Baseline Surveys for the Arroyo Toad (*Bufo californicus*) in the Sweetwater River Channel, San Diego County, California.

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WESTERN ECOLOGICAL RESEARCH CENTER

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Abstract

In 2002 The U. S. Geological Survey (USGS) was contracted by the Sweetwater Authority to conduct a study examining the short-term and long-term effects of Loveland Dam operations on the arroyo toad (*Bufo californicus*) below that dam in the Sweetwater River channel. The first phase of the study was a risk assessment, which examined the short-term and long-term effects of Loveland Dam operations on arroyo toad reproductive success and population viability (see Madden-Smith et al. 2004). This report covers the second phase of the study, which involved baseline surveys for arroyo toad habitat and arroyo toads below Loveland Dam. During the 2003 arroyo toad breeding season, daytime habitat and nocturnal presence surveys for arroyo toads were conducted at four sites along the Sweetwater River: 1) Sycuan Peak Ecological Reserve, Sweetwater River; 2) San Diego National Wildlife Refuge, Sweetwater River; 3) Cottonwood Golf Course along the San Diego National Wildlife Refuge border, and 4) upper Sweetwater Reservoir. Habitat assessment included: percent vegetative cover, streambed and bank vegetation type, substrate type, descriptions of arroyo toad habitat characteristics and hydrologic descriptions including stream width and estimates of flow. Habitat assessment at Sycaun Peak Ecological Reserve resulted in two reaches rated as high quality, two reaches rated as good quality, three reaches rated as marginal quality and two reaches rated as poor quality. Habitat assessment at San Diego National Wildlife Refuge and upper Sweetwater Reservoir resulted in one reach of high quality habitat for each site. Habitat assessment at Cottonwood Golf Course resulted in one reach of good quality habitat. Based on the results of the daytime habitat assessment, nocturnal adult presence surveys were conducted at potentially suitable arroyo toad habitat (habitat rated high or good quality). Nocturnal surveys were conducted for six nights at each site and arroyo toads were not detected at any of the sites. Survey techniques were in accordance with the recommended U. S. Fish and Wildlife Service (USFWS) Protocol (USFWS1999b). For inaccessible areas, available arroyo toad abundance and distribution data were used to fill in where current information is lacking. Management concerns (e.g., presence of bullfrogs or other non-native predators, obstructive vegetative growth [native and non-native], etc.) were also identified as part of the baseline surveys. Results of the risk assessment and baseline surveys will be used in the development of the Sweetwater Authority Subarea Plan of the Joint Water Agencies Subregional Natural Community Conservation Planning (NCCP) program and will be used in the process of gaining scientific justification for the USFWS and California Department of Fish and Game (CDFG) incidental take permits associated with the Sweetwater Authority Subarea Plan (Fleury 2001). The goal is for Sweetwater Authority to

maintain flexibility in the management of their reservoirs while maintaining arroyo toad populations within the system (Fleury 2001).

1. Introduction

Throughout the world, riparian ecosystems have been substantially altered by the construction and operation of dams. An estimated two-thirds of the fresh water flowing to the world's oceans is obstructed by dams (Nilsson & Berggren 2000) and approximately 193,500 square miles is inundated by the reservoirs associated with these dams (Collier et al. 2000). In the United States, nearly every river is regulated by dams, locks, or diversions (Collier et al. 2000). In California there are 1395 dams within the jurisdiction of the State of California's Department of Water Resources (CDWR 1993). Three hundred and forty of these dams occur in southern California and 56 of these are found in San Diego County (Figure 1) (CDWR 1993).

Besides the initial destruction and degradation of habitat resulting from the construction of dams, some of the most important effects of dams are: 1) altered flow regime, 2) reduced sediment and nutrient load, 3) increase in riparian vegetation cover and 4) invasion by non-native species (Baxter 1977; Williams & Wolman 1984; Ligon et al. 1995; Cole & Landres 1996; Lind et al. 1996; Richter et al. 1996; Collier et al. 2000; Nilsson & Berggren 2000). Alteration of flow regime can result in a reduction of discharges, a decrease of flood peaks and a reduction in the frequency of over bank flooding (Baxter 1977; Williams & Wolman 1984; Ligon et al. 1995; Collier et al. 2000; Nilsson & Berggren 2000). Sediments and inorganic nutrients are trapped by the reservoir and then restored downstream by the erosion of shores and streambed, resulting in channel simplification or widening, reduced geomorphic activity (e.g., lack of point bar deposition), and an increase in the particle size of the bed material (Baxter 1977; Nilsson et al. 1991; Ligon et al. 1995; Richter et al. 1996; Trimble 1997; Collier et al. 2000; Nilsson & Berggren 2000). Alteration or collapse of the stream's food web may result from the loss of inorganic and organic nutrients to the reservoir and/or the absence of scouring floods (Baxter 1977; Ligon et al. 1995; Richter et al. 1996; Wooten et al. 1996; Nilsson & Berggren 2000). Additionally, a decrease in peak flows can result in increased vegetation below the dam, usually by encroachment of the active channel (Williams & Wolman 1984; Ligon et al. 1995; Lind et al. 1996; Collier et al. 2000). Riparian habitats are vulnerable to invasion by non-native species as a result of recurrent disturbance and dams may contribute to this vulnerability by providing a year round source of water and by preventing winter scouring floods that may flush non-natives from the system (Lind et al. 1996; Nilsson & Berggren 2000). Other downstream effects of dams include changes in oxygen content, water chemistry, and water temperature (Baxter 1977; Ligon et al. 1995; Cole & Landres 1996; Richter et al. 1996) and a decrease in species richness (Nilsson et al. 1991).

The alteration of hydrologic regimes associated with dam operations is one of the leading threats to freshwater fauna in the United States and is especially predominant in the West (Richter et al. 1996). Alteration of the hydrologic regime along with direct habitat destruction and degradation from the construction of dams is considered one of the leading causes of amphibian decline. In southern California alone, there are eight species of amphibians that are considered at risk from hydrologic modifications: western toad (*Bufo boreas*), Pacific treefrog (*Hyla regilla*), California treefrog (*Hyla cadaverina*), California newt (*Taricha torosa*), western spadefoot toad (*Spea hammondii*), mountain yellow-legged frog (*Rana muscosa*), California red-legged frog (*Rana aurora*) and arroyo toad (*Bufo californicus*) (Hunter 1999). Several of these species have some level of protection. The arroyo toad is federally endangered, the mountain yellow-legged frog is federally endangered, the California red-legged frog is federally threatened and the western spadefoot toad is a California species of special concern. The focal species of this study, the arroyo toad, was listed as an endangered species under the Federal Endangered Species Act on December 16, 1994 (USFWS 1994, Federal Register 59(241):64859-64867).

The arroyo toad, a small (55-82 millimeters snout to urostyle), dark-spotted toad of the family Bufonidae, (Figure 2) is a mostly terrestrial species that primarily uses streams during the breeding season, January to September (these dates range depending on precipitation and location) (USFWS 1999a). Arroyo toads are breeding habitat specialists, breeding only in shallow, slow-moving riparian habitats that are typically disturbed naturally on a regular basis by flooding (USFWS 1999a) (Figure 3). Sweet (1992) describes the major characteristics of arroyo toad breeding pools as: "proximity to sandy terrace habitat; minimal current; majority of pool < 1 inch deep; substrate of sand, gravel, or pebbles; gently sloping shoreline, or central bar; and bordering vegetation low or set back such that most of the pool is open to the sky." Unlike most western species of *Bufo* that will initiate breeding after rain events and often breed in ponds and standing water, the arroyo toad waits to initiate breeding until the above conditions exist (Sweet 1992; USFWS 1999a). The arroyo toad is specialized in such a stochastically fluctuating habitat, thus the compounded stress of habitat degradation and loss from manmade factors and predation by non-native species has lead to its disappearance in 75 percent of its previously occupied habitat in California (Jennings & Hayes 1994).

The decline of the arroyo toad is considered largely due to the degradation and destruction of breeding habitat as a result of dam construction and operation (Sweet 1992; USFWS 1994). Approximately 40% of the estimated original range of the toad has been lost to dam construction, including at least 25 large reservoirs that have inundated over 190 kilometers (120 miles) of suitable upland and breeding habitat (USFWS 1994, 1999a; Campbell et al. 1996). In addition, arroyo toad habitat downstream from reservoirs is affected by the alteration of the hydrologic regime, the reduction in coarse sediment, the increase in vegetation and the persistence of non-native predatory species. The reduction of peak flows prevents the movement and deposition of sediments required to create and maintain arroyo toad habitat. Additionally, arroyo toad habitat is further degraded as coarse sediments are stripped away and not replaced below dams (Campbell et al. 1996; USFWS 1999a). This is a function of the sediment load being trapped by the dam and then restored by the erosion of the channel below the dam (Baxter 1977; Nilsson et al. 1991; Ligon et al. 1995; Richter et al. 1996; Trimble 1997; Collier et al. 2000; Nilsson & Berggren 2000). A balance of scouring flows and sufficient sediment supply is required to maintain arroyo toad breeding habitat. Elimination of flow, which is common for storage reservoirs, reduces summer water levels and can lead to early drying of arroyo toad breeding pools, resulting in failure of reproductive effort (Campbell et al. 1996; USFWS 1999a). Unseasonable releases may prevent successful arroyo toad recruitment by altering breeding pools or by displacing arroyo toad eggs and larvae (Sweet 1992; USFWS 1994, 1999a; Campbell et al. 1996). Arroyo toad egg and larvae loss to dam releases has been documented at Cottonwood Creek as a result of water releases of several million gallons per day from Barrett Dam (Campbell et al. 1996) and in Piru Creek due a to month long release averaging 120 cubic-feet-per-second from Pyramid Lake in 1991 (Sweet 1992). Similarly, Lind et al. (1996) found complete loss of foothill yellow-legged frog (*Rana boylii*) egg masses due to dam releases in the

Trinity River. Furthermore, persistent water releases throughout the year encourage overgrowth of riparian vegetation and the change from an ephemeral water supply to a permanent supply maintains non-native predators. These effects are worsened by the reduction of peak flows and lack of scouring needed to prevent the overgrowth of riparian vegetation in arroyo toad breeding habitat and to flush non-native predators such as bullfrogs, green sunfish and African clawed frogs from the system annually or with peak flow events (Campbell et al. 1996). Viability of arroyo toad populations affected by dams is a concern throughout southern California.

In San Diego County, the possible downstream effects of Loveland Dam are a concern for the viability of arroyo toad populations found in the Sweetwater River between Loveland and Sweetwater Reservoirs. The Sweetwater Dam was constructed in 1886-1888 to create a drinking water reservoir and due to "water shortage and the large amount of storage required to obtain the full safe yield of the Sweetwater River" (Fowler 1952) the Loveland Dam was built in 1943-1945 approximately 16 miles upstream on the Sweetwater River to capture water that would have spilled from Sweetwater Reservoir (Fowler 1952; Kasner 2002). Sweetwater Authority took over operations of the reservoirs in 1977 and since then has carefully managed the levels of the two reservoirs in a way that maximizes water capture so they can continue to provide a reliable local water supply to their customers (Fleury 2001; Kasner 2002). The "rules of thumb" Sweetwater Authority uses for its transfer operations are included in Appendix 1 (Kasner 2002). The "rule of thumb" that may benefit the arroyo toad the most states, "releases should begin after we have had significant rainfall to saturate the river channel to maximize the volume recovered at Sweetwater" (Kasner 2002). According to this rule, controlled releases should occur during the typically wetter months of the year, November through March according to NOAA weather data (http://www.ncdc.noaa.gov), and either in conjunction or immediately after a rain event, thus mimicking the natural flow of the system. Flushing winter flows prior to breeding may be beneficial to arroyo toads by improving water quality and removing non-native species from breeding pools. Since 1977, Sweetwater Authority's management scheme has resulted in fewer controlled releases during the arroyo toad breeding season, with most releases occurring in November through February (67%) (Kasner 2002). Before 1977, more controlled releases occurred during the arroyo toad breeding season with only 24% of controlled releases occurring in November through February and 81% of the releases occurring during the arroyo toad breeding season, February through August (Figure 4).

In 2001, USFWS designated the Sweetwater River basin (Southern Unit, Unit 18) and 21 other riparian land units as critical habitat for the arroyo toad (USFWS 2001, Federal Register 66(26):9414-9474). As a result of litigation against the USFWS and the acquisition of new survey data for the arroyo toad, critical habitat designation was re-proposed for the 22 riparian land units in 2004 (USFWS 2004, Federal Register 69(82):23254-23328) and in 2005 a new final rule was published (USFWS 2005, Federal Register 70(70):19562-19633). The new final rule stated that all essential lands within San Diego County are excluded from critical habitat designation for economic reasons (USFWS 2005). USFWS states that while habitat protection is necessary for species conservation, in most cases the designation of critical habitat is of little additional value for listed species, yet is costly (USFWS 2005).

Approximately 26 kilometers (16 miles) of Sweetwater River between Loveland and Sweetwater Reservoirs falls within the San Diego Multiple Species Conservation Program (MSCP) Subregion of the Natural Community Conservation Planning (NCCP) Act. In Conjunction with two other regional water agencies, Sweetwater Authority is in the process of developing its own NCCP known as the Joint Water Agencies (JWA) Subregional Plan. As part of the Sweetwater Authority Subarea Plan for the JWA Subregional Plan, Sweetwater Authority must gain issuance of USFWS and CDFG incidental take permits, because incidental take of arroyo toads may occur as a result of current operations or future projects. Most notably, the water transfer operations between Loveland and Sweetwater Reservoirs have the potential to affect arroyo toads. The findings of both phases of this study (risk assessment and baseline surveys) will be used in the development of the Sweetwater Authority Subarea Plan of the JWA Subregional Plan and in the process of gaining scientific justification for the associated incidental take permits, and as a basis for any adaptive management necessary to maintain arroyo toad reproductive success and population viability.

The first phase of this study was a risk assessment examining the potential short-term and long-term effects of Loveland Dam operations on arroyo toad reproductive success and population viability (see Madden-Smith et al. 2004). Historical arroyo toad breeding, weather, hydrological, and Loveland Dam release data were used to examine the risk associated with the short-term and long-term effects of Loveland Dam operations on arroyo toad reproductive success and population viability. Dam releases during the arroyo toad breeding season were the biggest concern for reproductive success and the focus of the risk assessment. Using historical breeding occurrence data, rough upper and lower bounds for arroyo toad cohort loss due to controlled dam releases during the arroyo toad breeding season were estimated. Risk due to dam releases was found to be the highest in early March to late July when the greatest loss of egg masses, larvae and metamorphs was estimated to occur, with the upper bound ranging from 28% to 63% loss of the entire year's cohort. Over time, repeated loss of cohorts due to dam releases can decrease population viability, but further study is required to determine the exact risk. Simply avoiding controlled releases during the arroyo toad breeding season, especially from March to late July, will greatly reduce the risk to arroyo toad reproductive success and population viability. In addition, several other possible risks to arroyo toad reproductive success as a result of dam operations were qualitatively examined. These included the effects of dam releases concurrent with rain or spill events, the effects of dam releases during wet and dry years, the effects of the intensification and lengthening of drought periods and the effects of the degradation of arroyo toad breeding habitat from the increase in vegetative cover and the loss of coarse sediments. Due to the lack of specific data for this system, the exact effects of these stressors on arroyo toad reproductive success and population viability are unknown and will require further study, however qualitative assessments were possible.

The second phase of the study involved baseline surveys for arroyo toad habitat and arroyo toads. In 2003 habitat assessment and nocturnal presence surveys were conducted within the Sweetwater River channel with the following objectives in mind:

1. Identify habitat most likely to support the arroyo toad within the Sweetwater River channel and perform daytime habitat surveys to assess habitat suitability,

2. Determine the current status and distribution of the arroyo toad within the Sweetwater River channel,

3. Determine the current distribution of non-native predatory species known to be detrimental to the arroyo toad,

4. Identify human disturbances and other negative impacts to habitat at each survey site, and

5. Provide management recommendations for arroyo toads based on the findings of these surveys.

2. Study Area

The study area is approximately 26 kilometers (16 miles) of Sweetwater River between Loveland and Sweetwater Reservoirs (Figure 5). The Sweetwater River originates in the coastal mountains of eastern San Diego County, flows through Loveland and Sweetwater Reservoirs, and discharges into San Diego Bay (Figure 6). Loveland and Sweetwater Reservoirs have similar capacities, 25,000 acre-feet and 28,000 acre-feet respectively, but Sweetwater Reservoir is broader and shallower resulting in greater evaporative loss compared to Loveland Reservoir. As a result, Sweetwater Authority tends to keep water in Loveland Reservoir in order to minimize evaporative loss. In order to minimize transit loss, Sweetwater Authority tries to release water after precipitation and local runoff has saturated the river channel (Kasner 2002). Despite these efforts at conserving local water, the highly variable local precipitation combined with the relatively small capacity of each reservoir restricts management flexibility of the two-reservoir system. In years with above-average precipitation, local runoff can exceed the storage capacity of Loveland Reservoir and result in a spill event, much as if the reservoir were not present. However, this is dependant on the volume of inflow necessary for the Loveland Dam to overflow.

3. Methods

A multi-step filtering process recently developed by USGS (based on USFWS and U. S. Forest Service (USFS) arroyo toad protocols) was used to obtain habitat quality ratings for each site. The habitat quality ratings serve as a measure of predicting the likelihood of the arroyo toad occurring at sites and provide an efficient system for the sites to be ranked in terms of priority for follow-up focused night time surveys.

The arroyo toad is a mostly terrestrial species that primarily uses riparian channels during the breeding season. It is a habitat specialist known to breed in rivers, creeks and streams (avoiding breeding in reservoirs, lakes and ponds) and requires slow to quiet pools for spawning (Sweet 1992; Jennings and Hayes 1994; Campbell et al. 1996). The three characteristics most commonly associated with arroyo toad breeding habitat include: 1) sandy substrate, 2) adjacent open sandy terraces and 3) channel braiding; all of which are associated with low stream gradients (i.e., ≤ 3 %) and thus lower flow velocities (Sweet 1992; Campbell et al. 1996; Barto 1999) (Figure 5). Water flow is a function of gradient and lower stream gradients contain greater amounts of habitat features that are highly correlated with suitable arroyo toad breeding habitat. Consequently, it can be assumed that if these characteristics are present (sandy substrate, sandy terraces and channel braiding), there will be low channel gradient. In addition, the reverse may also be true (i.e., if the channel gradient is low these characteristics may exist). A low gradient reach (≤ 3%) with a sandy depositional substrate often results in conditions conducive to the formation of required seasonal quiet backwater breeding pools (Sweet 1992; Jennings and Hayes

1994; Campbell et al. 1996). The habitat quality rating used in this study is based on the presence of the three characteristics most commonly associated with arroyo toad habitat.

The multi-step process used in this study includes the following:

1. Assess drainages that could potentially contain suitable arroyo toad habitat by examining USGS topographic 7.5 minute maps using TOPO! California© CD-ROM software and available aerial imagery of the study area.

