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Dear Ms. Smith and Dr. Preston,

This letter transmits the U.S. Geological Survey (USGS) Western Ecological Research Center's Arroyo toad (*Anaxyrus californicus*) Monitoring for San Diego County, California, 2022. This work was completed under agreement number 548642.

Please note that this information is preliminary or provisional and is subject to revision. It is being provided to meet the need for timely best science. The information has not received final approval by the USGS and is provided on the condition that neither the USGS nor the U.S. Government shall be held liable for any damages resulting from the unauthorized use of this draft data for interpretation or resource decision-making.

Please direct any questions to me at (619) 206-5686.

Sincerely,

Principal Investigator



**Arroyo toad (*Anaxyrus californicus*)
Monitoring for San Diego County,
California, 2022**



Arroyo toad (*Anaxyrus californicus*) Monitoring for San Diego County, California, 2022

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U.S. GEOLOGICAL SURVEY
WESTERN ECOLOGICAL RESEARCH CENTER

Draft Report
Prepared for:

**San Diego Monitoring and Management Program
and
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Cover photograph: Arroyo toad larva, photograph by: T. Matsuda

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EXECUTIVE SUMMARY

In 2020, the U.S. Geological Survey (USGS) implemented an annual long-term monitoring program for the federally endangered arroyo toad (*Anaxyrus californicus*) across preserved lands in San Diego County, California. Surveys were conducted in 250-meter (m) segments with data recorded every 125m. Each 125m site was designated as either core, rotating, or discovery. Core sites were permanent sites sampled annually. Up to 50 rotating sites were surveyed each year, with the exact number depending on available resources. Discovery sites were potentially “high-quality” locations sampled during high rainfall years to increase the likelihood that they were wetted. Surveys targeted arroyo toad egg strings and tadpoles, which are substantially more detectable than adults, and are an indication of annual breeding. In addition to recording the presence or absence of arroyo toads, we collected data on several covariates, including the presence of other aquatic species (non-native and native), plus landscape, vegetation, and water attributes. A three-state integrated habitat occupancy model was used to analyze data that includes the probability a site is wet (or suitable for breeding), and if wet, the probability of arroyo toad breeding. Habitat, water, and the presence of non-native species were used to determine predictors of occupancy. Collecting annual metrics, such as rainfall, surface water availability, area occupied, and wet area occupied, will allow us to track trends in arroyo toad populations in San Diego County over time.

In nearly all watersheds surveyed in 2022, we observed a continued decline in water availability compared to our 2021 surveys. Precipitation across the representative stations for San Diego County all recorded below normal rainfall in 2022, and only 36% of sites were wet during sampling. We estimated percent area occupied (PAO) to be 5.90% (95% Highest Density Interval = 3.00 – 10.8%) of the total available habitat in the monitoring area. We predicted 13.3% (5.64 – 27.1%) of wet sites were occupied, county-wide. The watershed with the greatest probability of occupancy was the Santa Margarita River. We also observed a significant decline in PAO and percent wet area occupied (PWAO) in the San Diego River in 2022. No other watersheds (San Dieguito, San Juan, San Luis Rey, Sweetwater, and Tijuana) had a significant positive or negative effect on occupancy probability. Sites within the San Juan watershed were completely dry for the second year in a row. Overall detection probability was lower than in previous years (0.37, 0.17 – 0.62), and cumulative detection probability after two surveys was 0.60 (0.31 – 0.86). Our conclusions regarding the effects of covariates were very limited, due to the lack of water and low observed occupancy. Below-average rainfall years often result in a lack of data for analysis and limit the conclusions that can be drawn because the presence of water is necessary for occupancy by arroyo toad tadpoles. The breeding season in 2022 occurred during a below-average rainfall year and followed a previous year of below-average rainfall with declining arroyo toad occupancy. Although fluctuations in annual rainfall and recruitment are natural, prolonged drought can lead to the deterioration of habitat and breeding conditions and impact arroyo toad populations.

INTRODUCTION

The U.S. Geological Survey (USGS) San Diego Field Station of the Western Ecological Research Center conducts long-term demographic research on federally listed species. Our research seeks to understand the life cycles and population trends of amphibian taxa in southern California. We study responses of these taxa to threats and stressors, such as drought, wildfire, non-native predators, and disturbance caused by human activities. Studying and understanding these dynamics provides land managers and regulators with information to make management decisions. The arroyo toad (*Anaxyrus californicus*) is one of the focal species in southern California and San Diego County.

The arroyo toad is a habitat specialist endemic to the coastal plains and mountains of central and southern California and northwestern Baja California (Jennings and Hayes 1994). It has a life span of seven to eight years (Fisher et al. 2018). The species primarily inhabits low gradient streams and rivers composed of sandy soils and sandy streamside terraces (Sweet 1992 and 1993, Barto 1999). Reproduction depends on the availability of shallow, still, or low-flow pools in which breeding, egg laying, and tadpole development occur over 65–85 days (Sweet 1992). These habitat requirements are largely determined by natural hydrological cycles and scouring flood events (USFWS 1999, Madden-Smith et al. 2003). The arroyo toad has been listed as endangered since 1994 due to extensive habitat loss, human modification of natural water flow regimes, and introduction of non-native predators (Jennings and Hayes 1994, USFWS 1994).

In 2020, USGS developed a county wide monitoring plan encompassing preserved lands within San Diego County to implement a long-term monitoring dataset similar to the USGS monitoring programs at Marine Corps Base Camp Pendleton (Camp Pendleton) in 2003 and at Naval Base Coronado Remote Training Site Warner Springs (NBC Warner Springs) in 2010 (Brehme et al. 2004, Clark et al. 2010). These plans are intended to provide information on status and trends, threats and stressors, and responses of arroyo toads to habitat and water management (Brehme et al. 2006, 2011, 2019).

The county-wide program focuses on habitat-based spatial occupancy and calculates the annual percent of area occupied. These metrics provide stable monitoring comparisons from year to year. The study design also allows for model-based inference to analyze which site covariate data (habitat variables, environmental variables, and presence of other species) influence probabilities of occupancy, detection, colonization, and extinction of arroyo toads across San Diego County, and identify trends over the long term. The monitoring program consists of core survey sites to be sampled annually for analysis, rotating sites to balance the spatial sampling of arroyo toad sites over time, and discovery sites in years of high rainfall, within subwatersheds that have no known occurrences but need to be further evaluated. The monitoring program was also created to be adaptive and accommodate possible expansion within San Diego, as well as beyond the county, and to use varying resource availability, while allowing our agency partners to participate and contribute comparable data.

