Creek between Bandy Canyon Road an Ysabel Creek Road (Survey area #1) and along Santa Ysabel Creek between the east side of Cranes Peak and SR-78 (Survey area #3). Lowest densities were found along Santa Ysabel Creek between Guejito Creek and the origin of the San Dieguito River (Survey areas # 4 and 5); surface flows were shorter-lived in this area as well. Highest local densities were typically found along in-stream sand bars where adult males typically clustered in groups of three to ten individuals (up to a maximum of 17) along in-stream

sand bars, where they assembled to advertise for females. Within San Pasqual Valley Santa Ysabel, Santa Maria, and Guejito creeks are relatively open (that is, they lack a vegetation canopy and minimally support fast-growing invasive species such as tamarisk, giant reed, and cattails); however, along Santa Maria Creek upstream from where it joins Santa Ysabel Creek to form the San Dieguito River, the riparian habitats become denser and the creek bed is more regularly enclosed beneath a canopy composed of willows and cottonwoods. In this portion of Santa Maria Creek arroyo toads were more irregularly distributed; we found calling males often clustered on isolated sand bars along the river where the canopy was absent and the ground cover sparse. We infrequently found adult males advertising while they floated among sapling willows and cottonwoods within the river channel. The arroyo toad occurs along the San Dieguito River downstream from its confluence with Cloverdale Creek. However, as the river narrows, a dense riparian overstory limits arroyo toad breeding to scattered patches of open sand and ultimately, breeding habitat has been eliminated where the river has become channelized.

Upland surveys conducted between 1998 and 2004 found the arroyo toad most densely distributed on the sandy terraces between Santa Ysabel and Santa Maria creeks and along the edges of the agricultural fields which gird the valley's riparian habitats; we often found arroyo toads along the farm roads at the periphery of agricultural fields, but rarely within the tilled fields. When we found adult females in the uplands, they were often clustered in pockets of open sandy habitat with sparse, patchy herbaceous cover – this suggests not that individuals have a social system by rather that this is the arroyo toad's favored upland habitat in the valley.

We occasionally encountered arroyo toads in citrus groves where we found them not only moving along vegetation-free dirt access roads but also burying themselves into or emerging from the friable soils immediately surrounding citrus trees where mechanical disturbance by farm equipment is minimized. Between April of 1998 and

February of 2005 we found a small number of arroyo toads (n=2) along SR-78 despite the examination of more than 250 *Bufo* carcasses. However, we frequently encountered arroyo toads and arroyo toad carcasses along Bandy Canyon Road (see Figure 3). We infrequently found arroyo toads in the coastal sage scrub south of Bandy Canyon Road south of Santa Maria Creek; however, over a six-year period we dedicated fewer than five hours to directed searches in the uplands south of Bandy Canyon Road. It is probable that our data underestimate the arroyo toad's use of hillside sage scrubs south of Santa Maria Creek.

5.3 Threats to the Arroyo Toad

San Pasqual Valley and the watershed that feeds its creeks and river are home to the third largest meta-population of arroyo toads in San Diego County. Only the watersheds that feed the Santa Margarita (some of which lies within Riverside County) and San Luis Rey rivers harbor greater numbers of arroyo toads. All three riparian systems, however, harbor potentially injurious exotics including invasive plants (e.g., tamarisk and giant reed) and exotic predators (e.g., red-swamp crayfish and bullfrogs).

Off-road vehicles and foot traffic by humans and livestock are common in the riparian corridors of San Pasqual Valley, especially along Santa Ysabel Creek (personal observation). These are often associated with routine travel between ag lands north and south of the creek, and also at the confluence of the Santa Ysabel and Santa Maria creeks. Illegal use is also common and access points are numerous. Quicksand inhibits travel along the stream bed when the creek is flowing; however, the drying creek bed is an attractive nuisance, which results in illegal use at a time when the potential to adversely affect arroyo toads is greatest.