2. Survey (ground truth) the selected drainages, identify the areas of suitable arroyo toad habitat, and then rate them in terms of habitat quality (*high, good, marginal,* or poor) in regards to the toad's life history requirements.

3. Conduct nocturnal presence surveys (visual and aural) for arroyo toads only at sites that contained suitable habitat (*high quality* or *good quality*) or had historic records for arroyo toads or arroyo toad habitat in search of any of the various behaviors/life history stages (i.e., calling males, egg strings, larva, metamorphic individuals, and foraging juveniles and adults in upland habitats).

4. Record all non-native species and other possible impacts observed during both daytime habitat assessment and nocturnal encounter surveys.

3.1 Initial Site Selection

Initial site selection consisted of using USGS topographic maps and available aerial imagery to identify sites that were low gradient and possibly contained arroyo toad habitat. With the use of TOPO! California© CD-ROM software, seamless USGS 7.5 minute series topographic maps of potential study sites were examined and all drainage reaches with low gradients were identified as potentially suitable arroyo toad breeding habitat. Aerial photographs provided by Sweetwater Authority were then used to determine which low gradient reaches appeared to contain arroyo toad habitat.

3.2 Site Access

In early 2003, letters requesting permission to access all public and private properties along the Sweetwater River between Loveland and Sweetwater Reservoirs were sent to property owners. Access was only obtained for public land and Sweetwater Authority property, and was not obtained for the only known population within this stretch of Sweetwater River (Figure 7). This population occurs in Sloan Canyon on private property formerly owned by the Vulcan Minerals, Inc. Sloan Canyon Mining Company who denied access to their land (Sloan Canyon is now owned by the Sycaun Band of Indians). Access was restricted to only public and Sweetwater Authority land, consequently other areas possibly containing arroyo toad habitat could not be surveyed, including the stretch of Sweetwater River that runs through the Sycuan Singing Hills Golf Course (Figure 7). The four sites where access was obtained include: 1) Sycuan Peak Ecological Reserve, Sweetwater River; 2) San Diego National Wildlife Refuge, Sweetwater River; 3) Cottonwood Golf Course along the San Diego National Wildlife Refuge border, and 4) upper Sweetwater Reservoir (Figure 7).

3.3 Daytime Habitat Assessment Surveys

The objectives of the daytime habitat assessment survey were to confirm the presence and determine the distribution of suitable breeding and foraging/burrowing habitat within the study area. To meet these objectives daytime habitat assessment surveys (ground truthing) were conducted along all potentially suitable reaches where access had been obtained. This was necessary to verify which reaches contained habitat features conducive to suitable arroyo toad breeding habitat.

The daytime habitat assessment surveys consisted of hiking up the river channel and the adjacent uplands (i.e., terraces, flood plains) and noting physical features known to be associated with suitable arroyo toad habitat. Habitat assessment was based on physical features and channel morphology, and not on the presence of surface water (seasonal breeding pools). Ultimately the classification system used to rate habitat quality was based on the presence of the aforementioned key physical features shown to be highly correlated with the presence of arroyo toad populations (Sweet 1992; Jennings & Hayes 1994; Campbell et al. 1996; Griffin & Case 2002):

1. Channel substrate type being predominately composed of depositional sand

2. Sandy banks with adjacent flat sandy terraces

3. Channel braiding

Any given drainage, or portion there of, was assigned one of four habitat quality types (*high, good, marginal,* or *poor)* based on the number of the three key physical features determined to be present within a reach:

High: Any given survey reach with *all three* physical features present.

Good: Any given survey reach with *two* of the three physical features present.

Marginal: Any given survey reach with *one* of the three physical features present.

Poor: Any given survey reach with *none* of the three physical features present and unsuitable for arroyo toads.

Figure 8 provides photographic examples of the four habitat quality types and the habitat assessment survey protocol is in Appendix 2.

3.4 Streamflow Measurements

Streamflow was measured by a USGS hydrologist on April 25, 2003 at five locations on the Sweetwater River. Measurements were taken where access was permitted, flow was present and flow was not already being monitored by Sweetwater Authority (Table 1; Figure 9). Each site was established as a USGS surface water stations (data available at the USGS NWISWeb Data for the Nation web site: http://waterdata.usgs.gov/nwis) and included four locations within the Sycuan Peak Ecological Reserve and one location within the Cottonwood Golf Course site (Table 1). Measurements were taken during daylight hours with a "pygmy" meter using measurement techniques outlined by Carter and Davidian (1968).

3.5 Nocturnal Presence Surveys

Nocturnal presence surveys were conducted within sites that contained suitable habitat (*high quality* or *good quality*) during the arroyo toad breeding season on six separate nights with at least one week between surveys. Surveys entailed walking along drainages in search of any of the various behaviors/life history stages (i.e., calling males, egg strings, larvae, metamorphic individuals, and foraging juveniles and adults in upland habitats) by using multiple cues (direct observation and/or aural detection of calling males). 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. Headlamps with 45,000-candle power were used to provide the required amount of illumination to maximize detection (USFWS 1999b). The arroyo toad is restricted to breeding in lotic habitats with a range of hydroperiods (i.e., perennial, semi-permanent, seasonal, ephemeral) (Sweet 1992; USFWS 1999a), therefore nocturnal presence surveys were conducted along riparian corridors irrespective of the presence of surface water. In addition, because the timing of the surveys fell within a period of drought, surveys had to be conducted in areas without water and focused on detecting foraging adults rather than calling males. The nocturnal survey protocol is in Appendix 3.

Survey efforts were concentrated within habitat patches containing the best (*high* and *good quality*) habitat because these patches offer the greatest opportunity for detection of arroyo toads, presumably because of concentrated resources. Different life stages may be detected at different places with the habitat. For example, sparsely vegetated terraces or flood plains along the channel are prime areas for adults to forage for ants and to burrow; eggs and larvae are found in the still-quiet pools used for breeding and subsequently the growth and development of the eggs and larvae; and metamorphs are often found on the sandy banks in or near breeding pools where they like to forage and seek refuge in the damp sand.

Adult arroyo toads may be observed from January through September, depending on location and precipitation, usually corresponding with the period of greatest rainfall for a location. However, most observations are made from February through July. Adult arroyo toads are strongly nocturnal, favoring damp/wet substrate for activities above ground and typically avoiding cold and/or extremely dry conditions and full moon conditions. Search efforts for adults were concentrated when there was the greatest probability of detecting toads with the least amount of effort and under the most favorable environmental conditions (e.g., temperatures above 15 degrees Celsius and less than 95 percent of full moon illumination).

All nocturnal surveys that occurred on public land were conducted by USGS biologists or by a USGS biologist with help from Sweetwater Authority biologist Peter Famolaro. Sweetwater Authority conducted all nocturnal surveys on the Sweetwater Authority property in upper Sweetwater Reservoir. All surveys were conducted according to the USGS protocol adapted from the USFWS Protocol (USFWS 1999b).

3.6 Pre and Post Loveland Dam Release Surveys

USGS and Sweetwater Authority surveyed suitable arroyo toad habitat (*high* and *good* quality) prior to and after a controlled release from Loveland Dam. The purpose of the surveys was to look for evidence of breeding arroyo toads or other amphibians prior to and after the dam release. The controlled release occurred February 14 - 22, 2005. Pre-release surveys occurred on February 12, 2005 and post-release surveys occurred on February 25, 2005. This was the first opportunity to witness a release since the commencement of this project.

The controlled release occurred after rainfall had significantly saturated the river channel (to maximize the volume recovered at Sweetwater Reservoir). The maximum flow from the dam was 350 cubic-feet-per-second and a total release volume was 4700 acre-feet. The purpose of the controlled release was to prevent a future uncontrolled spill release from Loveland Dam due to the above normal rainfall San Diego was experiencing. Rainfall for San Diego (Airport) was 22.51 inches for July 1, 2004- June 30, 2005 (data available at the NOAA National Weather Service Forecast Office, San Diego, CA web site: http://newweb.wrh.noaa.gov/climate/local_data.php?wfo=sgx). Normal rainfall for San Diego is approximately just over 10 inches-per-year.

4. Results and Discussion

4.1 Daytime Habitat Assessment Survey

Of the four sites surveyed for arroyo toad habitat, a total of 12 different reaches were rated for potential arroyo toad habitat, resulting in four reaches rated as *high quality*, three reaches rated as *good quality*, three reaches rated as *marginal quality*, and two reaches rated as *poor quality* (Figures 10-12). Each site is discussed below in order of upstream to downstream locations. Some sites had multiple habitat quality ratings (multiple reaches with varying habitat quality). Table 2 summarizes the habitat quality ratings and the arroyo toad habitat characteristics found within each reach at a site and Figures 10-12 are maps illustrating the limits of the habitat quality ratings within each site. Below is a summary for each site:

Sycuan Peak Ecological Reserve (9 reaches total): two of these reaches rated as *high quality*, two reaches rated as *good quality*, three reaches rated as *marginal quality*, and two reaches rated as *poor quality* (Figure 10).

San Diego National Wildlife Refuge (1 reach): rated as *high quality* (Figure 11).

Cottonwood Golf Course (1 reach): reach rated as *good quality* (Figure 11).

Upper Sweetwater Reservoir (1 reach): rated as *high quality* (Figure 12).

4.2 Streamflow Measurements

Flow values ranged from 0.11 to 0.20 cubic-feet-per-second (Table 1). Data from the only active gage on the Sweetwater River, USGS gaging station #1101500 above Loveland Reservoir in Descanso, for the same date showed the daily mean streamflow to be 1.4 cubic-feet-per-second and the mean daily value for this day for approximately 70 years of record to be 11.1 cubic-feet-per-second (data available at the USGS NWISWeb Data for the Nation web site: http://waterdata.usgs.gov/nwis). According to Williams & Wolman (1984), a gaging station upstream from a dam "reflects to a significant degree the flows that would have occurred downstream from the dam if no dam had been built" and that "a control station is most useful located as close as possible to the dam as long as it is not within the backwater of the dam." In Madden-Smith et al. (2004) precipitation and gaged inflow data were compared to verify that flow through the Descanso gage is a good indicator of inflow into Loveland Reservoir (precipitation and flow through the gage are related) and thus a good indicator of what streamflow would be below Loveland Dam if the dam was not present. The streamflow measured below Loveland Dam was significantly lower than that measured by the gage above the dam, thus it is apparent how the presence of the dam reduces streamflow below the dam as the reservoir is filling and releases are not occurring.

4.3 Nocturnal Presence Surveys

Arroyo toads were not detected at any of the four sites nocturnally surveyed in the Sweetwater River channel. Of these sites, the upper Sweetwater Reservoir site is the only site that has previous records of arroyo toads (Jennings & Hayes 1994; Campbell et al. 1996; Haas & Famolaro 1998; Famolaro 1999; USFWS 1999a; Famolaro 2000; Famolaro & Tikkanen Reising 2001; Famolaro 2002; CDFG 2003;). Arroyo toads were last detected at this site in 1997 (Haas & Famolaro 1998; Famolaro 1999, 2000; Famolaro & Tikkanen Reising 2001; Famolaro 2002). Recent changes upstream may have caused degradation of the arroyo toad habitat in this location (i.e., the vegetation cover has increased and the substrate is becoming increasingly muddy) (Madden-Smith et al. 2004).

Some data on the Sloan Canyon arroyo toad population was obtained from limited survey data that had been submitted to USFWS (Haas, unpublished data) and a survey report completed for the Sweetwater Authority (Haas & Famolaro 1998). Although this population has apparently been monitored from 1995-2002 by William Haas of URS/Varanus Biological Services (Haas & Famolaro 1998; W. Haas pers. comm.), most available information spans 1997 and 1999-2001. According to Haas and Famolaro (1998), as many as 26 adult males and 16 adult females were present during surveys in 1997 and successful recruitment was documented in 1995-1998. According to the summary Haas (unpublished data) provided to the USFWS, a minimum of 25 calling males were detected on April 15, 1999, approximately 50 arroyo toads were detected on February 5, 2000 and 32 calling males were detected on March 14, 2001, including two pairs in amplexus (Haas, unpublished data). These are the maximum numbers of adult arroyo toads detected in Sloan Canyon according to Haas (unpublished data). Successful recruitment was also documented in 1999 (Haas, unpublished data). A summary of all arroyo toad detections, including juveniles, from Haas (unpublished data) and Haas and Famolaro (1998) is provided in Table 4.

Despite the occurrence of the Sloan Canyon population, the arroyo toad is not known to have colonized the *high* or *good quality* habit upstream or downstream from this location. The intervening conditions between the occupied habitat in Sloan Canyon and the *high quality* habitat downstream (San Diego National Wildlife Refuge) and upstream (Sycuan Peak Ecological Reserve) is highly disturbed and geomorphologically and hydrologically altered habitat. The lack of arroyo toad movement from Sloan Canyon upstream to Sycuan Peak Ecological Reserve (SPER) may be due to habitat degradation that has occurred over time due to the operation of Loveland Dam (Madden-Smith et al. 2004). There is an unconfirmed historical record for an arroyo toad near the SPER border (USFWS 2000), but this sighting is questionable. Downstream from the Sloan Canyon population habitat degradation has occurred as a result of the sand and gravel mining operations of Vulcan Minerals Inc. and the subsequent formation of the sand/gravel pond referred to as Lake Emma, in addition to the construction of Singing Hills Golf Course and a housing development along the drainage channel. These disturbances, especially the reduction in water flow due to the presence of the dam at Lake Emma, appear to function as a barrier to the successful establishment of arroyo toads downstream from Sloan Canyon to the San Diego National Wildlife Refuge (SDNWR) site (e.g., migrating adults by own volition, disbursing larvae by water current) or at a minimum affect breeding suitability due to the lack of water (during surveys no downstream flows were seen below Lake Emma except at Cottonwood Golf Course and upper Sweetwater Reservoir sites). These effects are then worsened by the effects Loveland Dam (Madden-Smith et al. 2004). In addition, according to aerial photos there appears to be suitable arroyo toad habitat remaining (although the uplands have been developed) along the stretch of Sweetwater River that runs through Singing Hills golf course between Lake Emma and SDNWR (access was also denied for these properties). This stretch could possibly serve as a dispersal corridor if habitat restoration occurs. There was one unconfirmed record of arroyo toad breeding (one breeding pool with young larvae on or near the SDNWR property and one downstream from this location) within the stretch of Sweetwater River between Singing Hills Golf Course and Cottonwood Golf course in 1997 (Haas & Famolaro 1998; Famolaro, pers. comm.).

It is likely that arroyo toads would have been detected if they did occur at any of these sites. Data collected during this study were included in a larger USGS study looking at the status and distribution of the arroyo toad throughout the San Diego MSCP (Madden-Smith et al. manuscript). In the MSCP study arroyo toads were detected at five of 18 nocturnally surveyed sites (includes both wet and dry sites). Using the loglinear modeling program PRESENCE (MacKenzie et al. 2002), a detection probability was estimated for the nocturnal survey methods used. Nocturnal survey methods used in this study were similar to those used in the MSCP study. In the MSCP study the proportion of sites occupied was 0.2853 (SE = 0.1087) and the estimated detection probability for the nocturnal survey methods used was 0.4544. Using this detection probability, if arroyo toads are present at a site there is a 97% chance of detecting them after six surveys (Figure 13). The chance of detecting an arroyo toad does not reach 100% until the ninth survey. The below normal rainfall which occurred during the period these surveys were conducted may have been a factor in the non-detection of arroyo toads. Nocturnal surveys should be conducted during a normal rainfall year to better assess the presence or absence of this species.

4.4 Native Non-target Animal Species Detected

During the daytime habitat assessment and nocturnal presence surveys six native species, two-striped garter snake (*Thamnophis hammondii*), western spadefoot toad (*Spea hammondii*), California treefrog (*Hyla cadaverina*), Pacific treefrog (*Hyla regilla*), western blind snake (*Leptotyphlops humilis*), and western toad (*Bufo boreas*), were observed (Table 5). The two-striped garter snake and western spadefoot toad are CDFG species of special concern. The western spadefoot is also a federal species of concern. The California treefrog, Pacific treefrog, western blind snake, and western toad are common species that do not have special status.

4.5 Non-native Animal Species Detected

During the daytime reconnaissance and nocturnal focused arroyo toad surveys five non-native animal species, crayfish (*Procambarus clarkii)*, green sunfish (*Lepomis cyanellus*), mosquitofish (*Gambusia affinis*), bullfrog (*Rana catesbeiana*), and African clawed frog (*Xenopus laevis*), were observed (Table 5). All of these are known to be aquatic predatory species. Non-native aquatic species were detected at all sites except San Diego National Wildlife Refuge (SDNWR) and were found in nine of the 12 reaches surveyed (Table 2). Non-native aquatic predatory species are known to exist throughout the Sweetwater River watershed (Madden-Smith et al. manuscript), thus it is likely they would have been detected at the SDNWR site had there been water. Other non-native aquatic predatory species known to exist in the Sweetwater River watershed, but not detected during these surveys, are largemouth bass (*Micropterus salmoides*), blue-gill sunfish (*Lepomis macrochirus*), black bullhead (*Ameiurus melas*) and pumpkinseed (*Lepomis gibbosus*) (Madden-Smith et al. manuscript). Previous studies have demonstrated that non-native aquatic predatory species can have negative effects on native amphibians, including the arroyo toad (Moyle 1973; Sih et al. 1992; Sweet 1992 & 1993; Jennings & Hayes 1994; Gamradt & Kats 1996; Gamradt et al. 1997; Griffin et al. 1999; Lawler et al. 1999; Knapp & Matthews 2000; Griffin & Case 2002). Potential negative impacts of these non-native species on native species include, introduction of non-native pathogens and parasites, competition, predation, as well as trophic alterations (Hurlbert et al. 1972; Taylor et al. 1984; Sweet 1993; Alford & Richards 1999; Warburton et al. 2002; Maezono & Miyashita 2003). The following non-native species are of particular concern regarding the arroyo toad and are discussed in detail below: crayfish, game fish (e.g., sunfish and largemouth bass), mosquitofish, bullfrog, and African clawed frog.

Crayfish are widespread throughout coastal San Diego County and because they are used as fishing bait, they are most often associated with the presence of non-native fish fauna (USGS, unpublished data). Recent studies have demonstrated that red swamp crayfish have the ability to consume native amphibian eggs and larva and are not deterred by the protective chemicals these species might have (Gamradt & Kats 1996; Gamradt et al. 1997; Punzo and Lindstrom 2001). In addition, preliminary results of a USGS study of arroyo toads on Marine Corps Base Camp Pendleton found that arroyo toad larvae were 20 times more likely to be detected when crayfish were absent; however, it is unclear at this time whether this is due to a direct or indirect effect (Brehme, et al. 2004).