Study Area

Our study area included conserved riparian areas along the streams of San Diego County within the San Diego Monitoring and Management Plan's (SDMMP) Management Strategic Plan Area (MSPA), Camp Pendleton, and NBC Warner Springs. San Diego County has a Mediterranean climate with relatively warm, dry summers and mild winters. The rainy season typically falls between October and April with most precipitation occurring between December and March (SDCWA 2021, Swain 2021). Annual rainfall in San Diego County can be highly variable among years largely due to the influence of the El Niño-Southern Oscillation (ENSO) cycle (Schonher and Nicholson 1989). This cycle is driven by warm ocean temperatures that create wetter than normal conditions (El Niño), while cool ocean temperatures create drier than normal conditions (La Niña).

METHODS

Sampling Frame

The sampling frame for the San Diego County arroyo toad monitoring program was narrowed down using the hierarchically nested USGS nationwide hydrologic unit code (HUC) system at the sub-watershed level (HUC 12, 12-digit subbasin code). Inclusion into the sampling frame was determined by the presence of arroyo toad or potential habitat in San Diego County. Coastal sub-watersheds dominated by urban development with no apparent arroyo toad habitat remaining and transmontane sub-watersheds draining into the desert or east of the Peninsular Ranges were excluded. The sampling frame (Figure 1) consists of sub-watersheds with historic presence of arroyo toad observations or habitat suitability, which was determined within the HUC, qualitative assessment of Treglia et al. 2018 models, and expert opinion from Chris Brown and Robert Fisher (USGS).

Stream segments were created from the California Department of Fish and Wildlife (2019) stream layer to generate 250-meter (m) stream segments for sampling San Diego County, consistent with the survey distance used in previous USGS arroyo toad monitoring projects (Brehme et al. 2006, Clark et al. 2010, Brown et al. 2020). These stream segments were further divided into consecutive, adjacent pairs of 125-m sites. Reversed Randomized Quadrant-Recursive Raster (RRQRR) was used for selection and order of stream survey sites (Theobald et al. 2007). Stream survey sites that fell within HUC12 units outside of the sample frame or were entirely within bodies of standing water were excluded from sampling, as were sites that were on private lands. Stream sites for inclusion were dependent on access to stream sites by land managers for conserved and military lands.

A total of 300 permanent initial core sites (sites with historic arroyo toad observations within 250 meters of the 250m segment) were surveyed annually to track status and trends. Initial core sites were selected based on RRQRR order, spatial balance, and validation of stream conditions. If a new occurrence of arroyo toad is documented in a location of interest (e.g., broader area of historic observations, but no recent occurrence), these sites may be added to the list of core sites

sampled yearly. To increase spatial coverage of sampling over time and better model habitat relationships, 50 new rotating sites (250m segments having no historic arroyo toad observations within 250 meters) would be selected from the RRQRR order each year. However, the number of rotating sites sampled per year would be based on funding and other constraints (e.g., logistical limitations, surface flow duration, and number of discovery sites also being sampled). Yearly selection of rotating sites would be assessed for survey practicality, safety, and access issues (i.e., presence of surface flow necessary for breeding, topographical barriers such as a waterfall or steepness, and other terrain issues, feasible access) and replaced with the next consecutive segment in the RRQRR order as necessary. Areas without arroyo toad historic records where further data was needed to assess possible occurrence (i.e., discovery sites) were (or will eventually be) surveyed during years of expected above-average rainfall to maximize the probability of detecting arroyo toads in these subwatersheds when conditions are optimal. For more use of resources, sites are selected annually based on the judgment of USGS species experts and review of satellite imagery, rather than the RRQRR ordered sampling. The opportunity to survey discovery sites during above-average rainfall years may be infrequent. It could be more effective to concentrate field efforts on surveying as many discovery sites as possible, as conditions are often unsuitable for discovery surveys in lower rainfall years. Prioritization over rotating sites in years with good rainfall may be required if there are limitations on funding and personnel.

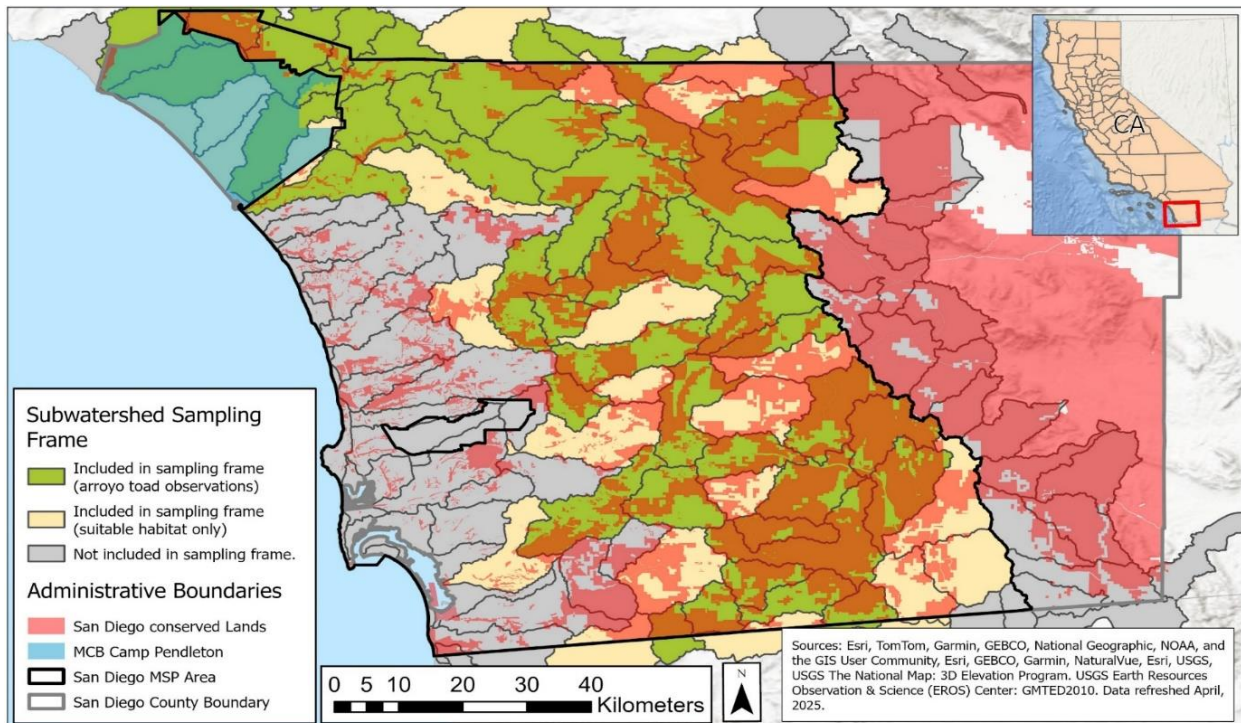


Figure 1. Arroyo Toad Monitoring Sampling Frame showing HUC12 unit status, conserved lands, MCB Camp Pendleton, and MSP Area boundary, San Diego County, California, USA.