More difficult to detect are the causes and effects of changes in water table. In southern California, where riparian systems are few and isolated, and where annual

rainfall is highly variable – in the study period alone, San Diego County experienced its lowest (2001- 2002) and its third highest (2004-2005) annual rainfall totals since data collection was initiated in 1850 – the arroyo toad may not be expected to breed annually. Thus, if the water table is further altered by unmetered use, the periodicity of breeding conditions may be extended beyond what has been accommodated through the arroyo toad's adaptations to natural climate cycles.

6.0 RECOMMENDATIONS

Monitoring strategies and protocols must be well-designed, practical and practicable. Monitoring of the arroyo toad presents a great challenge, especially in the southern portion of its range where annual rainfall totals vary sufficiently that breeding activity may be expected not to occur with regularity. This is especially true because, in the absence of breeding conditions, the activity cycle of the arroyo toad is intimately tied to rainfall (Haas 2001); high relative humidity also favors above-ground activity but not to the extent that a survey protocol may rely on this factor. The U. S. Fish and Wildlife Service has developed a presence/absence survey protocol (USFWS 1999) that is highly practicable, and which under certain circumstances is well-suited to detect the presence of and possibly provide some indication of population size based on the number of adult males detected. However, the protocol is not a practical solution for either detection or monitoring of the arroyo toad in drainages that do not have regular, if not annual rainfall. Even in years when rainfall is "above average" (that is, relative to recent historic rainfall amounts), when breeding conditions should be expected, there is no guarantee that every site will have adequate conditions to support breeding activity and thus validate the protocol. For these reasons, surveys for and monitoring of arroyo toad populations must be conducted opportunistically. Specifically, they must be scheduled with sufficient flexibility to accommodate variability in annual rainfall, periodicity of rainfall, and local conditions, especially the status of the local water table.

They must also take advantage of the height of breeding activity, which my be periodic and/or fleeting.

Although there is a requirement for the City to conduct tri-annual monitoring (surveys) for the arroyo toad where it occurs on the City's MSCP lands, to ascertain any data beyond occurrence requires methods beyond simple survey protocols. The methods and timing of surveys must take advantage of the species' rain-dependent activity cycle. However, it is ultimately of limited value to document the number of individuals active during any given year if over time there is no breeding activity. It is for this reason that we did not recommend extensive upland surveys in 2002 through 2004 in support of the City's monitoring responsibilities. Instead we recommend the following monitoring (survey) regime to facilitate the City's MSCP participation as it pertains to the arroyo toad:

1. Conduct arroyo toad breeding surveys every three years as required by its participation in the MSCP – providing breeding conditions suitable for the species are present.
2. Beginning with the first year during which breeding activity is documented, start the three-year clock that determines the date of the ensuing survey. Based on the results of 2005 surveys, the next survey should be conducted in 2008.
3. Postpone surveys during years if conditions are unsuitable for breeding: If during the scheduled survey year conditions are unsuitable for breeding, conduct surveys in the fourth, fifth, or sixth following year, as conditions allow.
4. Adhere to a monitoring protocol such as we outline in this document so that numbers of breeding males and their distributions can be compared

over time; immediately following the disappearance of breeding conditions conduct at least one survey to document recruitment.

5. Surveys should document the status of exotic species and minimally include a qualitative description of status and perceived risk of species considered to constitute major threats to the valley's arroyo toad population.

6. In non-breeding years three, four, and five, formulate an annual report that includes a summary of the year's weather conditions (especially temperature and rainfall regimes), aerial photographs of the preserve to document changes in vegetation, and status of the water table and water use in the valley.

7. If there are no suitable conditions to support breeding activity for a fifth consecutive year, consult with a team composed minimally of a hydrologist, an arroyo toad biologist, and city staff to determine whether the situation is a naturally occurring phenomenon or whether changes in local water use policies are in need of review and if changes in such policies are feasible.

Finally, access to Santa Ysabel Creek and the origin of the San Dieguito River should be limited to the few areas that have historically been used to access ag lands north and south of these waterways, especially in years when breeding conditions have materialized. Although limiting access will not be an easy task, special efforts should be exercised when breeding conditions have materialized in the valley and especially during the period between the disappearance of aboveground flows and the drying of surface substrates when neonates may be most vulnerable to adverse impacts.

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