Arroyo toad larvae do not possess effective anti-predatory mechanisms (Sweet 1992) and thus are vulnerable to predatory fish (Sexton & Phillips 1986; Bradford 1989; Fisher & Shaffer

1996; Hecnar & Closkey 1997). Game Fish (i.e., black bullhead, largemouth bass, green sunfish) and mosquitofish have all been shown to prey on amphibian eggs, larvae and/or transformed individuals despite the chemical compounds used for defense (i.e., noxiousness, unpalatability, and/or toxicity) (Lewis & Helms 1964; Grubb 1972; Gamradt & Kats 1996; Hecnar & Closkey 1997; Ervin et al. 2000; Hovey & Ervin 2005). Warm-water game fish have been intentionally introduced throughout coastal San Diego County beginning in the late 1800's to create/enhance recreational angler opportunities. In addition, mosquitofish are widely introduced into streams, rivers, ponds, and reservoirs throughout coastal San Diego County by the County Vector Control Department with the intent of controlling mosquito larva to reduce the risk of mosquito borne diseases to humans. Mosquitofish are known to prey on arroyo toad larvae and other amphibian larvae under laboratory conditions (Grubb 1972; Sweet 1993) and have been shown to prey on other amphibian larvae in the field (Gamradt & Kats 1996). Green sunfish are also considered major predators of arroyo toad larvae (Sweet 1992) and have been shown to lower densities of amphibian larvae (Sih et al. 1992). In addition, all these fish species have the potential to serve as vectors for the transmission of novel parasites and diseases to other fish, and under some circumstances, to amphibian larvae, creating a larger pool of non-native parasites and diseases (Warburton et al. 2002). Infections may include iridoviruses and the protozoan commonly referred to as white spot disease, or 'Ich' (*Ichthyophthirius multiliis*). A study of wild fish communities in San Diego County determined that native and introduced fish species were infected with the non-native parasite *I. multiliis* (Kuperman et al. 2001). Recent studies have demonstrated that iridoviruses and the protozoan *I. multiliis* can be transmitted between different taxonomic classes [i.e., fish ↔ amphibians] (Moody & Owens, 1994; Mao et al. 1999; Gleeson 1999). 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 (Gleeson 1999; Scholz 1999).

Bullfrogs are also widespread throughout San Diego County and can often be found at sites with perennial water sources. Studies of bullfrog diets demonstrate that bullfrogs are opportunistic generalist predators of invertebrates (earthworms, insects, crayfish snails) and vertebrates (tadpoles, salamanders, frogs, fish, turtles, lizards, snakes, birds, rodents, bats) (Moyle 1973; Bury & Whelan 1984). Bullfrogs are known to prey on arroyo toad adults and juveniles (Sweet 1993; Griffin & Case 2002) and are suspected of being partly responsible for the decline of several other sensitive species (Jennings & Hayes 1994; Lawler et al. 1999). Bullfrogs are known to co-occur with arroyo toads in Sloan Canyon (W. Haas, pers. comm.) and co-occurred with arroyo toads when they were present in upper Sweetwater Reservoir (P. Famolaro, pers. comm.).

Much has been published on the indiscriminant feeding of both the African clawed frog and bullfrog (Bury & Whelan 1984; Wager 1986; Tinsley & McCoid 1996; Measey & Tinsley 1998). The African clawed frog is principally an aquatic frog, essentially occupying a fish-like niche. Its diet consists of aquatic organisms such as zoobenthos, zooplankton, insects, tadpoles, and small fish. Consequently, where the African clawed frog occurs native amphibian larvae are at great risk of predation. However, the relative impact of predation would depend on the abundance and density of the predator, prey, and available refugia. African clawed frogs were detected in the Sweetwater River in Sycuan Peak Ecological Reserve, thus they likely co-occur with the arroyo toad population downstream in Sloan Canyon. At this time, it is unknown whether African clawed frogs are affecting this population. In addition, African clawed frogs and arroyo toads were both found at the upper Sweetwater Reservoir site, but never at the same time (P. Famolaro, pers. comm.). Eradication of the African clawed frog and other non-native aquatic species began at upper Sweetwater Reservoir in 1998 and arroyo toads were last detected in 1997 (P. Famolaro, pers. comm.).

4.6 Other Possible Impacts Observed

Other possible impacts to arroyo toads that were observed include non-native vegetation, recent fire and resulting sedimentation, nearby roads and recreational activities within the river channel. Non-native plant species were found to be the most widespread (nine of the 12 reaches surveyed), similar to non-native animal species (Table 2). A complete summary of the impacts found within each reach can be found in Table 2.

4.7 Pre and Post Loveland Dam Release Surveys

Pre-release surveys occurred at all four sites. Water was present at all sites and streamflows were above normal due to the above normal amounts of rainfall prior to and during the surveys. Due to the amount of rainfall, arroyo toad habitat had improved at the upper Sweetwater Reservoir site due to scouring of vegetation that had been choking out the former arroyo toad breeding pools and the SDNWR site had improved due to the presence of water. No arroyo toads or arroyo toad larvae were observed at any of the sites. Western toad larvae were observed at the Cottonwood Golf Course site, so a post-release survey was only done at this site. Western toad larvae were not observed during the post-release survey at Cottonwood Golf Course. It is unclear whether the absence of western toad larvae during the post-release survey was a result of the dam release or the already above normal flows due to the amount of recent rainfall.

5. Monitoring and Management Recommendations

Monitoring and management suggestions are proposed as a means to sustain and improve arroyo toad populations within the Sweetwater River channel. Increasing the known population within Sloan Canyon and expanding this population into other suitable areas should be a part of Sweetwater Authority's management goals and will likely be a joint venture with other agencies and landowners concerned with the arroyo toad within the Sweetwater River. This may be achieved by increasing habitat quality, removing non-native aquatic predatory species and restoring a more natural hydrologic regime within sites to be managed for arroyo toads. The following suggestions should benefit the arroyo toad and improve the understanding of this declining species within the study area.

5.1 Minimize Disturbance & Take Due to Dam Operations

Arroyo toads do occur below Loveland Dam, thus it will be necessary to monitor the effects of the dam on the arroyo toads and arroyo toad habitat and may be necessary to mitigate for these effects. Although the arroyo toad population in Sloan Canyon was not surveyed due to access restrictions, it is important to mention that this population may potentially be impacted by Loveland Dam operations (see Madden-Smith et al. 2004).

Besides the initial destruction and degradation of habitat resulting from the construction of dams, some of the most important effects of dams are: 1) altered flow regime, 2) reduced sediment and nutrient load, 3) increase in riparian vegetation cover and 4) invasion by non-native species (Baxter 1977; Williams & Wolman 1984; Ligon et al. 1995; Cole & Landres 1996; Lind et al. 1996; Richter et al. 1996; Collier et al. 2000; Nilsson & Berggren 2000). All of these effects can degrade or destroy arroyo toad breeding habitat over time.

Mitigation for these effects may include replacing and maintaining the coarse sediments required for arroyo toad breeding habitat, removing vegetation from arroyo toad breeding habitats and upland terraces where it has become too dense, and restoring a more natural hydrologic regime. A possible solution to decreased coarse sediments would be to supplement the sediment supply below dams using methods similar to gravel supplementation methods used for restoration of salmon spawning habitat (USDOI 2000; BC Hydro 2003). Most importantly, releases from Loveland Dam should be avoided during the arroyo toad breeding season, especially during the period of greatest risk to arroyo toad cohorts (early March to late July) (Madden-Smith et al. 2004).

5.2 Minimize Disturbance and Take from Other Factors

5.2.1 Human Recreation

As the county of San Diego continues to grow in population size, public use of open space areas such as those within or surrounding the Sweetwater River will continue to grow. This increase in public usage is very likely to be accompanied by an increase in the number of people recreating (hiking, biking, dog walking and fishing), both legally and illegally, in areas where arroyo toads exist. The Sweetwater River channel should be managed to prevent or minimize disturbance to arroyo toads and/or their habitat resulting from on-site activities (i.e., biking, hiking, OHV use etc.). This includes restricting access to arroyo toad upland and breeding habitats to help prevent disturbance to all arroyo toad life history stages (egg strings, larvae, metamorphs and adults).

Even moderate amounts of non-consumptive recreation can have an affect on arroyo toad populations (USFWS 1999a), thus recreation near or in arroyo toad breeding or upland habitat should be restricted at all times. Disturbance from non-consumptive recreation may result in altered behaviors, displacement and avoidance which can then lead to distribution and habitat changes that may ultimately alter reproductive success and lead to unstable populations (Cole & Landres 1995; Knight & Cole 1995; Joslin & Youmans 1999; Gains et al. 2003).

Backpacking, hiking, horseback riding, mountain biking and OHV use may stress or displace any life stage of the arroyo toad even if direct contact does not occur (Joslin & Youmans 1999; USFWS 1999a; Ervin et al., in press). If these activities occur near arroyo toad breeding habitat, erosion of trails can lead to siltation of breeding pools or alteration of breeding pool structure which would be detrimental to eggs and larvae or prevent breeding altogether (USFWS 1999a). In addition, arroyo toad populations in or near recreation areas may be at risk of increased direct mortality as a result of handling, trampling or killing (intentional and unintentional) by humans or their pets (i.e., dogs and horses) (Sweet 1993; Joslin & Youmans 1999; USFWS 1999a; Ervin et al., in press). Sweet (1993) noted significant direct mortality of arroyo toad juveniles and destruction of arroyo toad breeding habitat as a result of trampling related to recreational activities (e.g., fishing, hiking). In addition, wild predators, such as coyote, ravens, striped skunks and raccoons, may also be supported in higher numbers in recreational areas or in areas surrounded by urbanization (Joslin & Youmans 1999). Disturbance from recreational activities may also result in invasions by non-native plant species (Cole & Landres 1995) which can negatively affect arroyo toad breeding habitat and result in a reduction in overall reproductive output (USFWS 1999a).

The Sweetwater River within this study area is likely to be impacted by both permitted and illegal recreation. OHV use has been observed in Sloan Canyon near the arroyo toad population and people have been observed trespassing to fish in Lake Emma (M. Madden-Smith, pers. obs.). People have also been seen trespassing with mountain bikes near the historic arroyo toad location in upper Sweetwater Reservoir (M. Madden-Smith, pers. obs.) and people often trespass to fish in the nearby sand ponds and Sweetwater Reservoir (P. Famolaro, pers. comm.). The San Diego National Wildlife Refuge is also heavily recreated by hikers, bikers and dog-walkers and each of these activities has been observed within the Sweetwater River channel.

5.2.2 Roads

Both paved and unpaved roads have the potential to negatively affect arroyo toads, especially when the roads are close to or bisect arroyo toad habitat (USFWS 1999a), thus steps should be taken to minimize the impacts to arroyo toad populations near roads. Amphibians in general may be especially vulnerable to roadkill because they are inconspicuous, relatively slow-moving and their life histories often involve upland movement (Trombulak & Frissell 2000). Arroyo toads often use roads, especially dirt roads, to forage at night and may bury themselves in sandy roadbeds during the daytime when they can be crushed by vehicle, bicycle or foot traffic (USFWS 1999a). In addition to causing animal mortality, roads also change soil density, temperature, soil water content, light levels, dust levels, surface waters, patterns of runoff, sedimentation, and they add heavy metals (especially lead), salts, organic molecules, ozone and nutrients to roadside environments (Trombulak & Frissell 2000).

The arroyo toad population in Sloan Canyon occurs near roads and should be investigated for the effects of roads. Sloan Canyon Road crosses Sweetwater River and runs along the location of this population. Arroyo toads, including road-killed arroyo toads have been observed on this road (USGS, unpublished data). Roads should also be taken into consideration in areas where population expansion or reestablishment may be considered (see section 5.9). Sweetwater River is bisected or paralleled by either paved or dirt roads for most of the stretch between Loveland and Sweetwater Reservoir. If population expansion or reestablishment occurs in areas where restrictions on road access may be enforced, restrictions similar to those recommended by Zimmitti and Mahrdt (1999) might be considered. Zimmitti and Mahrdt (1999) recommended that only vehicles moving slowly (<5 mph) with an occupant experienced in identifying arroyo toads should be allowed to use roads near arroyo toad populations after sunset. In areas where restrictions on road access are difficult or impossible to enforce the installation of ecopassages (Barichivich & Dodd 2002) with diversion walls tall enough to prevent arroyo toads from using the roads might be considered where Sweetwater River is crossed by a road near an arroyo toad population.

5.2.3 Collection

As mentioned above, with increased human access there is a greater possibility of humans encountering arroyo toads and collecting them. Arroyo toads are most susceptible to collection during their immature life stages, such as egg masses or tadpoles. At the egg mass and tadpole stages, a larger number of individuals can be removed from the system than if a visitor finds and collects a single adult animal. Wherever arroyo toads occur, signage should encourage people to enjoy the wildlife experience, but to leave what they encounter in place. In addition, it should be made clear that taking of an endangered species is a state and federal offense (California Fish and Game Code Section 2080, Article 3; Endangered Species Act, 1973).

5.3 Additional Surveys

Additional surveys for the arroyo toad below Loveland Dam should focus on obtaining access to the Sloan Canyon property. If access to the Sloan Canyon property is ever obtained from the landowner, it will be necessary to estimate the population size and status and habitat requirements of these arroyo toads. Surveys using the methods carried out in this study should be repeated and expanded to examine upland habitat use, breeding habitat characteristics, recruitment, survivorship, and population viability. This study occurred during a period of low rainfall; therefore future nocturnal surveys should take place during a normal rainfall year.

5.3.1 Population Dynamics and Population Viability

In order to properly manage for the arroyo toad below Loveland Dam, it will be necessary to gain better knowledge of population dynamics and population viability of the Sloan Canyon population. This will require gaining access to historical data for this location and the establishment of a long-term monitoring program which investigates the fluctuations in population size, survivorship, age structure and recruitment (Campbell et al. 1996).

5.3.2 Surveys for Egg Masses and/or Larvae

Future arroyo toad surveys should include conducting surveys and monitoring for egg masses and/or larvae annually for the Sloan Canyon population, if access can be obtained for this site. Egg masses and larvae are hypothesized to be an easier life stage to monitor than adults and provide a direct measure of reproduction (USFS 2002; Atkinson et al. 2003). It is not known how successful recruitment is or whether successful recruitment is even happening within the Sloan Canyon population, thus it is important that the egg and larval stages be monitored to provide more insight on recruitment and population viability. Surveys for egg masses and larvae should also occur for all accessible areas with *high* or *good quality* habitat during a normal rainfall year.

5.3.3 Breeding Habitat Assessment

Arroyo toad breeding habitat, both current and historic, should be periodically surveyed to assess the extent and quality within the Sweetwater River channel and determine if it is increasing or decreasing (every 5-8 years). Despite the appearance of suitable arroyo toad habitat below Loveland Dam, urbanization, dam building and the resulting reservoirs, water diversions, sand and gravel mining, road placement across and within stream terraces, introduction of non-native species, off-highway vehicle use, and the use of stream channels and terraces for recreational activities have degraded arroyo toad habitat within the Sweetwater River watershed. Arroyo toad habitat may be maintained or improved with proper management.

5.3.4 Upland Habitat Requirements

The arroyo toad is primarily a terrestrial species typically using the water channel during the breeding season, thus determining the upland requirements should be another part of the management plan for this species. In order to accurately track the upland movements and habitat use of the arroyo toad, radio-telemetry will be necessary (see Griffin et al. 1999; Griffin & Case 2001; Ramirez 2002). Habitat analysis should be conducted at both burrow sites and at locations of active arroyo toads and should include the analysis of characteristics such as substrate type, compaction, moisture, pH, temperature, and vegetation type and cover (Griffin et al. 1999; Ramirez 2002). Burrowing sites are especially important to arroyo toad survival, as they provide refugia from predators and desiccation, thus maintaining suitable burrowing sites may be necessary to minimize the risk of mortality (Griffin et al. 1999; Griffin & Case 2001). In addition to gaining information on upland habitat preferences, radio-telemetry can also provide information on arroyo toad home-ranges.

5.3.5 Water Quality Assessment

Another measure of habitat quality that should be taken into account is water quality. Water quality should be monitored and if necessary, improved in areas where arroyo toads occur. Water quality measurements that should be taken during future habitat assessment should at a minimum include: dissolved oxygen, pH, turbidity, nitrogen (i.e., nitrate and ammonia) and phosphorous (i.e., phosphates) levels. Normal values are unknown for these water quality parameters, thus baseline values can be measured at the most natural of the locations (e.g., SPER or upper Sloan Canyon). Bishop et al. (1999) found significant correlations between ammonia, phosphorous, particulates, biological oxygen demand (BOD) and total Kjeldahl nitrogen (TKN) levels and anuran development, resulting in lower anuran diversity, density and reproductive success. Furthermore, organophosphorus pesticides and agricultural fertilizers (nitrate and ammonia) have been linked to deformities or mortality of larval amphibians (Bishop et al. 1999).

5.4 Non-native Predatory Species

Non-native predatory species known to be detrimental to arroyo toad populations were found at most of the sites, thus it is important that these non-native predatory species be controlled within all sites that support or could support arroyo toads. Eradication of non-native predators should be easier during drier years when they are concentrated in the limited number of pools. It will also be important to monitor the effectiveness of eradication techniques and measure benefits to arroyo toads. Again, early removal of known problem species can be more cost effective than delaying removal until impacts on the arroyo toad are clearly detectable. Refer to section 4.5 for discussion on the possible impacts of non-native predatory species.

5.5 Non-native Plant Species

Some non-native plant species have the ability to degrade upland and breeding habitat, thus the extent of non-native plant species and their effects on arroyo toad breeding habitat should be monitored. Highly invasive species such as tamarisk (*Tamarix* spp.) and giant reed (*Arundo donax*) can quickly colonize and stabilize flood terraces and decrease the longevity of pools through evapotranspiration (USFWS 1999a). Non-native grasses, such as *Bromus* spp. and *Avena* spp., can make both upland and breeding habitats unsuitable by filling in the breeding pools and the friable soils of the upland terraces. Upland species of non-native grasses are often found in stream channels where there has not been significant streamflow to remove them. Where necessary non-native species should be removed, removal effectiveness should be monitored and benefits to arroyo toad should be measured. Early removal of known problem species can be more cost effective than delaying removal until an impact on the toads is clearly detectable.

5.6 Habitat Restoration and Creation

Another management goal should be to expand the abundance and range of known populations of arroyo toads through restoration or creation of breeding habitat, including restoration of the natural hydrologic regime of the system. Arroyo toads require shallow, slow-moving, open, sandy pools to breed and nearby open sandy terraces to forage and burrow, therefore in most cases restoration would involve the removal of dense vegetation (both native and non-native) from breeding habitat and sandy terraces, replacement of sand and other coarse sediments and restoration of a more natural hydrologic regime. The need for restoration may be most apparent below dams, where vegetation cover tends to increase and coarse sediments tend to get flushed away. It is not known whether habitat restoration has been done successfully for arroyo toads, but it has been done successfully with salmon which have similar habitat requirements.

5.7 Genetics

Although necessary to properly manage for this species, information on arroyo toad genetic diversity is virtually non-existent. Arroyo toad genetic analysis can be used to evaluate the degree of genetic variation within and between populations and to possibly identify genetic bottlenecks or barriers (Campbell et al. 1996). This will be especially important if populations are to be expanded or reestablished through translocation of larvae or juveniles (see section 5.9).