Population Monitoring

This arroyo toad monitoring program approach tracks the presence of arroyo toad breeding populations by documenting the presence of eggs and tadpoles (e.g., Atkinson et al. 2003, Brehme et al. 2006, Clark et al. 2010). Egg strings and tadpoles are easily observable during the day, directly indicate the presence of reproductive adults, and are twice as likely to be detected as adults (Brehme et al. 2004). Surveying for egg strings and tadpoles requires both the presence of water and arroyo toad breeding activity. Therefore, dry sites are not surveyed for breeding and are considered unoccupied by egg strings and tadpoles.

Stream surveys

Occupancy surveys are conducted during the arroyo toad breeding season. Timing of surveys follows Holland et al. (2001) and Brehme et al. (2011), who document that breeding and tadpole development of arroyo toads in San Diego County typically occur between March and July, depending upon annual weather conditions. Breeding is expected to begin earlier in the year in ephemeral creeks and later at higher elevation sites and at perennial streams, when temperatures warm up and water flow subsides. During early spring, overnight low temperatures are monitored for suitable conditions for arroyo toad adult activity (>55°F, Sweet 1992). Spot checks are also conducted at representative sentinel survey sites throughout San Diego County to determine the suitability of water flow (shallow, slower-moving water within the channel) and to confirm general area site conditions, status of breeding activity, and prioritization of future site visits. Specific sites include Talega Creek (near confluence with Cristianitos Creek), lower Santa Margarita River (Camp Pendleton), San Luis Rey River (Wilderness Gardens Preserve and Puerta La Cruz), Santa Ysabel Creek (San Pasqual Valley), Temescal Creek, Sweetwater River (Green Valley), Cottonwood Creek (off Buckman Springs Rd.), and Potrero Creek (Barrett Junction). Sentinel sites were chosen based on varying hydrology (ephemeral/perennial), elevation (coastal, inland, foothills/mountains), and where consistent arroyo toad presence has been documented. Once the temperature and water conditions were suitable at sentinel sites, preferably with confirmation of arroyo toad breeding activity, all similar survey sites were visited to collect data if water was present. A second site survey was conducted approximately 3–6 weeks after the first survey, while conditions remained suitable.

Two field biologists trained in the identification of toad egg strings and arroyo toad tadpoles and the aquatic stream survey protocol (USGS 2006, Brehme et al. 2020) conducted each survey. For the initial detection of any arroyo toad age class, GPS coordinates and presence are recorded. For the first detection of arroyo toad tadpoles within a site, we characterized the pool containing them. We recorded location within the channel, water depth, water velocity, and vegetation types present. We used a conservative approach to identifying egg strings and recorded them only as toad (*Anaxyrus* sp.) because characteristics used for identification may not be clear under field conditions, particularly when egg strings have accumulated debris on the membrane. Additional arroyo toad tadpole observations are not individually recorded but are used to record arroyo toad larval abundance data. We record the following: 1) an estimated total count of tadpoles, 2)

percentage of 125-m site with tadpoles, 3) percentage of early-stage tadpoles, 4) percentage of mid-stage tadpoles, and 5) percentage of late-stage tadpoles (Turschak et al. 2009). We also record the first encounter of all other aquatic animal species and non-native aquatic plants observed. Finally, we recorded various landscape and water attributes at each site (Table 1; detailed field protocol in USGS 2006) and took photos at the start of each site, facing upstream and downstream to document site conditions.

Table 1. Covariates recorded at each survey site.

Water conditions	Vegetation	Other	Pool characterization	Landscape attributes
Water temperature	Percent cover of aquatic emergent	Presence of Nonnative animals and plants	Percent sand cover	Aquatic substrates (top 3)
Water depth	Proportion of channel vegetation	Index of arroyo toad larval abundance (counts, percent of reach with larvae present)	Proportion of pool vegetation	Channel width/bankful
Wetted channel width	Dominant riparian plants (top 3)	Percent of shallow water	Percent cover of aquatic submerged	Flood-prone width
Surface water velocity	Percent cover of aquatic submerged	Percent of medium water	Percent cover of aquatic emergent	Entrenchment ratio
Water chemistry (pH, conductivity)	Percent cover of aquatic floating	Percent of deep water	Percent cover of aquatic floating	Presence of channel braiding (>10m)
Wet length of survey	Percent overhead canopy	Watershed management area (as delineated by San Diego County)	Pool depth	Presence of disturbance
			Pool velocity	Riparian community type

Precipitation Data

Annual rainfall varies widely from the coast to the mountains in San Diego County. For each year of monitoring, we compared annual precipitation data from the National Oceanic and Atmospheric Administration (NOAA) to NOAA climate normals for weather stations representative of different regions of the monitoring area (NOAA NCEI 2024, Durre et al. 2013). Tracking this data will provide information on how rainfall for each year of monitoring compares to averages and the previous years of monitoring in the short term and could provide insight on how precipitation may be affecting arroyo toad occupancy in the long term.

Data Analyses

We analyzed arroyo toad presence from data collected during stream surveys using the software R (version 4.4) to calculate annual estimates of PAO, PWAO, as well as probabilities of detection (MacKenzie et al. 2002, 2003, 2018), and trends between years. Since the probability of detecting a species on any single survey is imperfect, site occupancy is often underestimated. Using this modelling approach, site occupancy is determined after correcting for a detection probability calculated from data obtained on multiple visits. Percent site occupancy is then used as a metric to monitor long-term population trends.

Based on the integrated habitat occupancy models used for Camp Pendleton arroyo toad monitoring (Bailey et al. 2014, MacKenzie et al. 2018), we estimate arroyo toad occupancy relative to site covariates using a single-season, zero-inflated occupancy model that estimates the probability a site is occupied, while modeling excess zeros. We estimate the probability that a site was wet, and the probability that arroyo toads occupied a site conditional on wet conditions, accounting for imperfect detection. This allowed us to incorporate the random effects of sampling block and watershed management area (adapted from San Diego County 2020), to account for patterns in the probability that a site is wet or occupied associated with the hierarchical structure of stream sites. We fit models using JAGS from R with the package *jagsUI* (Kellner 2015). All models were run for a total of 40,000 iterations, with a burn-in of 5000 iterations, and a thinning rate of two. We assess model fit and convergence via visual inspection of chains, summary of Gelman-Rubin statistics (Rhat), and within-sample posterior predictive p-value using Freeman-Tukey residuals.