5.8 Population Expansion or Reestablishment

After threats (e.g., habitat loss, non-native predators, and pollution) to arroyo toads have been removed and suitable habitat has been restored or created, the possibility of reestablishing or creating arroyo toad populations by translocating larvae or juveniles from more robust populations (i.e., Sloan Canyon) should be explored to sites where arroyo toads no longer exist, occur in very low numbers, or never existed but habitat has been created. Detailed studies investigating the cause of decline or extirpation of the arroyo toad populations must first be conducted at sites considered for population reestablishment. Additionally, any causes for decline (e.g., loss of breeding habitat, presence of invasive predatory species, etc.) must be remedied before arroyo toad populations can be reestablished. The recovery program for the natterjack toad (*Bufo calamita*), an endangered species in Britain that has faced threats similar to those of the arroyo toad and is also a habitat specialist, has successfully used the reintroduction of egg strings to help restore the historical range of this species (Denton et al. 1997). Methods similar to the natterjack toad reintroduction should be considered for the arroyo toad (see Denton et al. 1997). Possible enhancement/reintroduction sites include the Sycuan Peak Ecological Reserve, the San Diego National Wildlife Refuge and the possibility of upper Sweetwater Reservoir should be discussed.

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Table 1. Flow data (in cubic-feet-per-second) from the five established water monitoring stations within the Sweetwater River.

Station Number	Location	Latitude[1]	Longitude	Date Collected	Flow (cfs)
324619116475701	Sycuan Peak Ecological Reserve	32.77194	116.79917	4/25/2003	0.18
324621116483201	Sycuan Peak Ecological Reserve	32.7725	116.80889	4/25/2003	0.14
324619116491201	Sycuan Peak Ecological Reserve	32.77194	116.82	4/25/2003	0.11
324621116493301	Sycuan Peak Ecological Reserve	32.7725	116.82583	4/25/2003	0.12
324427116554101	Cottonwood Golf Course	32.74083	116.92806	4/25/2003	0.20

[1]In WGS 84

Table 2. Arroyo toad habitat characteristics and habitat quality ratings for each reach surveyed in the Sweetwater River. Includes any possible disturbances that may affect arroyo toads. See Figures 11-13.

Reach	Start Latitude[1]	Start Longitude	End Latitude	End Longitude	Slope	Sandy Substrate	Adjacent Sandy Terraces	Braided Channel	Habitat Quality Rating	Dominant Plant Species	Visible Disturbances
Sycuan Peak Ecological Reserve											
Reach 1	32.77053	116.81321	32.77195	116.81057	1.40%	no	no	no	poor	Willow, Arundo, Pea species	Non-native plant species detected;High canopy and understory cover; Nearby road.
Reach 2	32.77193	116.81057	32.772	116.80854	2.84%	yes	yes	yes	high	Willow, Mulefat, Oak	Recent fire, erosion and siltation; Non-native plant and animal species detected; High canopy and understory cover; Nearby road and road crossing.
Reach 3	32.772	116.80854	32.77365	116.80717	2.95%	yes	no	yes	good	Cottonwood, Willow, Mulefat	Recent fire, erosion and siltation; High canopy and understory cover; Nearby road.
Reach 4	32.77365	116.80717	32.77438	116.80558	7.30%	no	no	yes	marginal	Willow, Cottonwood, Oak	Recent fire, erosion and siltation; Trash; Non-native animal species detected.
Reach 5	32.77438	116.80558	32.77385	116.80315	3.85%	yes	no	no	marginal	Willow, Cottonwood, Mulefat	Non-native plant and animal species detected; High canopy cover.
Reach 6	32.77385	116.80315	32.77252	116.80159	3.89%	no	no	yes	marginal	Willow, Cattails, Arundo	Non-native plant and animal species detected; High canopy and understory cover.
Reach 7	32.77252	116.80159	32.7722	116.79836	2.03%	no	no	no	poor	Willow, Cattails, Arundo	Non-native plant and animal species detected; High canopy cover; Nearby road.

Table 2 (continued).

Reach	Start Latitude	Start Longitude	End Latitude	End Longitude	Slope	Sandy Substrate	Adjacent Sandy Terraces	Braided Channel	Habitat Quality Rating	Dominant Plant Species	Visible Disturbances
Reach 8	32.7722	116.79838	32.77399	116.79369	0.43%	yes	yes	yes	high	Willow, Sycamore, Cottonwood	Non-native plant and animal species detected; High canopy and understory cover.
Reach 9	32.77398	116.79369	32.77474	116.79317	8.00%	no	yes	yes	good	Willow, Cottonwood, Bullrush	Non-native animal species detected.
San Diego National Wildlife Refuge											
Reach 1	32.76629	116.88029	32.76967	116.88034	0.00%	yes	yes	yes	high	Tamarisk, Mulefat, Non-native Grass	Non-native plant species detected; Past grading in channel.
Cottonwood Golf Course along SDNWR boarder											
Reach 1	32.74054	116.92781	32.74024	116.92151	0.70%	yes	yes	no	good	Mulefat, Tamarisk, Non-native Grass	Mowing of channel; Non-native animal and plant species detected; Golf course; High canopy and understory cover.
Upper Sweetwater Reservoir											
Reach 1	32.71043	116.95764	32.71277	116.95764	0.43%	yes	yes	yes	high	Willow, Mulefat, Non-native Grass	Water diversion directly above (urban runoff diversion system); Non-native plant and animal species detected; High canopy and understory cover; Historic sand and gravel mining nearby; Nearby road; Recreational activities (biking and hiking)

[1]In WGS 84

Table 3. Dates of nocturnal presence surveys.

	Dates Surveyed					
Location	Survey 1	Survey 2	Survey 3	Survey 4	Survey 5	Survey 6
Sycuan Peak Ecological Reserve	4/21/03	5/12/03	5/20/03	5/27/03	6/3/03	6/10/03 & 6/24/03[1]
San Diego National Wildlife Refuge	4/23/03	5/13/03	5/21/03	6/4/03	6/11/03	6/24/03
Cottonwood Golf Course	4/23/03	5/13/03	5/21/03	6/4/03	6/11/03	6/24/03
Upper Sweetwater Reservoir	3/11/03	3/27/03	4/10/03	5/1/03	5/16/03	6/6/03

[1]The sixth survey of reach 2 occurred on 6/24/03, because it was not surveyed on 6/10/03.

Table 4. Summary of Sloan Canyon arroyo toad data from Haas & Famolaro (1998) and Haas (unpublished data).

Date	Adults	Juveniles	Metamorphs	Larvae	Comments
1997	26 calling males, 13 females (based on egg masses and upland sightings of gravid individuals)	None reported	None reported	None reported	Successful recruitment was documented from 1995-1998.
April 15, 1999	28 calling males in stream, 2 adults in uplands	2 in uplands	None reported	None reported	
April 22, 1999	3 calling males in stream, 6 adults in uplands	None reported	None reported	None reported	
June 17, 1999	None reported	None reported	500+ neonates in upland	None reported	
September 23, 1999	19 in uplands	5 in uplands	None reported	None reported	
February 5, 2000	See comments	See comments	See comments	See comments	Approximately 50 according to distribution of arroyo toads map. No age given.
March 14, 2001	32 calling males in stream, 2 pairs in amplexus	None reported	None reported	None reported	
May 8, 2001	1 in stream, 18 in uplands	None reported	None reported	None reported	
May 23, 2001	None reported	None reported	None reported	None reported	

Table 5. Species detected during habitat assessment and nocturnal presence surveys for the arroyo toad in the Sweetwater River channel.

	Common Name	Scientific Name
Sycuan Peak Ecological Reserve		
	Green Sunfish	*Lepomis cyanellus* [1]
	Mosquitofish	*Gambusia affinis* [1]
	Western Toad	*Bufo boreas*
	Pacific Treefrog	*Hyla regilla*
	California Treefrog	*Hyla cadaverina*
	Bullfrog	*Rana catesbeiana* [1]
	African Clawed Frog	*Xenopus laevis* [1]
	Western Blind Snake	*Leptotyphlops humilis*
	Crayfish	*Procambarus clarkii* [1]
San Diego National Wildlife Refuge		
	Western Spadefoot	*Scaphiopus hammondii* [2,3]
	Western Toad	*Bufo boreas*
Cottonwood Golf Course		
	Mosquitofish	*Gambusia affinis* [1]
	Western Spadefoot	*Scaphiopus hammondii* [2,3]
	Western Toad	*Bufo boreas*
	Pacific Chorus Frog	*Hyla regilla*
	Two-Striped Garter Snake	*Thamnophis hammondii* [2]
	Crayfish	*Procambrius clarkii* [1]
Upper Sweetwater Reservoir		
	Largemouth Bass	*Micropterus salmoides* [4]
	Bluegill	*Lepomis macrochirus* [4]
	Green Sunfish	*Lepomis cyanellus* [4]
	Black Crappie	*Pomoxis nigromaculatus* [4]
	White Crappie	*Pomoxis annularis* [4]
	Common Carp	*Cyprinus carpio* [4]
	Grass Carp	*Ctenopharyngodon idella* [4]
	Channel Catfish	*Ictalurus punctatus* [4]
	Mosquitofish	*Gambusia affinis* [1]
	Western Spadefoot	*Scaphiopus hammondii* [2,3,4]
	Western Toad	*Bufo boreas*
	Pacific Chorus Frog	*Hyla regilla*
	Bullfrog	*Rana catesbeiana* [1]
	African Clawed Frog	*Xenopus laevis* [1,4]
	Two-Striped Garter Snake	*Thamnophis hammondii* [2,4]
	Red-eared Slider	*Trachemys scripta elegans* [4]
	Painted Turtle	*Chrysemys picta* [4]
	Snapping Turtle	*Chelydra serpentina* [4]
	Crayfish	*Procambrius clarkii* [1,4]

[1]Non-native species.

[2]CDFG species of special concern.

[3]Federal species of concern.

[4]Animals detected only during Sweetwater Authority non-native species eradication 1998-2004 (P. Famolaro, pers. comm.).

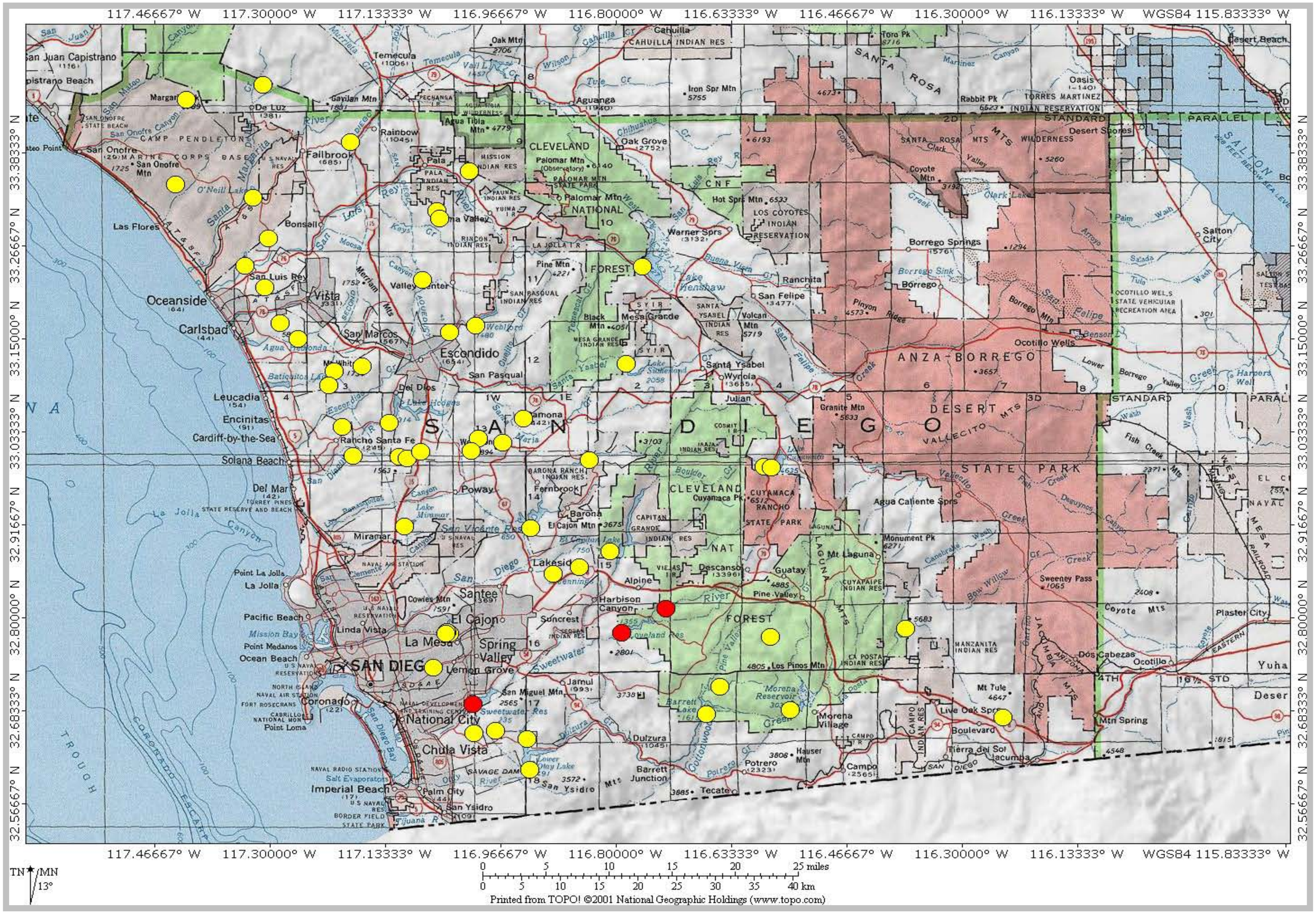


Figure 1. Dam locations in San Diego County. Red dots represent dams on the Sweetwater River. Data from CDWR 1993.

Figure 2. Photograph of an arroyo toad (*Bufo californicus*).

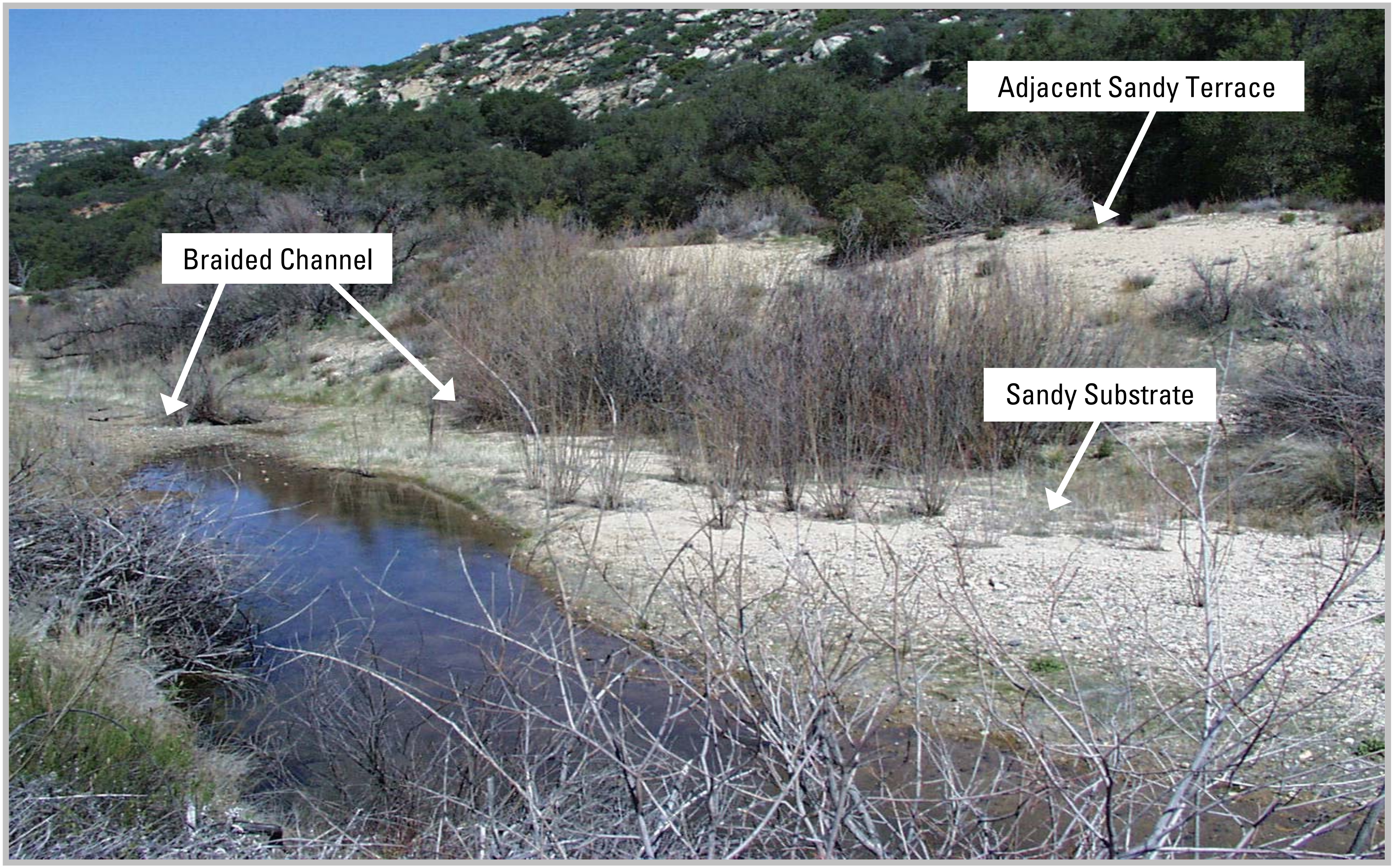


Figure 3. Habitat requirements of the arroyo toad. This diagram shows the three components of arroyo toad habitat including: sandy substrate, braided channel, and adjacent sandy terraces.

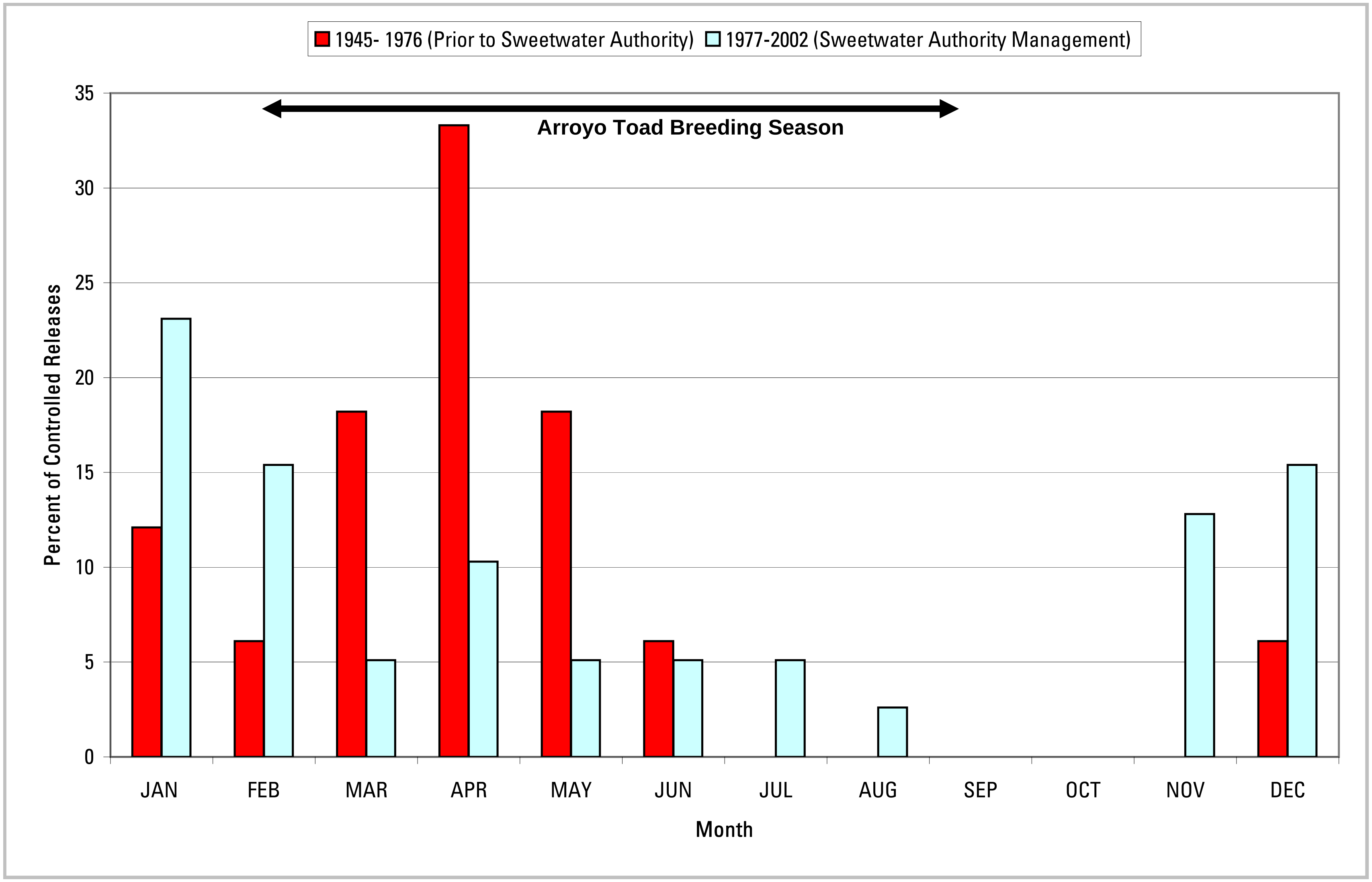


Figure 4. Controlled Releases from Loveland Dam 1945-1976 and 1977-2002. Since Sweetwater Authority has taken over the management of Loveland Dam, fewer releases have occurred during the arroyo toad breeding season.

Figure 5. Aerial photograph of study area, approximately 16 miles between Loveland and Sweetwater Reservoirs. Map from Fleury 2001.

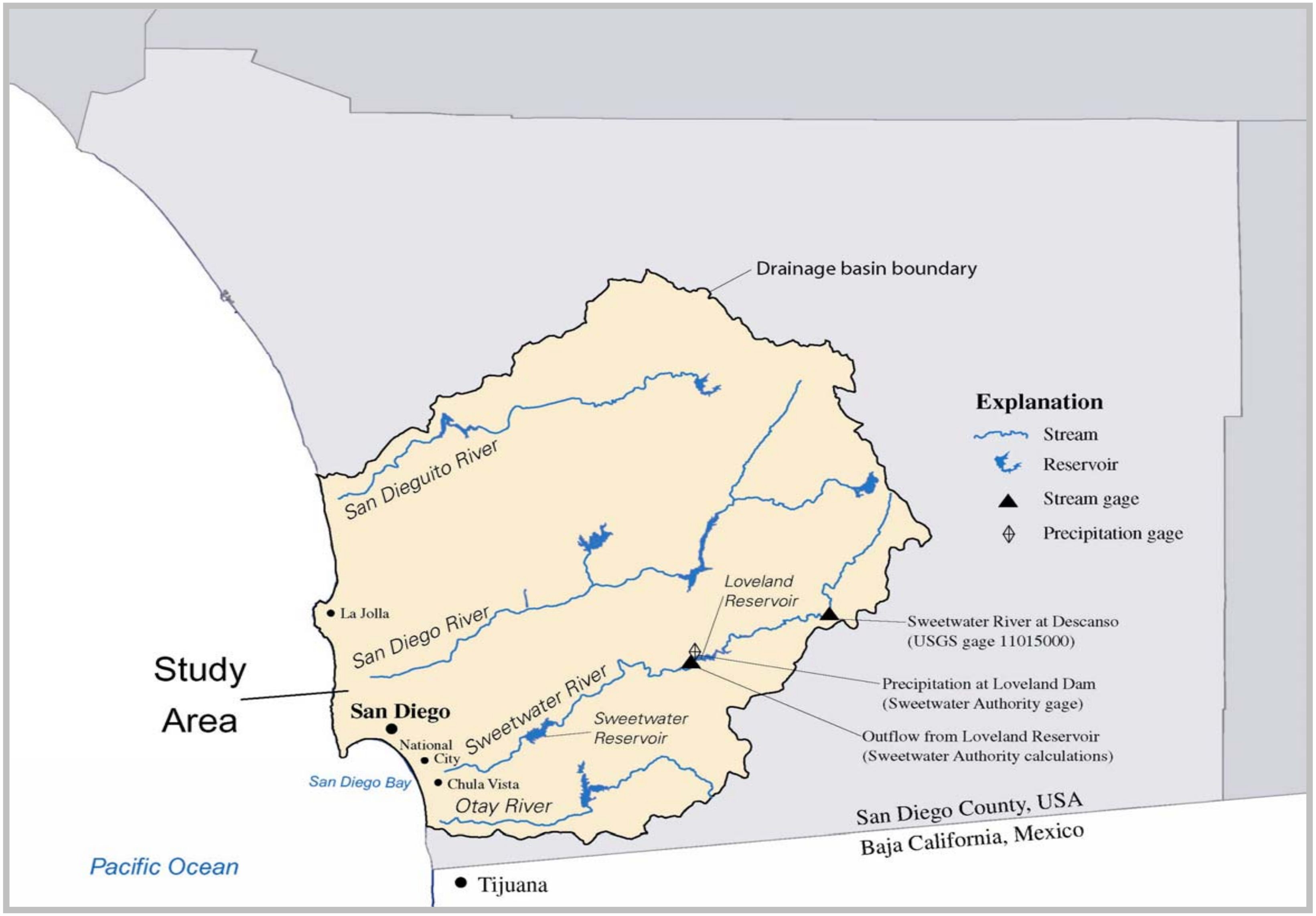


Figure 6. Sweetwater River and surrounding rivers. The USGS gage in Descanso is the only active gage on Sweetwater River. Map from Madden-Smith et al. 2004.

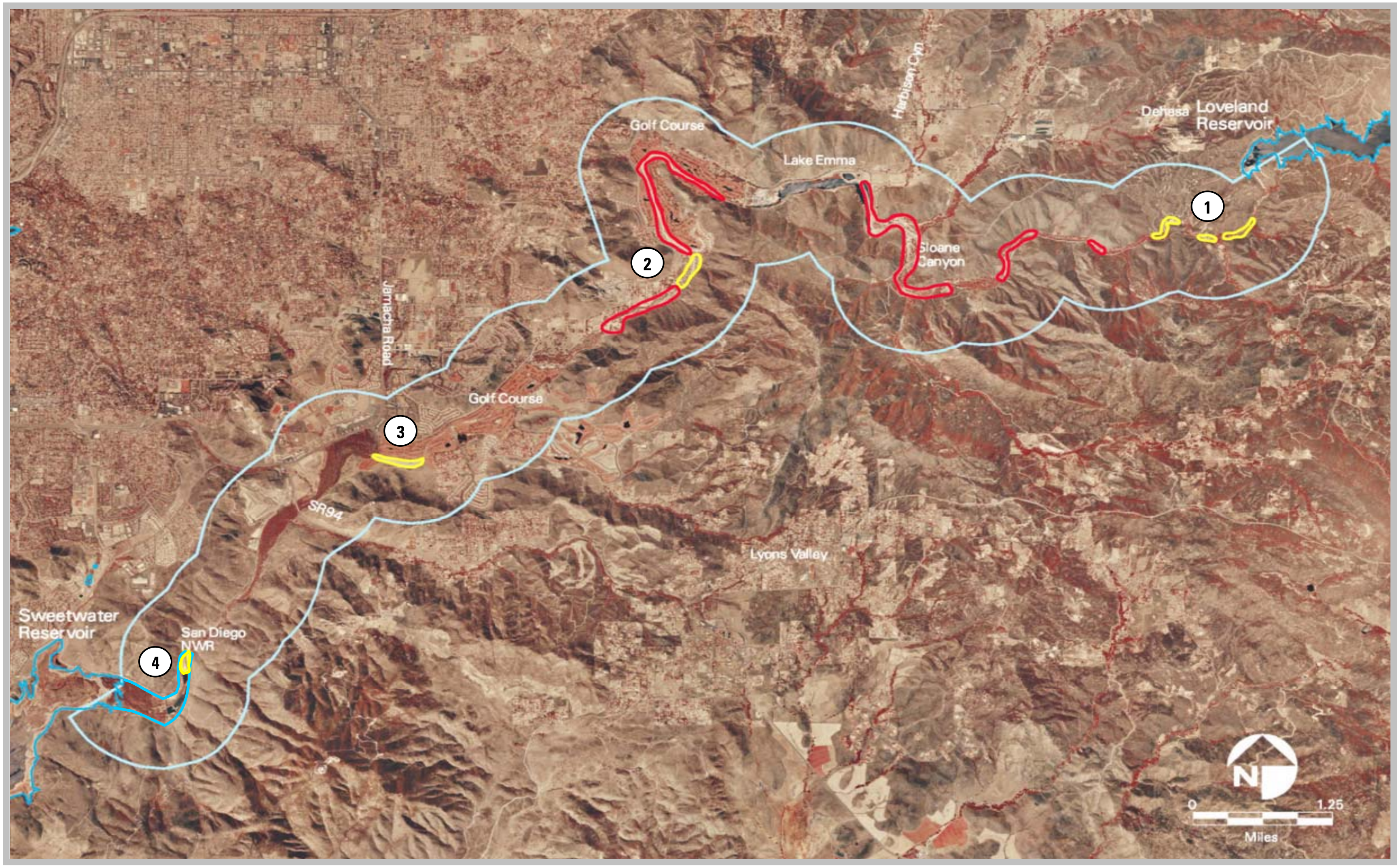


Figure 7. Aerial photograph of study area denoting possible areas containing arroyo toad habitat where access was obtained (yellow) and where access was denied (red). The four sites where access was obtained include: 1) Sycuan Peak Ecological Reserve, Sweetwater River; 2) San Diego National Wildlife Refuge, Sweetwater River; 3) Cottonwood Golf Course along the San Diego National Wildlife Refuge border and 4) Sweetwater River just east of Sweetwater Reservoir.

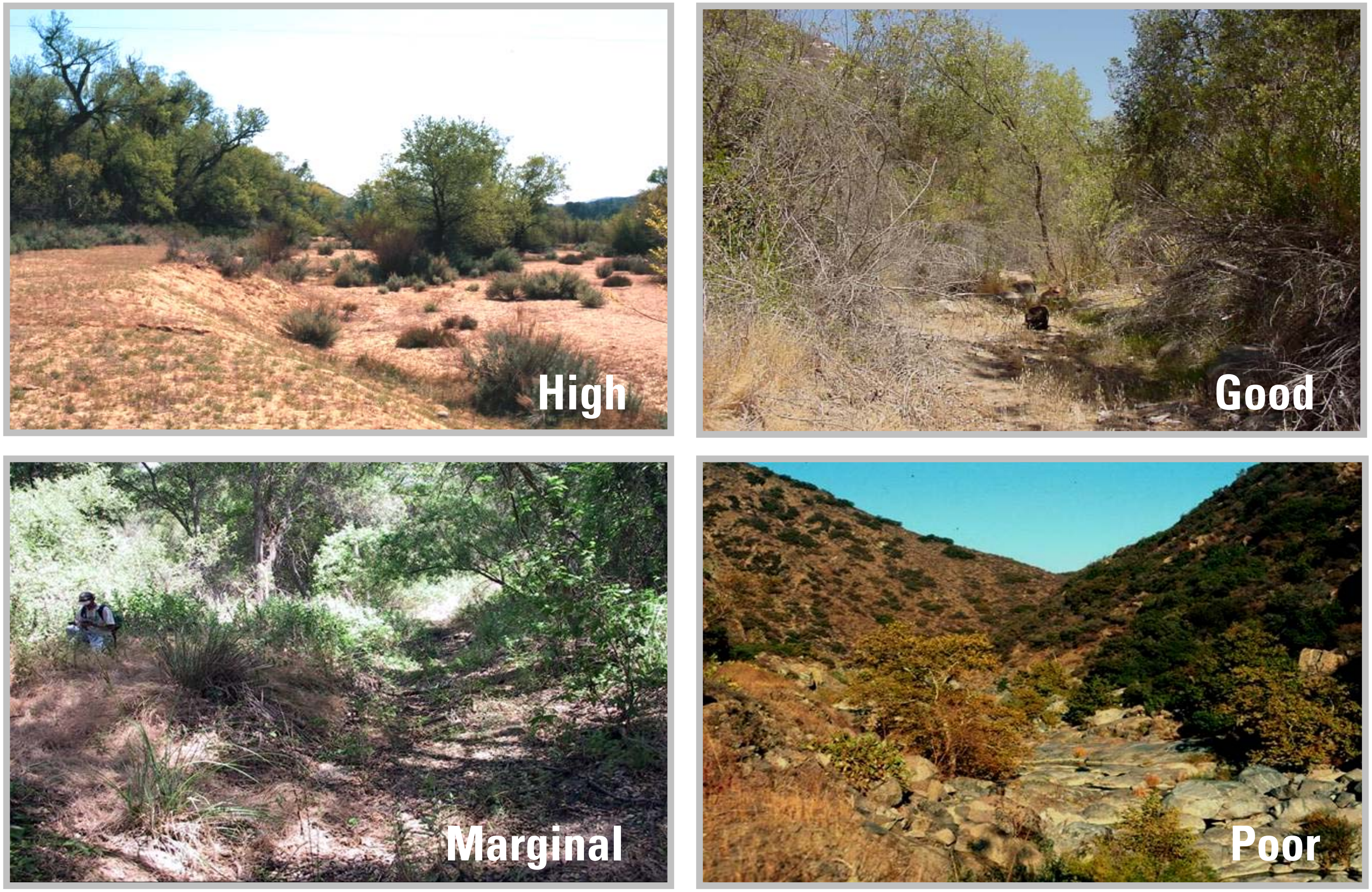


Figure 8. Examples of the possible habitat quality ratings of arroyo toad habitat. This figure shows examples for sites ranked *high* , *good* , *marginal* , and *poor quality* for arroyo toads using criteria described for daytime habitat suitability surveys.

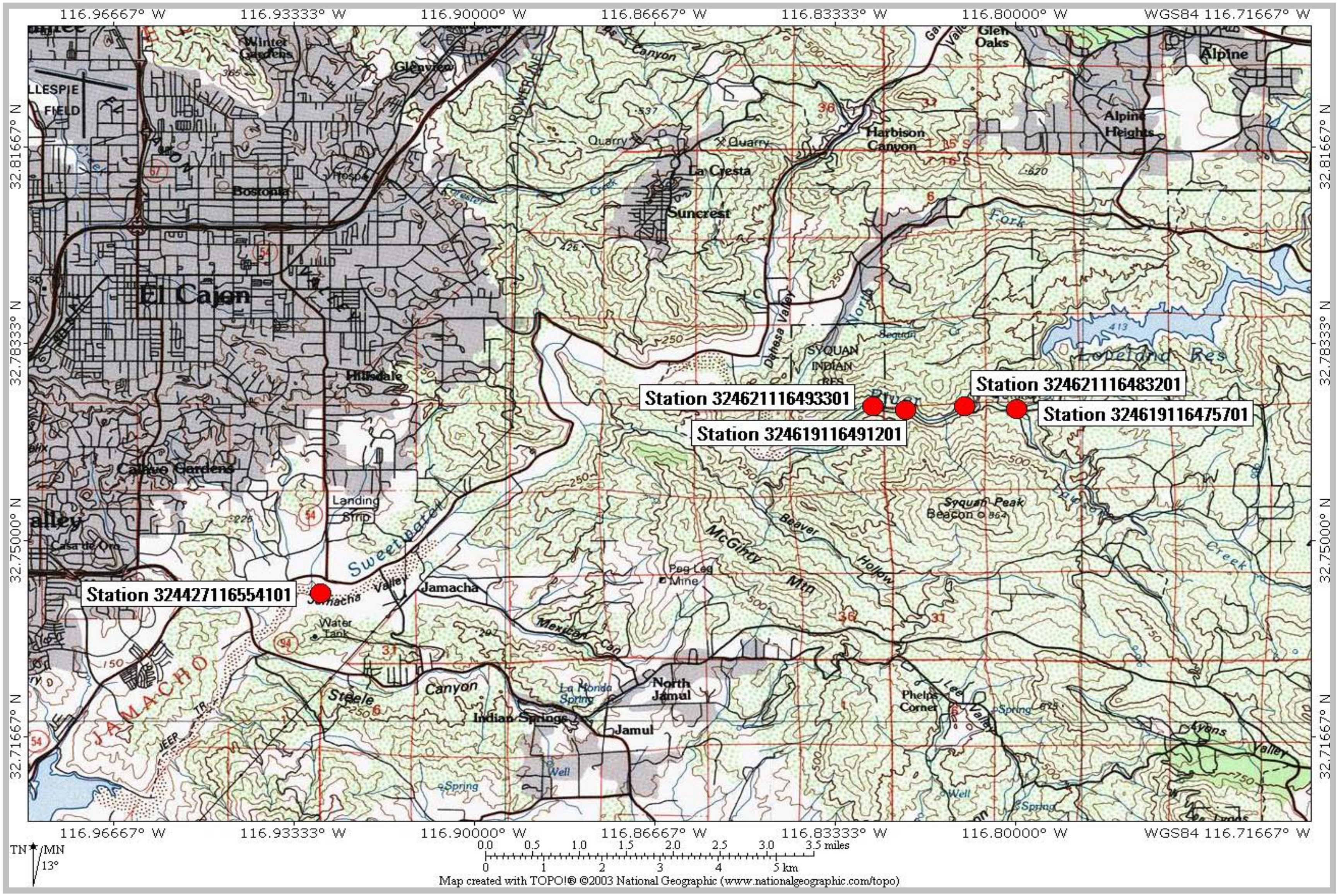


Figure 9. Map of established water sampling stations along the Sweetwater River.