The modelling setup to analyze occupancy and effects of covariates was also based on the approach used for the Camp Pendleton arroyo toad monitoring program (Brehme et al. 2006). Covariates used in this monitoring program are examined for multivariate patterns and correlations, reducing the number of possible covariates to those most likely to directly affect arroyo toad occupancy or detectability. We are implementing model selection via stochastic search variable selection (see Hooten and Hobbs 2015 for an overview). Here, priors for individual coefficients were defined via a joint prior distribution, or “spike-slab prior,” for each beta coefficient. This prior specification allows the prior to differ between iterations where the covariate is predicted to be included (slab portion) or excluded (spike) based on the estimated inclusion probability. We first ran a full model, including 17 site-level covariates, and reduced this selection to include only those covariates with inclusion probabilities >0.5 . Upon running the reduced model, we determined the most parsimonious model as the combination of latent inclusion that is most frequently observed across posterior samples.

In addition to the model selection described above, we ran a separate model to investigate the effects of the three individual species groups (*Lithobates catesbeianus* [bullfrog], *Procambarus clarkii* [red swamp crayfish], and predatory fish) that comprised our non-native species index (NNI). In this model, we included the same model structure described above, but ran a single model with the presence of the three species groups as covariates.

RESULTS

Population Monitoring

Stream surveys

Our county-wide presence surveys for arroyo toad tadpoles were conducted between mid-April and the beginning of August 2022 at 375 sites. One hundred thirty-six had surface water present during the first site visit. Arroyo toad breeding was documented at 12 sites (Figure 2).

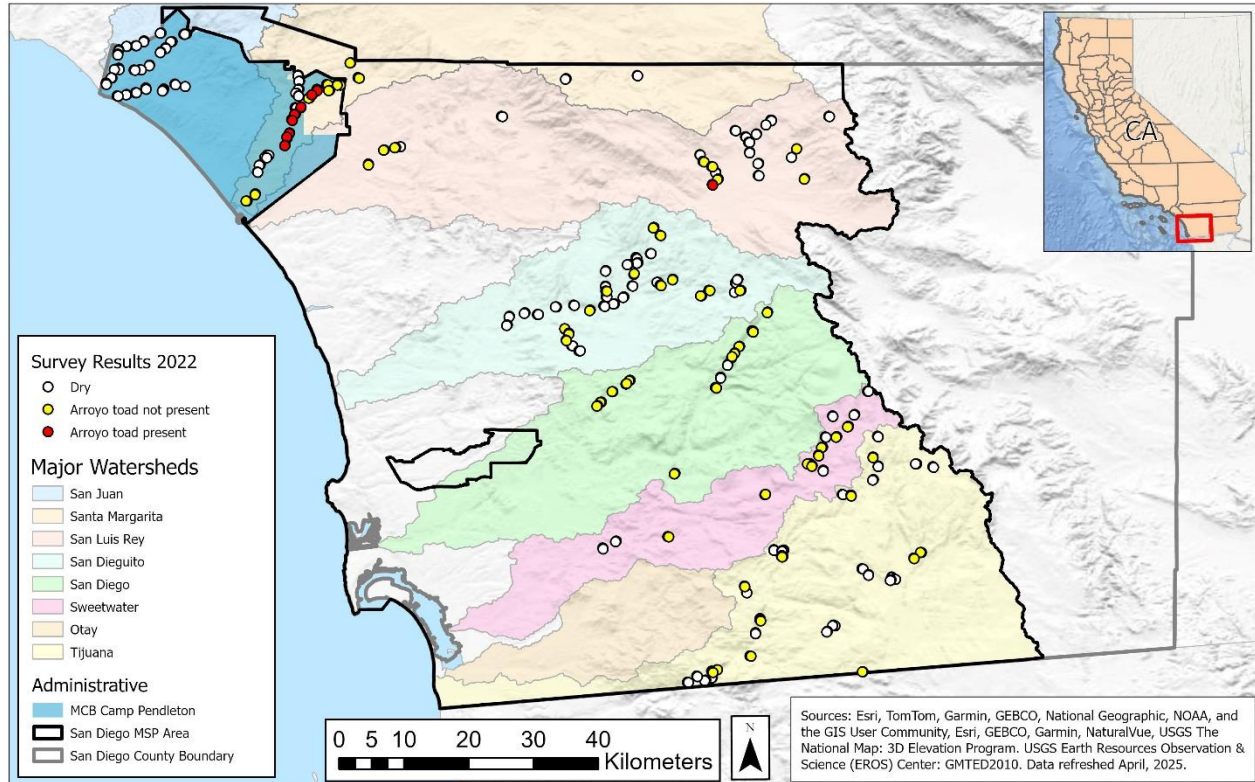


Figure 2. Results of arroyo toad surveys (presence/absence), San Diego County, USA, 2022.

Precipitation data

Precipitation in 2022 was below climate normals (NOAA NCEI 2024, Figure 3).

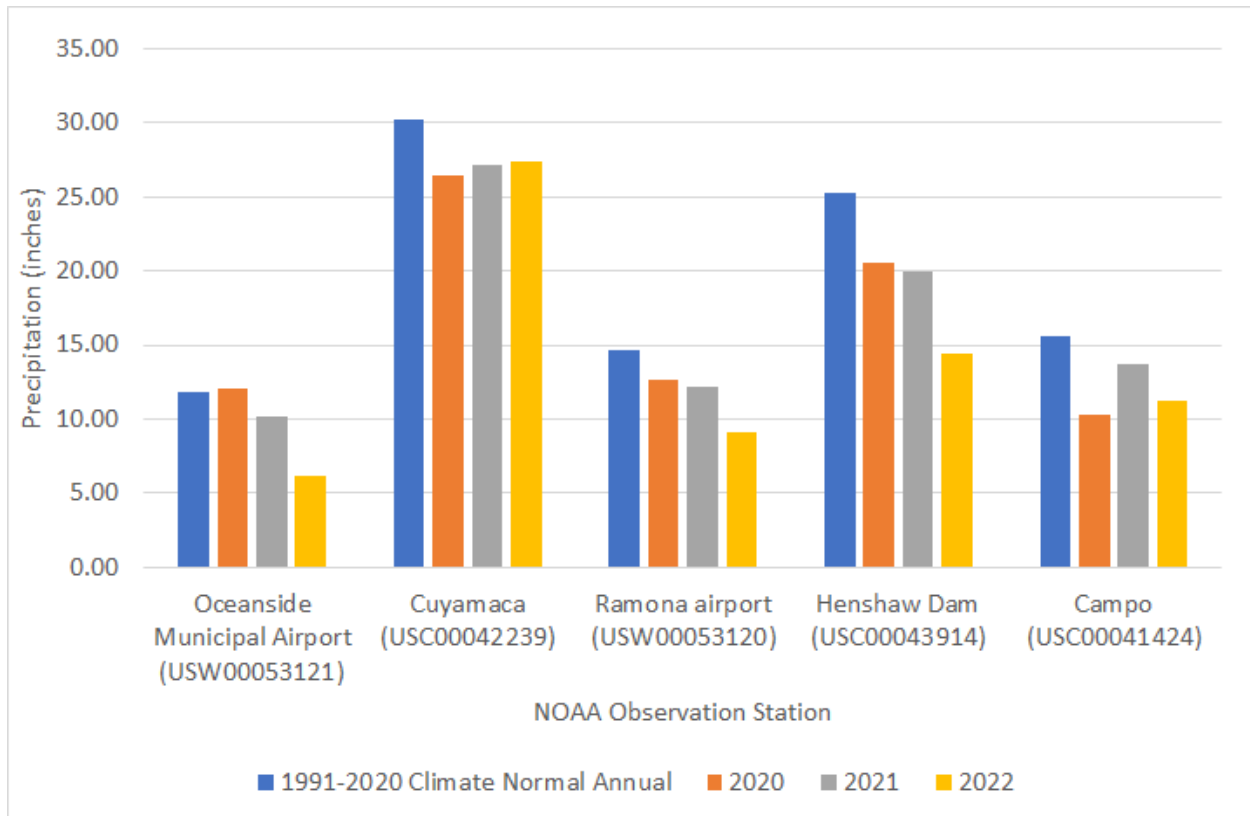


Figure 3. Total annual precipitation at select NOAA observation stations located in San Diego County from 2020–2022 in comparison to the climate normal annual average from 1991 to 2000 (blue bar).

Data Analysis

Occupancy

In 2022, 36% of sites were wet during sampling. We estimated PAO to be 5.90% (95% Highest Density Interval = 3.00 – 10.8%) of the total available habitat in the monitoring area (Figure 4). We predicted PWAO to be 13.3% (5.64 – 27.1%) county-wide (Figure 4).

The watershed with the greatest probability of occupancy was the Santa Margarita River. We estimated that the odds of a site being occupied increased 141x (3.82 – 12,333x) if the site was within the Santa Margarita River, compared to the overall average. The predicted PAO within the Santa Margarita River was 0.44 (0.26 – 0.93) (Table 2). We also observed a significant decline in PAO and PWAO in the San Diego River in 2022 (Figure 5), with PAO declining to 0.01 (0 – 0.07) and PWAO declining to 0.02 (0 – 0.09). No other watersheds had a significant positive or negative effect on occupancy probability.

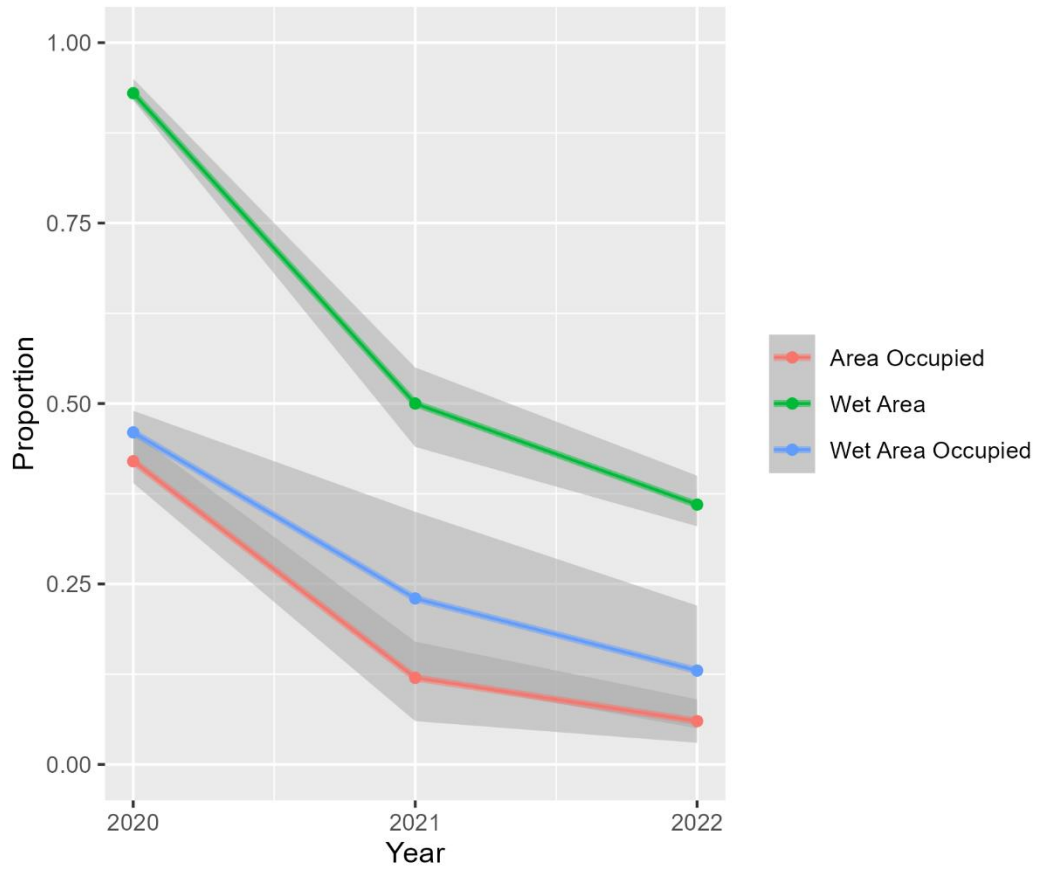


Figure 4. Trends in the area of surface water, proportion area occupied (PAO), and wet area occupied (PWAO) within permanent monitoring plots. Points indicate the mean, and intervals correspond to the 90% highest density intervals.

Table 2. Estimates for wet area and arroyo toad occupancy in 2022 within permanent sites, grouped by watershed management area.

		2022		
Among Watershed Management Areas				
	Measure	Mean	95%-LCI	95%-UCI
	% Area Wet	0.36		
	% Area Occupied	0.06	0.03	0.11
	% Wet Area Occupied	0.13	0.06	0.27
Among Watershed Management Areas				
San Diego	% Area Wet	0.80		
San Diego	% Area Occupied	0.01	0.00	0.05
San Diego	% Wet Area Occupied	0.01	0.00	0.06
San Dieguito	% Area Wet	0.32		
San Dieguito	% Area Occupied	0.01	0.00	0.05
San Dieguito	% Wet Area Occupied	0.03	0.00	0.15
San Juan	% Area Wet	0.00		
San Juan	% Area Occupied	0.09	0.00	0.60
San Juan	% Wet Area Occupied	0.00	0.00	0.00
San Luis Rey	% Area Wet	0.37		
San Luis Rey	% Area Occupied	0.07	0.00	0.30
San Luis Rey	% Wet Area Occupied	0.19	0.00	0.82
Santa Margarita	% Area Wet	0.59		
Santa Margarita	% Area Occupied	0.42	0.02	0.93
Santa Margarita	% Wet Area Occupied	0.72	0.03	1.58
Sweetwater	% Area Wet	0.44		
Sweetwater	% Area Occupied	0.02	0.00	0.07
Sweetwater	% Wet Area Occupied	0.03	0.00	0.17
Tijuana	% Area Wet	0.28		
Tijuana	% Area Occupied	0.01	0.00	0.04
Tijuana	% Wet Area Occupied	0.03	0.00	0.16