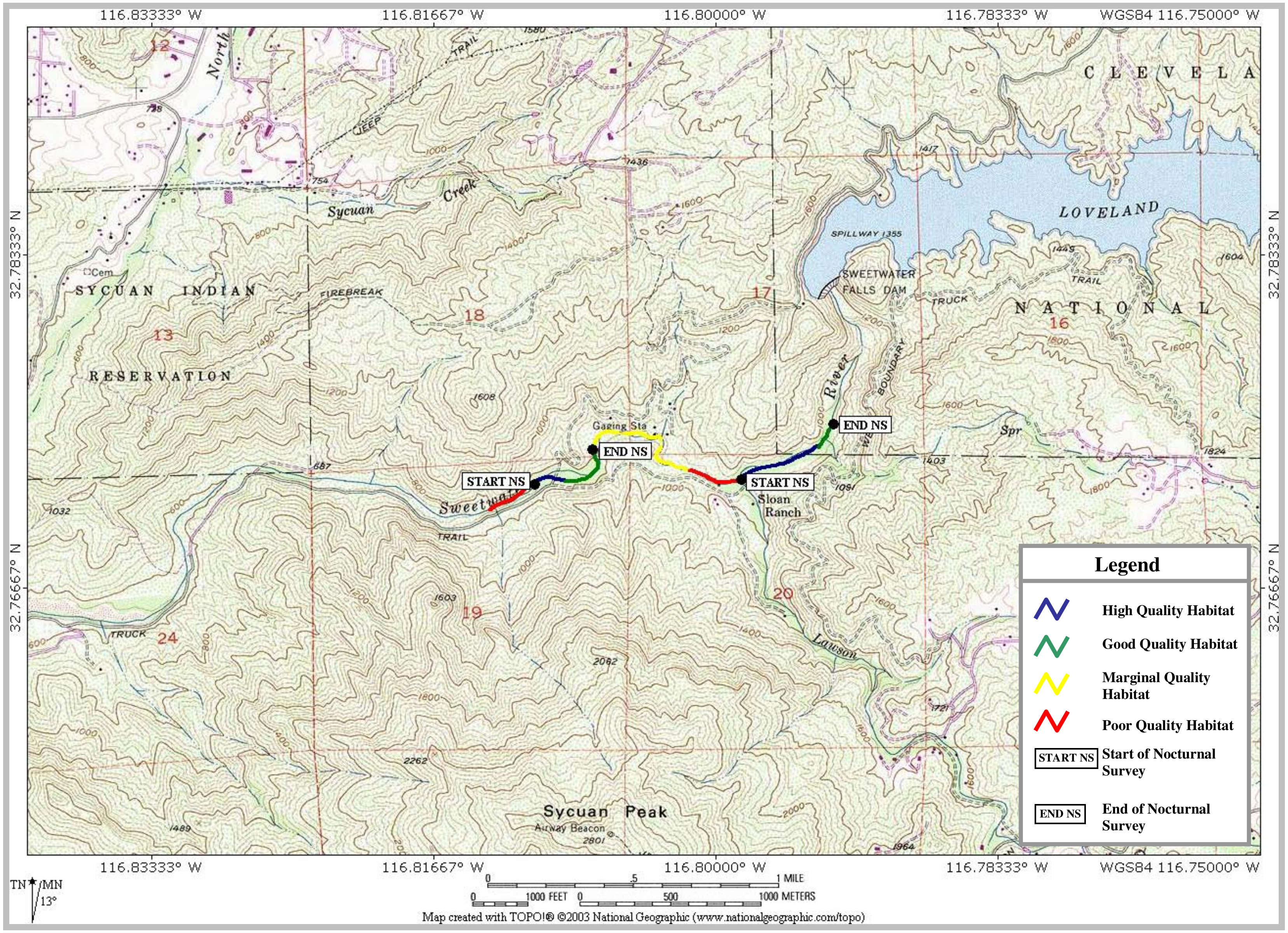


Figure 10. Habitat assessment and nocturnal survey map for Sycuan Peak Ecological Reserve site.

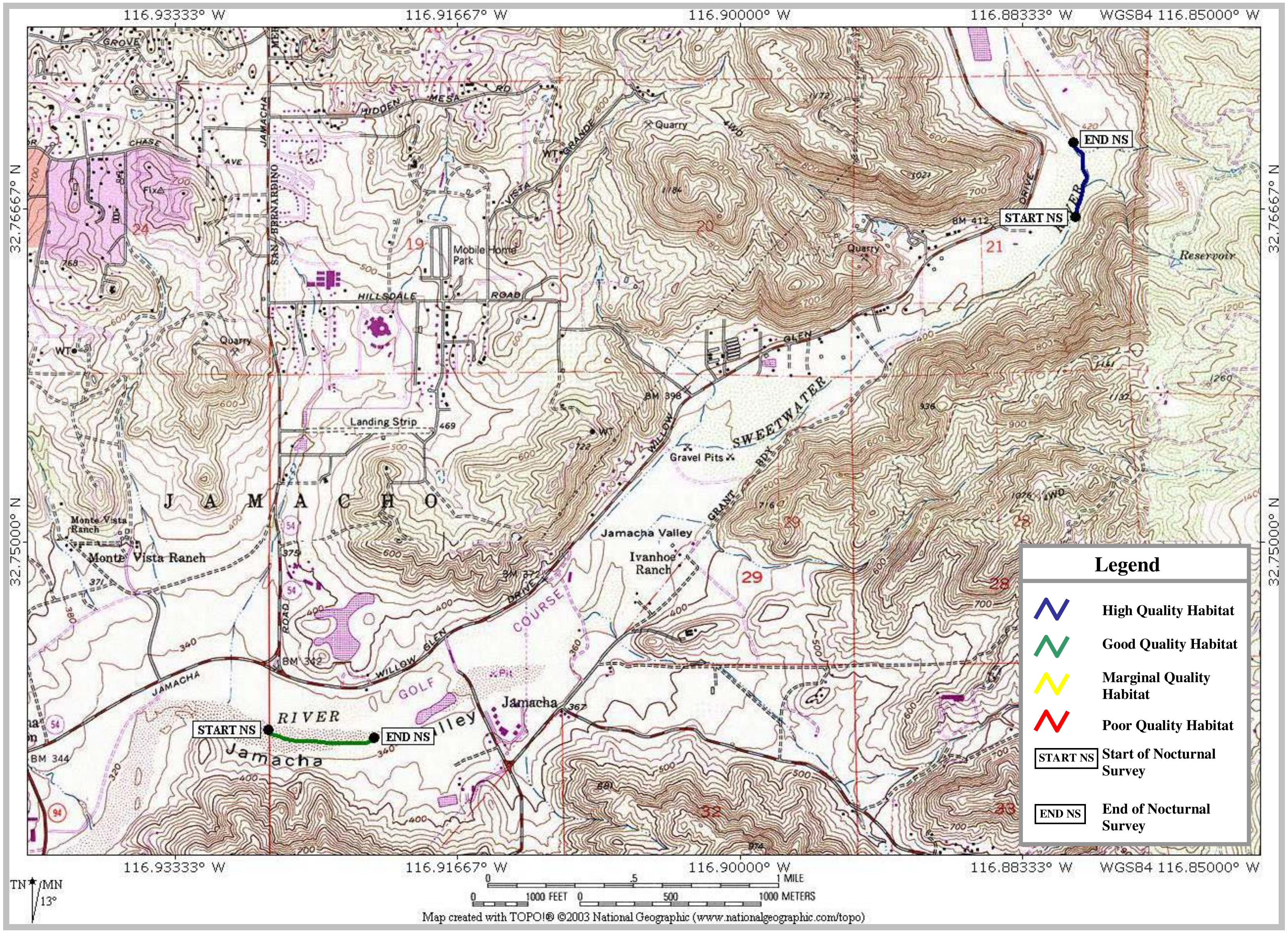


Figure 11. Habitat assessment and nocturnal survey map for the San Diego National Wildlife Refuge and Cottonwood Golf Course sites.

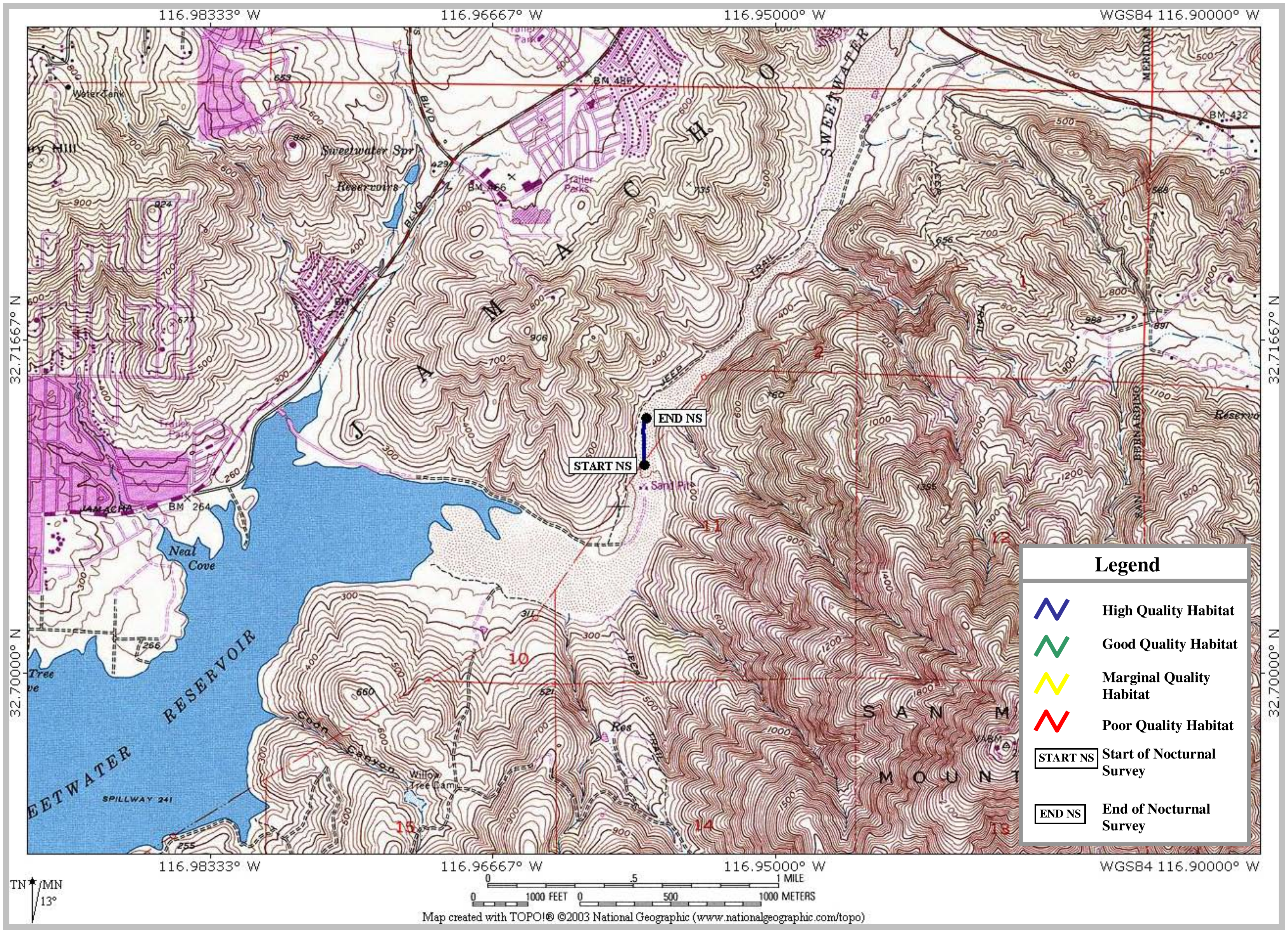


Figure 12. Habitat assessment and nocturnal survey map for Sweetwater River east of Sweetwater Reservoir site.

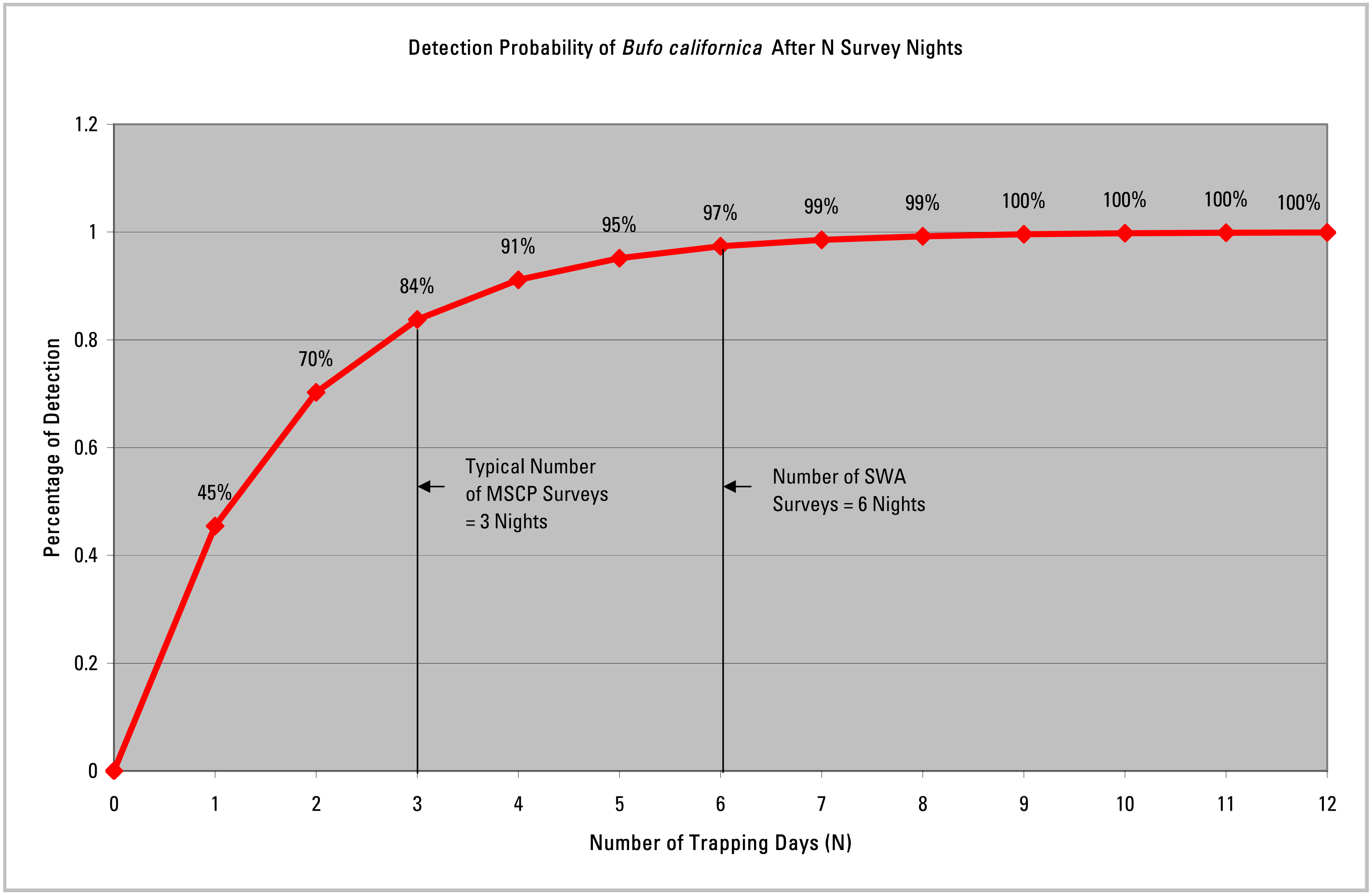


Figure 13. Arroyo toad nocturnal survey detectability curve for the nocturnal survey methods used in this study (proportion of sites occupied = 0.2853; detection probability = 0.4544; SE = 0.1087).

Appendix 1. Sweetwater Authority Interoffice Memorandum on Historical (1977-2002) Loveland Dam Releases and Projections.

SWEETWATER AUTHORITY

INTEROFFICE MEMORANDUM

TO: PETE FAMOLARO

FROM: KEVIN KASNER

SUBJECT: HISTORICAL (1977-2002) LOVELAND RELEASES AND PROJECTIONS

DATE: NOVEMBER 14, 2002 – REVISION 1

CC: DB, JLS, MG, SWA GEN FILE: WATER RESOURCES

Background

Loveland reservoir was constructed in 1945 to store water on the Sweetwater River that would have otherwise spilled from Sweetwater Main Dam.

Historically, water has been released through the dam to "move" water from Loveland to Sweetwater through the middle Sweetwater River where it can be treated and served to our customers. Historically, these transfers have occurred in every month of the year, but typically occur at the beginning or end of the winter. Since Sweetwater took over operation of the system in 1977, the transfers have occurred mostly (66% of releases) in November through February.

Current conditions for transfer:

There are a couple of "Rules of thumb" that have been applied to transfers since 1977: (1) When feasible, the quantity of the release is based on proportioning the amount of available space for water capture to 1/3 of the total available space at Sweetwater and 2/3 of the total space available at Loveland. The intent of this split is to try and ensure that Sweetwater only spills after Loveland begins spilling; (2) releases should begin after we have had significant rainfall to saturate the river channel to maximize the volume recovered at Sweetwater; and (3) since evaporation rates at Sweetwater are considerably greater than Loveland, only transfer enough water from Loveland to Sweetwater to supply the upcoming summer and fall.

Predictions of weather patterns might dictate preference of (1) over (3), or vice-versa. For example, if the year is expected to be very wet, proportioning available space to maximize capture is probably the controlling factor. However, in dry years, minimizing evaporation by only transferring enough to meet rule (3) would be the controlling factor.

Late season transfers, such as April – August typically occur in years when Loveland spilled but Sweetwater did not. The release is initiated as the reservoir stops spilling to increase the amount of water that reaches Sweetwater. This is usually done to meet rule of thumb (3) above.

Depending upon the volumes to be transferred, releases can be as short as a couple of weeks, or as long as a couple of months.

Winds of Change:

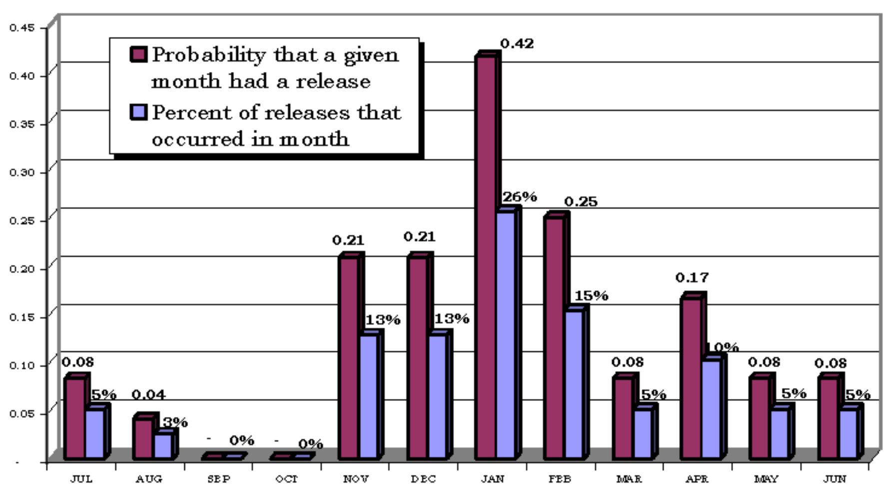
Several external factors could likely influence the decision process for future transfers and their influence has yet to be fully explored. These include: A new rate structure in place at both MWD and CWA considers "time of use" of imported water during the peak summer months, as well as several other factors; A five-year program with MWD and CWA will facilitate placement of imported water into Sweetwater Reservoir during the winter months without exposing Sweetwater Authority to the costs associated with evaporation and the potential for spilling water if the winter suddenly turns "wet".