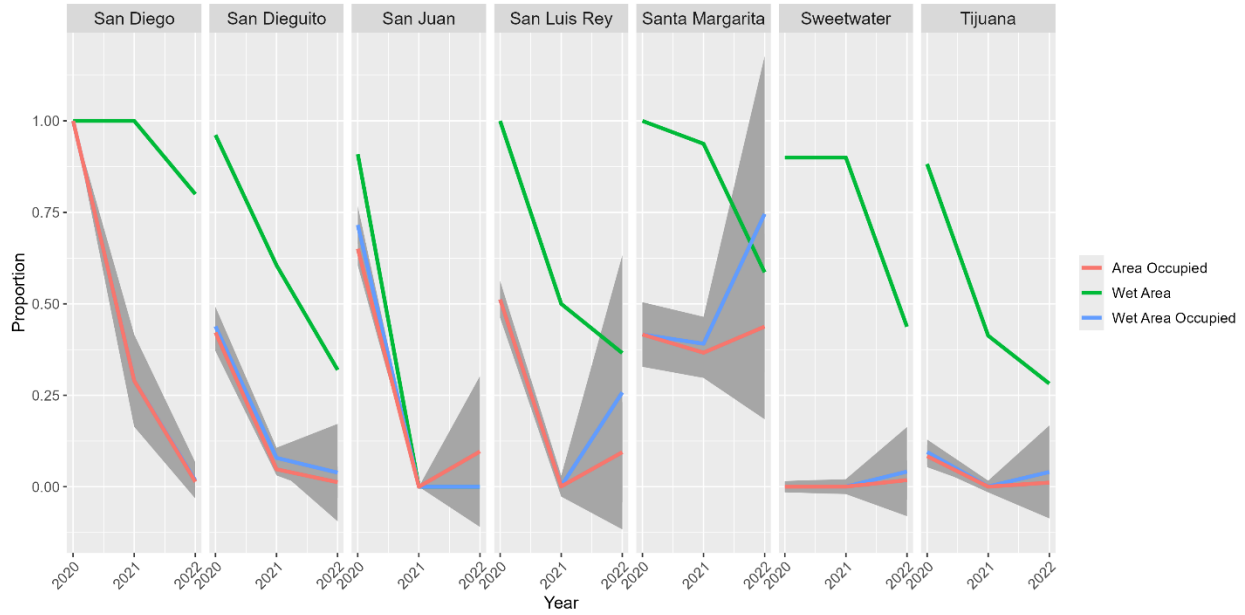


Figure 5. Trends in the area of surface water, proportion area occupied (PAO), and wet area occupied (PWAO) across all watershed management areas and within watershed management areas. Lines represent the mean trend across three years. Shaded regions represent ± 1 SD of the mean.

2022 – Model with covariates

To evaluate the effects of site covariates on arroyo toad occupancy, we used data collected from core and rotating sites in 2022 ($n = 375$). Upon running the full model with variable selection implemented, we identified one covariate (water velocity) with inclusion probabilities >0.5 . After running the reduced model with these covariates, model selection results indicated that the best-fitting model included water velocity, as opposed to the null model. The final model was deemed to have achieved sufficient convergence, and the derived p-value indicated sufficient posterior-predictive strength ($p = 0.43$). Overall detection probability was lower than in previous years (0.37, 0.17 – 0.62), and the cumulative detection probability after two surveys was 0.60 (0.31 – 0.86).

Conditional occupancy probability was positively associated with water velocity (Figure 6). Arroyo toad occupancy increased with water velocity (Odds Ratio [OR]: 81.45, 2.03 – 5166.8), corresponding to a 1.36x (1.05 – 1.81x) increase in occupancy probability with each 5% increase in water velocity.

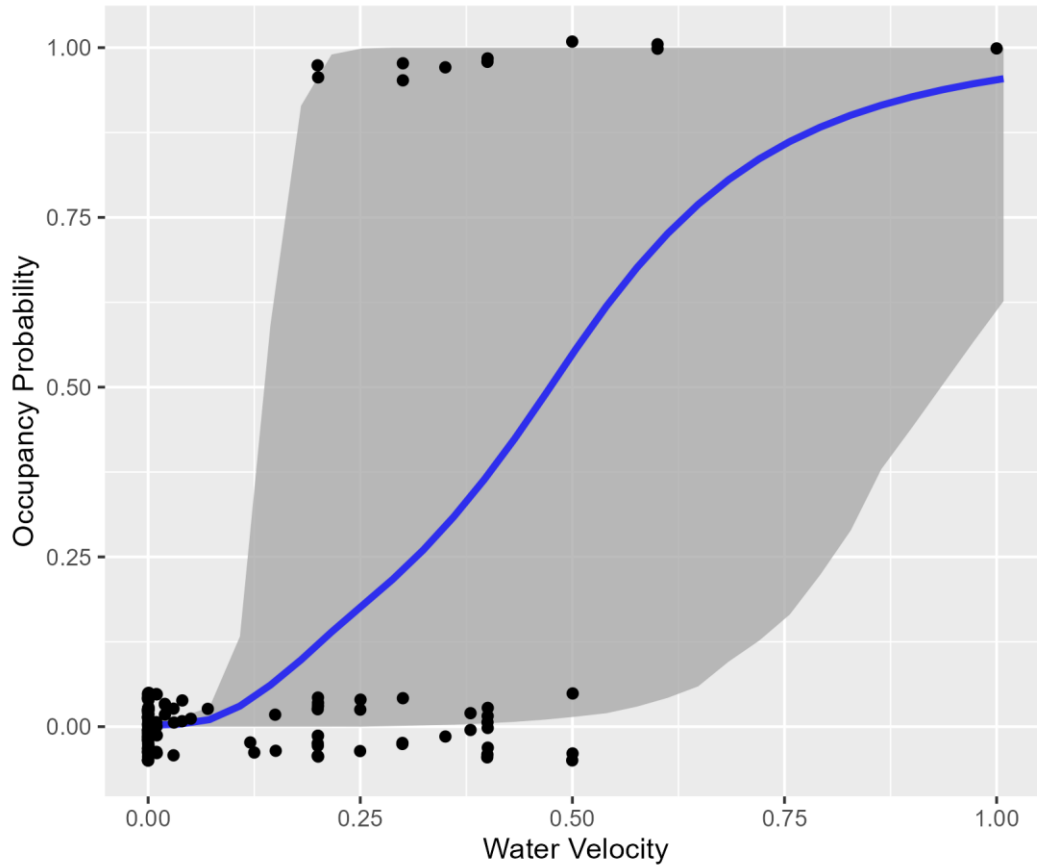


Figure 6. Marginal effect of water velocity on arroyo toad occupancy probability, conditional on wet conditions in 2022. Shaded regions represent the 90% highest density interval. Points correspond to observed occupancy state.

2022 - Non-native species index model

Although NNI was not in the final model, we further investigated the effects of all individual non-native species group presence. There was evidence that the presence of mosquito fish positively affected arroyo toad occupancy probability. We found that arroyo toad occupancy probability was 15.3x (1.06 – 40.7x) higher when mosquito fish were present, compared to sites without mosquito fish (Figure 7). We documented mosquito fish at 40 / 373, or 11% of sites. Arroyo toad occupancy was not significantly associated with the presence of bullfrogs, red swamp crayfish, or predatory fish species that make up the NNI.

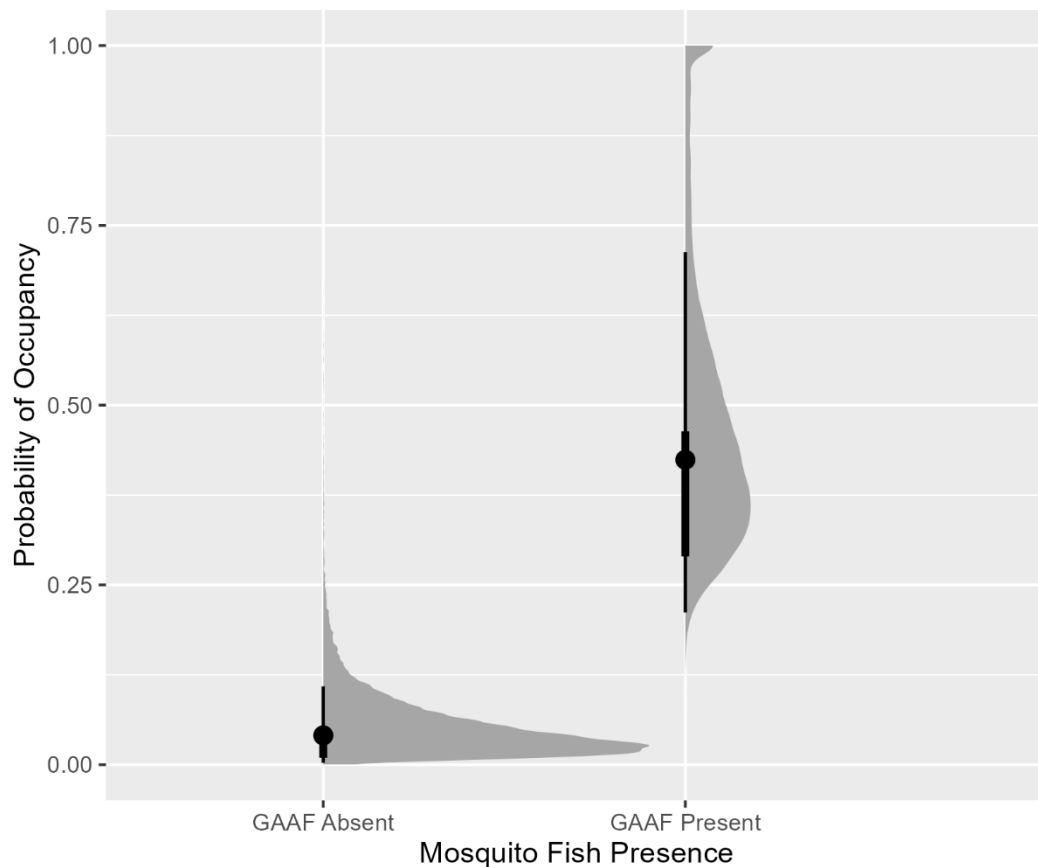


Figure 7. Marginal effect of mosquito fish presence on arroyo toad occupancy probability, conditional on wet conditions in 2022. The grey shaded region represents the posterior distribution of occupancy probability estimates. Points represent median posterior estimates, black bold lines correspond to 50% credible intervals, and thin lines correspond to 90% credible intervals.

DISCUSSION

Population Monitoring

Stream surveys

As we continue to conduct surveys to compile longer-term data sets through this monitoring plan, we are also reviewing historical arroyo toad observations to assess current occupancy status at these locations. In some cases, arroyo toads have not been documented at these locations for more than a decade. A few of the historical locations that are currently part of core monitoring sites remain of concern as there have been no recent arroyo toad observations in these locations since annual monitoring began in 2020. These included the following: Boden Canyon since 2003, upper Sweetwater River since 2009, lower San Luis Rey River since 2011, and middle Sweetwater River (below Loveland Reservoir) and lower Cottonwood Creek (near the border with Mexico) since 2016 (based on USFWS and USGS arroyo toad data; USFWS 2015, Preston et al. 2022). Some of the previous surveys were conducted in below-average rainfall years (2012,

2015, 2016), as was the case in 2020–2022. In certain places, land managers may want to conduct night surveys for adults after multiple low rainfall years to confirm that the arroyo toads are still present. Collecting data in high rainfall years may be the best opportunity to determine the status of arroyo toads at these sites.

Precipitation

Because precipitation was below climate normals for 2022, this could have affected the detectability of toads. Figures 2 show several sites that were dry. Arroyo toads are a drought-adapted species, so it is possible they could have survived this dry timeframe and were simply undetectable but still present at these sites. Repeated surveys at these locations during years that sustain surface water could help confirm presence/absence.

Data Analysis

Occupancy

We observed a continued decline in water availability in 2022 in nearly all watersheds. Precipitation across the representative stations for San Diego County was below normal rainfall in 2022. The decline in water availability was associated with continued low overall occupancy and low PWAO county-wide. This year is the third year of below-average rainfall for most of these stations, so it is not unexpected that overall surface water, total area occupied, and wet area occupied have overall trended downward since 2020, with consecutive dry years. The only sites that did not conform to these general trends were sites within the Santa Margarita watershed, which continue to support levels of occupancy significantly higher than the county-wide average. Streamflow is more reliable due to the guaranteed discharge of water from the Rancho California Water District into the Santa Margarita River basin even in drought years (CWRMA 2002). In addition to steadier streamflow, channel morphology in the lower Santa Margarita River and De Luz Creek appears to be relatively stable, retaining suitable habitat conditions for breeding from year to year. We also observed the strongest decline in occupancy in the San Diego watershed, despite the San Diego watershed supporting the largest proportion of wet sites in 2022. Although sites in the San Diego watershed had water present, other factors contribute to whether conditions are suitable for breeding for arroyo toads. Further investigation of these patterns may inform thresholds in covariates that can lead to declines in associated occupancy trend-metrics.