Additionally, the water resources group is constantly looking to refine the operation of both reservoirs to maximize their benefits to our ratepayers. This includes exploring new sources of water, better uses of existing resources, and balance of the use of our existing sources of supply.

Probability of release occurring in a given month:

Based on the above discussion, the best estimation of when transfers are likely to occur is from our historical record, since Sweetwater Authority was formed in 1977. In the 25 years since 1977, there have been 39 months where releases have taken place.

The likelihood of a release occurring in each month is shown on the graph below. Note that the "zero" probabilities do not mean that a release will not occur, only that they are not probable to occur based on historical practices.



The first column for each month shows the probability of a controlled release occurring. This probability is based on the number of times that a release is expected to occur in that month. For example, January has a probability of about 0.42. This means that, on average, we will release in January 4 times in ten years. The probabilities shown do not add up to 1.0, because each month is compared only to its own history.

Percentage of releases occurring in a given month:

The second column for each month shows the percentage of releases that occurred in a given month. This percentage is based on the number of times a release occurred in a given month, and the number of months where releases occurred. For example, controlled releases occurred in 39 months since 1977, and of the 39 months 10 were January so the percentage is 26%.

Appendix 2. Daytime Habitat Assessment Survey Protocol for the Arroyo Toad (*Bufo californicus*) With Use of Personal Digital Assistant for Data Collection.

Prior To Survey

1. On the day prior to going out in the field to conduct the habitat assessment survey you will need to do the following:
    a) Familiarize yourself with the general objectives of the daytime habitat assessment survey for the arroyo toad.
    b) Make sure that your GPS is unit is properly backed up and delete all locations in the track memory. Be sure not to delete the waypoint list (you may delete the waypoint list but be sure to back it up/download the waypoints prior to doing so).
    c) Identify the start and end points of the survey reach, as determined from the initial site evaluation, and enter/download them into the GPS unit. You will use these locations to a) navigate to the downstream starting point of the survey reach and b) determine where the upstream end point of the survey is reached.
    d) Add any pre-defined sites into your Palm Pilot.
    e) Be sure to have the appropriate field equipment for the daytime habitat assessment survey.
    f) Contact landowner, if necessary, to let them know you will be accessing the site. **Note:** Certain properties may require greater than 24 hour notice prior to accessing the property.
    g) Secure access letters, permits (access and collecting), keys, and any maps (TOPO! and Terraserver) that you may need for the survey.

Day Of Survey

1. On the day of the survey, make sure the following items are attended to:

    a) All necessary field equipment
    b) Batteries and spare batteries are charged
    c) All necessary keys and permits (access and collecting)
    d) Any necessary maps
    e) Check the vehicle check log to make sure the vehicle is in proper working condition

2. When arriving at the site, navigate to the downstream endpoint and set the GPS unit "trip" record to 0.0km. **Note:** It is important to start at the downstream end of the survey reach so that the field of view is not impaired by any debris loosened during the survey.

3. To create a record for this survey reach, open up the Palm Pilot form "**Control Form"** and enter the following survey data fields:

    Survey

a) *Observer ID*: automatic entry (or tap on the "Lookup" button and add the appropriate name)
b) *Date*: date that the habitat suitability analysis was conducted; automatic entry
c) *Start time*: time that the habitat suitability survey started; end time is the time that the habitat suitability survey ended; **it will be entered at the completion of the habitat suitability survey (Step 16)**
d) *Notes:* add other observers that are present on the survey

4. Enter the weather and project data fields on the "**Control Form"** by selecting the "<u>Project & Weather</u>" subform. Click on the "Select One" option, highlight the "<u>Weather 1.4</u>" option, select the "add" button, and enter the following data fields:

<u>Weather</u>

a) *Weather condition*: select weather condition based on sky codes (tap on the "Lookup" button to bring up the list of sky codes)
b) *Start air temp*: record current air temperature; end air temp is the temperature at the end of the survey; **it will be recorded at the completion of the habitat suitability survey (Step 19)**
c) *Start wind*: record current wind speed based on Beauford wind scale; end wind is the wind speed at the end of the survey; **it will be recorded at the completion of the habitat suitability survey (Step 19)**
d) *% Cloud cover*: record cloud cover (as observed from the visible sky) based on the following percent categories: 1: <10%, 2: 11-25%, 3: 26-50%, 4: 51-75%, 5: >76%
e) *Prior Precipitation*: select the time frame of the most recent precipitation event from the pull-down menu (this can be added after the survey if it is not known immediately).
f) Select the "End" button at the bottom of the screen
g) Select the "Done" button at the bottom of the screen

To enter the project data, select the "Select One" option and highlight the "<u>Field Project</u>" option. Select the "Add" button and enter the following data fields:

<u>Project</u>
a) Project ID: select the appropriate project from the pull-down menu
b) Field Project Notes: enter any notes relative to this particular project
c) Select the "End" button at the bottom of the screen
d) Select the "Done" button at the bottom of the screen
e) Select the "Record View" button at the bottom of the screen

5. In order to have a record of the survey reach that you are sampling, create a site record for the site that you are surveying. Select the "<u>Site</u>" subform on the "**Control Form**" by tapping on the page icon to the right. Select the "Add" button and enter the following site data fields:

<u>Site</u>
a) *Site name*: enter site name if the survey reach is a new site; otherwise, proceed to 5b. The site name should contain no spaces between words and be in Title Case

format (i.e. SanMateoCreek). If the survey reach is a new site, enter it into the pre-defined site list.

b) *Pre-defined sites*: select the survey reach from the pull-down list of pre-defined sites

c) *GPS position grab*: Make sure that your GPS unit is properly hooked up to the Palm Pilot; hold the stylus on the line to the right of the "Start GPS Grab" field (hold for approximately 3 seconds). Tapping on this line will record the start latitude and longitude, the EPE, elevation, and datum (make sure that all of these fields are grabbed). After the location is grabbed, you may need to click on another field to see the values. You may need to try the GPS grab more than once. The "End GPS Grab" is the GPS location at the end of this survey reach; **it will be recorded at the completion of this particular stream reach (Step 14)**

The following fields will be automatically updated if the survey reach is a pre-defined site, otherwise, enter them in:

d) *Drainage*: enter the highest order stream/river that the survey reach is in
e) *County*: enter the county name in which the survey is taking place
f) *Quad name*: enter the name of the USGS quadrangle(s) that the habitat assessment survey is taking place
g) *Land owner*: enter the owner (local, state, federal) of the land on which the habitat assessment survey is taking place

6. Continue scrolling down to the terrestrial habitat portion of the "<u>Site</u>" subform (or click on the arrow to the right of the "Section" field and select "Terrestrial Habitat") and enter the following terrestrial habitat data fields:

<u>Terrestrial Habitat</u>

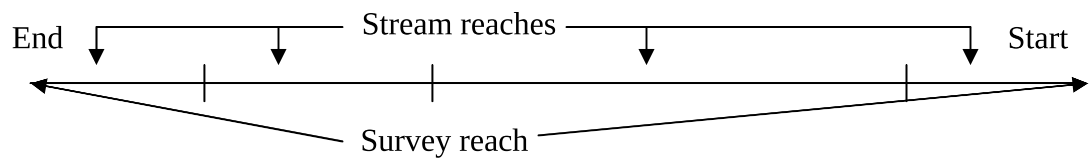
a) *Slope*: slope/gradient of stream; this will be determined by calculating the ratio between the difference of the start and end locations of the stream reach and the total length of the stream reach and will be calculated when returning back from the field. See example of how to calculate slope (Steps 1-4 in Initial Site Evaluation Protocol).
b) *Aspect*: the compass direction that the stream is flowing. This will be calculated after returning from the field by calculating the bearing between the start and end point of the survey.

7. Continue scrolling down to the aquatic habitat portion of the "<u>Site</u>" subform and enter the following aquatic habitat data fields:

<u>Aquatic Habitat</u>

a) *Site length*: length of the survey reach. This will calculated after returning from the field by measuring the stream distance between the start and end points of the survey reach.

8. Having entered the site data for the entire survey reach, you will now need to enter additional subsite records for each portion of the survey reach that has a different habitat suitability rating (each portion is called a stream reach).



Therefore, you will be entering from 1 to *n* site records of stream reaches for this entire survey reach. To begin the *first* reach, scroll up to the "SubSite" subform and tap on the page icon to the right. Select the "Add" button and enter the following subsite data fields:

SubSite

a) *Site name*: this is an automatic entry that is carried over from the "Site" form
b) *SubSite name*: if the stream reach is a pre-defined site, proceed to 8c. Otherwise, enter the site name as it reads from Step 5a followed by the reach # (for single digits, use a "0" before 1, 2, 3, etc…). For example, if starting a habitat assessment survey on a new site (i.e. San Mateo Creek), the site name (as entered in Step 5a) would be "SanMateoCreek"; for the first stream reach (this step), the site name would be "SanMateoCreekr01". If returning to this step again (after Step 14) the next site would read "SanMateoCreekr02", etc…
c) *Pre-defined subsites*: select the stream reach from the pull-down list of pre-defined subsites
d) *GPS position grab*: Make sure that your GPS unit is properly hooked up to the Palm Pilot; tap on the line to the right of the "Start GPS Grab" field. Tapping on this line will record the start latitude and longitude, the EPE, elevation, and datum.

9. If water is present at the beginning of the stream reach, scroll down the "SubSite" subform (or click on the arrow to the right of the "Section" field and select "Aquatic Habitat") and enter the following aquatic habitat data fields:

Aquatic Habitat

a) *Water*: enter whether there is any body of water present (checkmark) or absent (no checkmark). If you encounter water anywhere along the reach, you may come back to this field and enter water present.
b) *Site length*: this will be calculated after returning from the field by measuring the stream distance between the start and end points of the stream reach

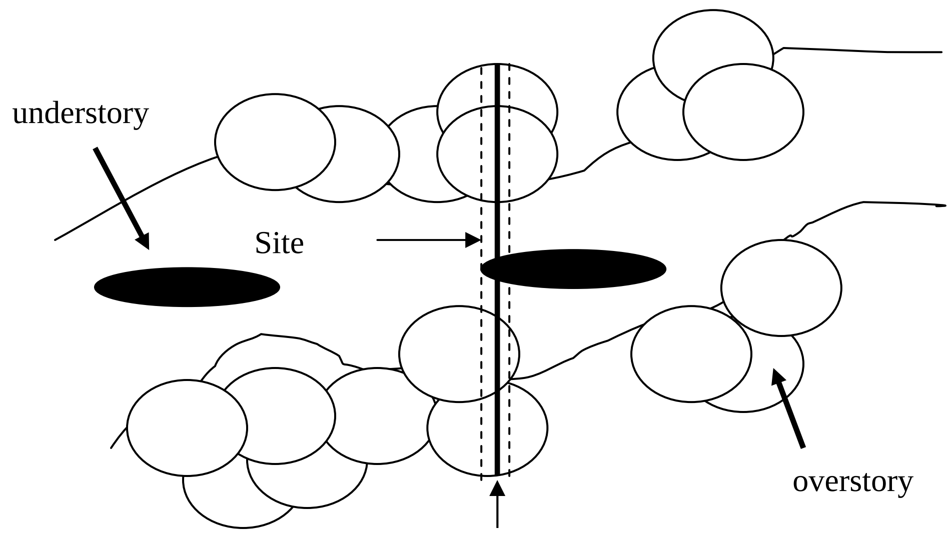
10. Select the "Water Quality" subform by tapping on the page icons to the right. Select the "Add" button and enter the following water data fields:

Water

a) *Start water temp*: water temperature at starting point (in C)
b) *End water temp*: the end water temperature for each stream reach will be the same as the "start water temp" for the next reach. Therefore, the only time an "end water temp" will be taken is at the end of the survey
c) *Transparency*: water transparency, as determined from the secchi disk
d) Select the "End" button at the bottom of the screen
e) Select the "Done" button at the bottom of the screen

11. Begin the survey by walking 20m from the start point. Here, you will record the first set of stream variables. These variables will be recorded every 100m (thus, measurements will be taken at 20m, 100m, 200m, 300m, etc…); they can be identified by looking at the “trip” distance on the GPS unit. At each of these locations, you will record the following variables: stream width, % Canopy cover, % Understory, and the 3 dominant plant species. Following are definitions of each:

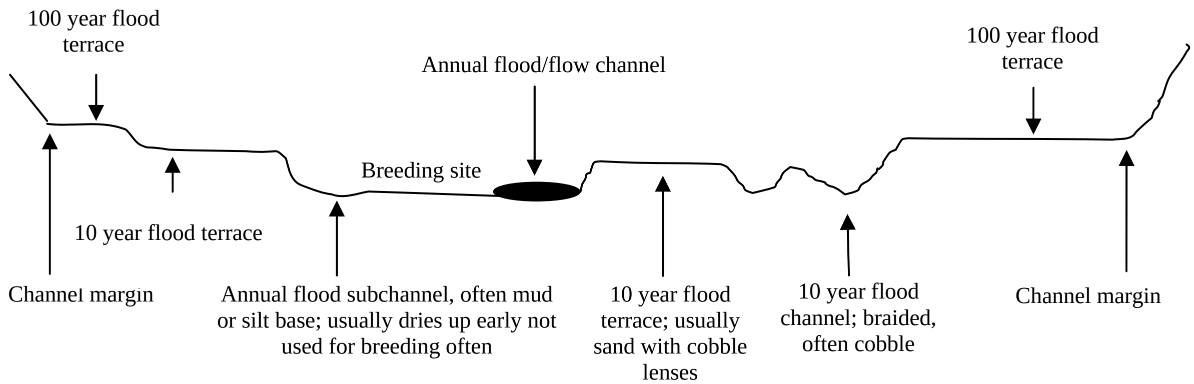
    a) *Site width*: this is equal to the average width of dominant riparian vegetation (riparian area, usually the 10 year flood terrace). The dominant vegetation will typically be mule fat and/or willow and are along the margins of the stream bank (where the riparian vegetation transitions to upland vegetation). If no riparian vegetation is present, than the site width is defined as the width between the transition of soil substrate on opposite sites of the stream channel. The transition is the outer limits of the stream substrate. The site width will be measured by a 100m tape measure. For stream channels that are extremely wide, an optic measuring device will be used. Stream width will be measured every 100m and averaged for each stream reach
    b) *% Canopy cover*: this is the percent category of vegetative cover (including woody debris) >1m in height that overlaps a 1m-wide belt (centered along the tape measure that was used to measure site width). Categories include: 1: <10%, 2: 11-25%, 3: 26-50%, 4: 51-75%, 5: >76%. In this example, the % Canopy cover would be 4 (51-75%). The % canopy cover will be measured every 100m and averaged for each stream reach
    c) *% Understory*: this is the percent category of vegetative cover <1m in height that overlaps a 1m-wide belt (centered along the tape measure that was used to measure site width). Categories include: 1: <10%, 2: 11-25%, 3: 26-50%, 4: 51-75%, 5: >76%. In this example, the % Understory cover would be 1 (<10%). The % understory
    d) *Dominant vegetation 1*: the most dominant plant species covering the 1m-wide belt
    e) *Dominant vegetation 2*: the 2nd most dominant plant species covering the 1m-wide belt
    f) *Dominant vegetation 3*: the 3rd most dominant plant species covering the 1m-wide belt



12. Continue hiking upstream. Be sure to walk slowly along the stream margins and in adjacent riparian habitat, visually searching for (but not disturbing) eggs, larvae, and juveniles. Also, be cognizant of any T & E plant species that may be along the stream banks. Along this stretch, be sure to observe the upland habitat immediately adjacent to the stream channel. Walking the reach will entail meandering back and forth along the stream channel, banks, and upland habitat in order to accurately assess the potential for arroyo toad breeding habitat; surveyors may walk within the stream, but must not disturb or create silt deposits within breeding pools. If stream crossings are necessary, they should occur on the downstream ends of potential breeding pools or in fast-flowing channels.

    While hiking along this reach, you will be looking for the following habitat characteristics which are indicators of arroyo toad breeding habitat (see Figure below; adapted from S. Sweet, US Fish & Wildlife Service Survey Protocol For The Arroyo Toad). They include:

    a) *Sandy substrate*- any portion of the stream reach that contains >10m (continuous) in which sand is the greatest proportion of substrate type (other substrate types include silt/clay, gravel, cobble, rock, and boulder)
    b) *Adjacent terraces with friable soils* -any portion of the stream reach that contains >10m (continuous) of sandy terraces with loose soils that are sparsely to heavily vegetated with brush and trees such as mulefat, California sycamore, cottonwoods, coast live oak, and willows, and mulefat; the understory of stream terraces may consist of scattered short grasses, herbs, and leaf litter, with patches of bare or disturbed soil, or have no vegetation at all
    c) *Braided channels*- the channel has multiple watercourses for a stretch of >10m (continuous); these watercourses may be dry



The reach that you are walking will either have none of these characteristics, a subset of them, or all three of them. You will also note the following site, terrestrial habitat, and aquatic habitat variables while walking along this stretch **(these variables may be entered in the Palm Pilot as you encounter them or at the end of this reach (step 14)):**

<u>SubSite variables to consider while walking reach</u>

a) Disturbance and threats
-select from the list provided or add any others that are not on the list

<u>Terrestrial habitat variables to consider while walking reach</u>

a) *Plant community*: assign the plant community adjacent to the creek (i.e. the upland habitat type) from the habitat type list

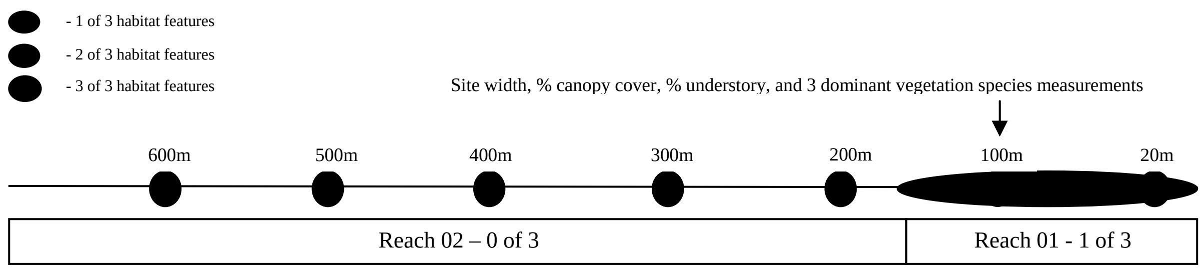
<u>Other variables to consider while walking reach</u>

a) *Sandy and exposed stream banks*: observe sandy and exposed stream banks along the margins of the stream channel
->10m (continuous) of reach in which sand is the greatest proportion of substrate type
b) *Sand and gravel bars*: observe sand and/or gravel bars within the stream channel
->10m (continuous) of reach in which sand and/or gravel bars are present within the stream channel
c) *Fish species*: note the fish species and numbers observed along this reach by filling out an animal record ("<u>Animal</u>" subform) for each fish species encountered along the reach; voucher specimens of each exotic and non-sensitive native species should be collected.

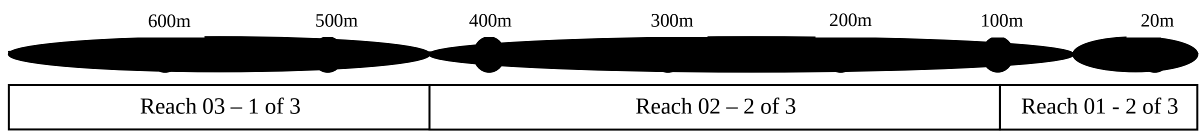
Protocol for collecting voucher specimens in the field

13. The end of the stream reach is defined as that location where the habitat suitability changes. A habitat suitability change is defined as the addition or loss of one of the three arroyo toad breeding habitat characteristics. For example, if at the start of the survey there are none of the three habitat characteristics present, the end of the survey reach would occur when one,

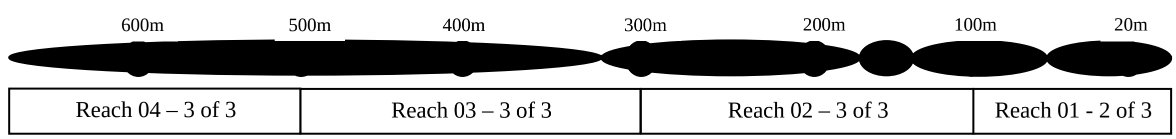
two, or three of the habitat characteristics appear along the stream channel being surveyed. At this point, you would proceed to step 14. Alternatively, if there were two of the three habitat characteristics present at the start of the survey, you would proceed to step 14 at the point along the stream reach where there are none, one, or all three of the habitat characteristics present along the stream channel. The minimum a reach will be is 100m. Therefore, if a habitat feature is gained or lost before two site width/vegetation measurements are made, a new reach will not begin until the 2nd site width/vegetation measurement is made. The rating for that reach will be based on the highest number of habitat features within that reach (see examples below).



Example 1: The first reach starts with 1 of the three characteristics. Two site width/vegetation measurements are taken before the habitat feature is lost. Where that habitat feature is lost, a new reach begins. The site width/vegetation measurements for the 20m and 100m locations are averaged for r01; the site width/vegetation measurements for the 200m to 600m locations are averaged for r02.



Example 2: The first reach starts with 1 of the three characteristics. A second characteristic is gained, however it occurs along the reach before two site width/vegetation measurements are measured. Once the second measurement is made (in this example, at 100m) a new reach (r02) is started. The first reach is given a 2 of 3 rating; the second reach is given a 2 of 3 rating and continues until another habitat feature is gained or lost (even if a new feature is gained or lost within a short distance, at least two site width/vegetation measurements must be made; see example below). The site width/vegetation measurements for the 200m, 300m, and 400m locations are averaged for r02.



Example 3: The first reach starts with 1 of the three characteristics. A second characteristic is gained, however it occurs along the reach before two site width/vegetation measurements are measured. Once the second measurement is made (in this example, at 100m) a new reach (r02) is started. The first reach is given a 2 of 3 rating. The second reach starts with 2 of the 3 characteristics. A third characteristic is gained, however it occurs for only a short distance. Two site width/vegetation measurements must be made before a new reach starts. When this location is reached (in this example, at 300 m) a new reach (r03) is started. Within a short distance, the third characteristic appears again. Although this is a change in the habitat suitability rating (from 2 characteristics to 3 characteristics), the reach started with only 2 of the 3 characteristics. Thus, 2 site width/vegetation measurements must be made. When this location is reached (in this example, at 500m) a new reach (r04) is started.

14. When the location along the drainage described in step 13 is reached, the remaining fields not initially entered in the site, terrestrial habitat, aquatic habitat, and water portions of the "SubSite" subform will need to be entered. These data fields include:

SubSite

a) *GPS position grab*: Make sure that your GPS unit is properly hooked up to the Palm Pilot; tap on the line to the right of the "End GPS Grab" field. Tapping on this line will record the end latitude and longitude, the EPE, elevation, and datum.
b) *Disturbance and threats*: list any disturbances and/or threats encountered along stream reach

Terrestrial habitat
a) % Canopy cover: this value will be the average value of the % Canopy cover recorded at all locations along this stream reach
b) Plant community: assign the upland plant community from the habitat type list
c) % Understory: this value will be the average value of the % Understory recorded at all locations along this stream reach

Aquatic habitat
a) *Site length*: this will be calculated after returning from the field by measuring the stream distance between the start and end points of the stream reach
b) *Site width*: this value will be the average value of the site width recorded at all locations along this stream reach

All of the above data fields are contained within the "SubSite" subform and can be found by scrolling up and down the form. For the "Water" data field, scroll to the "Water Quality" subform and tap on the page icons to the right. Select the "Add" button; enter the following water data field:

Water
a) *End water temp*: water temperature at end point (in C)
b) Select the "End" button at the bottom of the screen
c) Select the "Done" button at the bottom of the screen

15. Next, enter the following data for the following fields identified in the "Arroyo Toad Habitat Suitability" section of the Palm Pilot form "SubSite" subform. Scroll down the "SubSite" subform until you reach the following fields (you may need to highlight the "Show All" button at the bottom of the field list to display all of these fields):

a) *% of reach with sandy and exposed stream banks*: enter the % category of the previous reach in which the banks along the stream channel were sandy and exposed: 1: <10%, 2: 11-25%, 3: 26-50%, 4: 51-75%, 5: >76%
b) *% of reach with sand and gravel bars*: estimate the % category of the previous reach in which sand and/or gravel bars were present within the stream channel: 1: <10%, 2: 11-25%, 3: 26-50%, 4: 51-75%, 5: >76%
c) *Fish observed*: tap on the box to enter a checkmark if there were fish observed within this reach

The following three physical habitat characteristics will then be assigned a yes (tap on the box to enter a checkmark) or no (leave the box blank):

d) *Sandy substrate*: did the previous stream reach contain >10m (continuous) where sand was the greatest proportion of substrate type?

e) *Adjacent terraces with friable soils*: did the adjacent upland terraces (i.e. those banks that represent the upper limits of 100-year flood events) contain >10m (continuous) of easily broken soil (i.e. sand and loose gravel as opposed to cobble and rock)?
f) *Braided channels*: does the channel have multiple watercourses for at least 10m (continuous)?

Finally, based on the answers to the above three questions, you will assign a quality of Arroyo Toad breeding habitat value to the reach of stream just surveyed. To find this field, scroll back up the "SubSite" subform to the "Overall Site Quality" field:

g) *Overall Site Quality*: assign the appropriate rating based on the number of physical habitat characteristics the stream reach contains. Rating is defined as:

High – the reach contained all 3 of the physical habitat characteristics
Good – the reach contained 2 of the 3 physical habitat characteristics
Marginal – the reach contained 1 of the 3 physical habitat characteristics
Poor – the reach contained none of the 3 physical habitat characteristics

16. Site Photo: take a photo of the previous reach you just surveyed

17. This completes the habitat assessment for the first reach of stream. To begin a new "SubSite" subform for the next stream reach:

a) Select the "End" button at the bottom of the screen
b) Click the "Add" button at the bottom of the screen; this will open up a new "SubSite" subform for the next stream reach (the new site would be (i.e.) LittleRockCreekr02)
c) Go back to Step 8 and repeat the process of entering the appropriate data fields for all remaining stream reaches

18. Continue assessing the arroyo toad breeding habitat suitability for each subsequent reach of stream, defined by the point along the stream where the habitat suitability changes, until the entire survey reach is completed.

19. After reaching the end of the survey reach, select the "Water Quality" subform by tapping on the page icons to the right. Select the "Add" button and enter the following water data field:

Water
a) *End water temp*: water temperature at end point (in C)
b) Select the "End" button at the bottom of the screen
c) Select the "Done" button at the bottom of the screen

Next, leave the "SubSite" subform by selecting the "End" button at the bottom of the screen. On the next screen, tap on the "Done" button to bring up the "Site" subform. Enter the following data fields:

Site

a) *GPS position grab*: Make sure that your GPS unit is properly hooked up to the Palm Pilot; tap on the line to the right of the "End GPS Grab" field. Tapping on this line will record the end latitude and longitude, the EPE, elevation, and datum.

Next, leave the "Site" subform by selecting the "End" button at the bottom of the screen. On the next screen, tap on the "Done" button to bring up the "**Control Form**". Enter the following survey and weather fields. The remaining fields include:

Survey

a) *End time*: time that the habitat suitability survey ended

Weather

a) *End air temp*: temperature at the completion of the habitat suitability survey
b) *End wind*: wind speed at the completion of the habitat suitability survey; based on Beauford wind scale

20. Complete the Control Form by selecting "End" at the bottom of the screen.

21. After returning from the field, download all waypoints and track points to your computer. These points should be located in a file that identifies the date and survey site from which the locations were recorded.

Appendix 3. Nocturnal Presence Survey Protocol for the Arroyo Toad (*Bufo californicus*) With Use of Personal Digital Assistant for Data Collection.

Prior To Survey

1. On the day prior to going out in the field to conduct the nocturnal presence survey you will need to do the following:

    a) Familiarize yourself with the general objectives of the nocturnal presence survey for the arroyo toad.
    b) Make sure that your GPS is unit is properly backed up and delete all locations in the track memory. Be sure not to delete the waypoint list (you may delete the waypoint list but be sure to back it up/download the waypoints prior to doing so).
    c) Identify the start and end points of the "High" and "Good" quality habitats as determined from the daytime habitat suitability survey. Upload the start and end points of these reaches into your GPS unit.
    d) Be sure to have the appropriate field equipment for the nocturnal presence survey.
    e) Contact landowner, if necessary, to let them know you will be accessing the site. **Note:** Certain properties may require greater than 24 hour notice prior to accessing the property.
    f) Secure access letters, permits (access and collecting), keys, and any maps (TOPO! and Terraserver) that you may need for the survey.
    g) Make sure that the appropriate vehicle is signed out.

Day Of Survey

1. On the day of the survey, make sure the following items are attended to:

    a) All necessary field equipment
    b) Batteries, spare batteries, and Kohler Wheat lamps are charged
    c) All necessary keys and permits (access and collecting)
    d) Any necessary maps
    e) Check the vehicle check log to make sure the vehicle is in proper working condition

2. When arriving at the site, navigate to the downstream endpoint. **Note:** It is important to start at the downstream end of the survey reach so that the field of view is not impaired by any debris loosened during the survey.

3. To create a record for this survey reach, open up the Palm Pilot form "**Control Form**" and enter the following survey data fields:

    Survey
    a) *Observer ID*: automatic entry (or tap on the "Lookup" button and add the appropriate name)
    b) *Date*: date that the nocturnal presence survey was conducted; automatic entry

c) *Start time*: time that the nocturnal presence survey started; end time is the time that the nocturnal presence survey ended; **it will be entered at the completion of the nocturnal presence survey (Step 12)**
d) *Notes*: add other observers that are present on the survey

4. Enter the weather and project data fields on the "**Control Form**" by selecting the "Project & Weather" subform. Click on the "Select One" option, highlight the "Weather 1.4" option, select the "Add" button, and enter the following data fields:

Weather
a) *Weather condition*: select the weather condition based on the sky codes (tap on the "Lookup" button to bring up the list of sky codes)
b) *Start air temp*: record current air temperature; end air temp is the temperature at the end of the survey; **it will be recorded at the completion of the nocturnal presence survey (Step 12)**
c) *Start wind*: record current wind speed based on Beauford wind scale; end wind is the wind speed at the end of the survey; **it will be recorded at the completion of the nocturnal presence survey (Step 12)**
d) *% Cloud cover*: record cloud cover (as observed from the visible sky) based on the following percent categories: 1: <10%, 2: 11-25%, 3: 26-50%, 4: 51-75%, 5: >76%
e) *Prior precipitation*: select the time frame of the most recent precipitation event from the pull-down menu (this can be added after the survey if it is not known immediately)
f) *Moon phase*: select the moon phase based on the list of moon phase codes from the pull-down menu (this can be added after the survey if it is not known immediately)
g) *Fraction of illumination*:
h) Select the "End" button at the bottom of the screen
i) Select the "Done" button at the bottom of the screen

To enter the project data, select the "Select One" option and highlight the "Field Project" option. Select the "Add" button and enter the following data fields:

Project
a) Project ID: select the appropriate project from the pull-down menu
b) Field Project Notes: enter any notes relative to this particular project
c) Select the "End" button at the bottom of the screen
d) Select the "Done" button at the bottom of the screen
e) Select the "Record View" button at the bottom of the screen

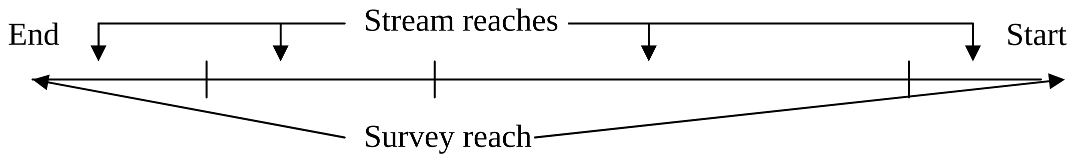
5. In order to have a record of the survey reach that you are sampling, create a site record for the site that you are surveying. Select the "Site" subform on the "**Control Form**" by tapping on the page icon to the right. Select the "Add" button and enter the following site data fields:

Site
a) *Site name*: If the site that is being surveyed was entered as a pre-defined site during the daytime habitat assessment survey, then proceed to 5b. Otherwise,

enter the site name if the survey reach is a new site. The site name should contain no spaces between words and be in Title Case format (i.e. SanMateoCreek). If the survey reach is a new site, enter it into the pre-defined site list (see Instructions on adding pre-defined sites into the Palm Pilot)

b) *Pre-defined sites*: select the survey reach from the pull-down list of pre-defined sites

6. Having entered the site data for the entire survey reach, you will now need to enter additional subsite records for each portion of the survey reach that has a "High" or "Good" suitability rating (each portion is called a stream reach). These "High" and "Good" stream reaches would have been identified during the daytime habitat suitability assessment survey. NOTE: Certain projects may require that all stream reaches within a survey reach be surveyed regardless of their habitat suitability rating; please refer to the project scope of work to determine if a complete survey of the entire survey reach is required.



To begin the *first* reach, scroll to the "SubSite" subform and tap on the page icon to the right. Select the "Add" button and enter the following subsite data fields:

SubSite

a) *Site name*: this is an automatic entry that is carried over from the "Site" form
b) *SubSite name*: if the stream reach is a pre-defined site (this should have been completed during the daytime habitat assessment survey), proceed to 8c. Otherwise, enter the site name as it reads from Step 5a followed by the reach # (for single digits, use a "0" before 1, 2, 3, etc…). For example, if starting a habitat assessment survey on a new site (i.e. San Mateo Creek), the site name (as entered in Step 5a) would be "SanMateoCreek"; for the first stream reach (this step), the site name would be "SanMateoCreekr01". If returning to this step again (after Step 14) the next site would read "SanMateoCreekr02", etc…
c) *Pre-defined subsites*: select the stream reach from the pull-down list of pre-defined subsites

7. If water is present at the beginning of the stream reach, scroll down the "SubSite" subform (or click on the arrow to the right of the "Section" field and select "Aquatic Habitat") and enter the following aquatic habitat data fields:

Aquatic Habitat

a) Water: enter whether there is any body of water present (checkmark) or absent (no checkmark). If you encounter water anywhere along the reach, you may come back to this field and enter water present.

8. Select the "Water Quality" subform by tapping on the page icons to the right. Select the "Add" button and enter the following water data fields:

Water

a) *Start water temp*: water temperature at starting point (in C)
b) *End water temp*: water temperature at end point (in C); this will be recorded at the end of the reach in Step 11
c) Select the "End" button at the bottom of the screen
d) Select the "Done" button at the bottom of the screen

9. Begin walking the survey reach slowly and carefully on the stream banks. Surveyors should stop periodically and remain still to wait for arroyo toads to begin calling (this can be conducted when the end of the stream reach is reached and the remaining data fields are being entered). Along this stream reach, be sure to observe the upland habitat immediately adjacent to the stream channel, any open, sandy patches of sparse vegetation, sandy banks, and breeding pools. Note any arroyo toad tadpoles or egg masses. If stream crossings are necessary, they should occur on the downstream ends of potential breeding pools or in fast-flowing channels; stream crossings/entering the water must be avoided near amplexing or courting pairs. Surveys should be conducted as silently as possible; talking or other human-generated noises may cause arroyo toads to stop calling or leave the creek.

10. When an arroyo toad is detected, scroll to the "<u>Species</u>" subform and tap on the page icon to the right. Select the "Animal 3.0" option, select the "Add" button, and enter the following species data fields:

    a) *GPS position grab*: Make sure that your GPS unit is properly hooked up to the Palm Pilot; hold the stylus on the line to the right of the "Start GPS Grab" field (hold for approximately 3 seconds). Tapping on this line will record the start latitude and longitude, the EPE, elevation, and datum (make sure that all of these fields are grabbed). After the location is grabbed, you may need to click on another field to see the values. You may need to try the GPS grab more than once.
    b) *Type*: select "Frog" from the pulldown menu
    c) *Species*: select "BUMI" from the Lookup list
    d) *Sex*: select the sex of the toad from the pulldown menu*
    e) *Age*: select the appropriate age of the toad from the pulldown menu*
    f) *Photo*: take a photo of the animal
    g) *Air temp*: record the air temperature (C) at the time that the animal is detected
    h) *Water temp*: if the toad is in the stream, record the water temperature (C)
    i) Select the "End" button at the bottom of the screen
    j) Select the "Done" button at the bottom of the screen
    * these fields may require handling of the toad and should only be conducted if the observer has the proper permits

    If toads are amplexing or courting, surveyors must leave the vicinity immediately.

11. Continue walking the designated reach, recording all arroyo toads present. At the end of the stream reach, select the "<u>Water Quality</u>" subform by tapping on the page icons to the right. Select the "Add" button and enter the following water data field:

    a) *End water temp*: water temperature at end point (in C)
    b) Select the "End" button at the bottom of the screen

c) Select the “Done” button at the bottom of the screen

12. Repeat steps 6-11 for all “High” and “Good” stream reaches. After reaching the end of all “high quality” and “good quality” stream reaches, complete the remaining data fields in the survey and weather portions of the Palm Pilot form “Control Form”. The remaining fields include:

Survey
a) End time: time that the habitat suitability survey ended

Weather
a) End air temp: temperature at the completion of the habitat suitability survey
b) End wind: wind speed at the completion of the habitat suitability survey; based on Beauford wind scale

13. Complete the Control Form by selecting “End” at the bottom of the screen.