Predictors of Occupancy- Water Variables

In 2022, our conclusions about the effects of covariates were very limited due to the lack of water and low observed occupancy. We observed that occupancy was positively associated with water velocity, which may have captured a general trend in water availability and habitat complexity, rather than water velocity *per se*. Water velocity is a single measurement point at the start of a 250m survey site, so it does not represent water velocity conditions of the entire site. Variability in water velocity within the channel may result in sections suitable for arroyo toad breeding that would not be reflected in the single measurement point at which velocity was recorded. Our previous analysis indicated that during years with more water availability,

breeding was more prevalent in sites with higher temperatures, lower conductivity, and more shallow water micro-habitats. Although we failed to observe strong relationships with these variables in 2022, our results indicate that water velocity, perhaps as a correlate for total water volume or water permanence, was important during a year with low surface water availability.

Predictors of Occupancy- Non-native aquatic species

The non-native species index was not a strong negative driver of arroyo toad occupancy in 2022, despite being documented previously. A strong negative relationship has been documented from 20 years of monitoring at Camp Pendleton (Brehme et al. 2006, Brehme et al. 2010, Brehme et al. 2014, Brehme et al. 2019). The absence of a negative effect on arroyo toads in 2022 from the non-native species index, or the species that make up the index, is likely due to the lack of available data on both arroyo toad occupancy and non-native species presence. It is expected that below-average rainfall would result in less streamflow, leading to dry sites or insufficient water for arroyo toad breeding and persistence of non-native species. When we ran the sub-model that included individual non-native species group presence, rather than NNI, we found only the presence of mosquito fish had a strong positive impact on occupancy, likely associated with limited aquatic habitat availability, rather than a positive ecological relationship. Unlike the non-native species that make up the index, mosquitofish can remain in shallow water and are often observed in similar conditions where arroyo toad tadpoles are found.

Despite the absence of observable effects of NNI in 2022, the threat from direct (competition and predation) and indirect (differences in habitat requirements) effects on arroyo toads is worth discussing, as they are present in many of the watersheds. Predatory fish species (e.g., catfish, bass, green sunfish) are all known to prey upon amphibian eggs, larvae, or adults (Sweet and Sullivan 2005). Most predatory fish species require perennial or near-permanent water for survival (Gasith and Reth 1999, Adams 2000) and are usually an indicator of the presence of deep water which is unsuitable for arroyo toad breeding. In addition to predatory fish communities, invasive American bullfrogs (*Lithobates catesbeianus*) successfully compete with and predate on arroyo toads, across both larval and adult life stages (Brehme et al. 2010). In localized monitoring programs at Camp Pendleton and NBC Warner Springs, bullfrogs are a threat to the arroyo toad populations in perennial sites (Matsuda et al. 2018, Clark et al. 2021). Our results shed some light on the complex dynamics between water permanency, invasive species presence, and observable effects of invasive species on arroyo toad populations. This result provides further support that future models may benefit from the consideration of species interactions and non-native species dynamics to fully understand how water availability affects arroyo toad occupancy.

Summary

Between 2020 and 2022, we observed a continued decline since 2021 in surface water availability, which corresponded with continued low levels of county-wide occupancy and wet-area occupancy rates. These patterns were less prevalent in sites within the Santa Margarita River watershed, which continued to support the highest level of occupancy in the county.

Furthermore, we estimated the near-complete absence of breeding in the San Diego River watershed, despite sites having surface water at higher rates than all other watersheds in 2022. Notably, the San Juan watershed was the only watershed in which all surveyed sites were dry in 2022, which is the second consecutive year this has occurred. Below-average years in rainfall often result in a lack of data for analysis and limit the conclusions that can be drawn because the presence of water is necessary for occupancy by arroyo toad tadpoles. Although fluctuations in yearly rainfall and recruitment are natural, each additional year of below-average rainfall can lead to the deterioration of habitat conditions and breeding conditions and impact arroyo toad populations. With additional years of monitoring, this program will provide useful information on occupancy trends and patterns related to climate, hydrology, habitat, and non-native aquatic species. The results can inform land managers and allow SDMMMP, USFWS, and other agencies to conduct coordinated management planning across the County and focus efforts on specific areas.

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Appendix 1. Site name, site type, location, and date surveyed in 2022 organized by watershed from north to south and by stream order within watershed from upper to lower.

Watershed	Stream	Reach	Site Type	Start Latitude	Start Longitude	First Survey	Last Survey	Survey Result
San Juan	Cristianitos Creek	Reach 51A-A	Core	33.42019	-117.57030	12-Apr-2022	12-Apr-2022	Dry
	Cristianitos Creek	Reach 51A-B	Core	33.42137	-117.56983	12-Apr-2022	12-Apr-2022	Dry
	Cristianitos Creek	Reach 52E-A	Core	33.43988	-117.57118	12-Apr-2022	12-Apr-2022	Dry
	Cristianitos Creek	Reach 52E-B	Core	33.44097	-117.57102	12-Apr-2022	12-Apr-2022	Dry
	Cristianitos Creek	Reach 53B-A	Core	33.44558	-117.57011	12-Apr-2022	12-Apr-2022	Dry
	Cristianitos Creek	Reach 53B-B	Core	33.44671	-117.56975	12-Apr-2022	12-Apr-2022	Dry
	San Mateo Creek	Reach 39F-A	Core	33.39917	-117.58680	12-Apr-2022	12-Apr-2022	Dry
	San Mateo Creek	Reach 39F-B	Core	33.40074	-117.58737	12-Apr-2022	12-Apr-2022	Dry
	San Mateo Creek	Reach 40E-A	Core	33.40797	-117.58022	12-Apr-2022	12-Apr-2022	Dry
	San Mateo Creek	Reach 40E-B	Core	33.40825	-117.57903	12-Apr-2022	12-Apr-2022	Dry
	San Mateo Creek	Reach 41E-A	Core	33.41956	-117.57589	12-Apr-2022	12-Apr-2022	Dry
	San Mateo Creek	Reach 41E-B	Core	33.41987	-117.57456	12-Apr-2022	12-Apr-2022	Dry
	San Mateo Creek	Reach 42A-A	Core	33.42005	-117.57071	12-Apr-2022	12-Apr-2022	Dry
	San Mateo Creek	Reach 42A-B	Core	33.41971	-117.56938	12-Apr-2022	12-Apr-2022	Dry
	San Mateo Creek	Reach 43D-A	Core	33.41913	-117.54844	12-Apr-2022	12-Apr-2022	Dry
	San Mateo Creek	Reach 43D-B	Core	33.41852	-117.54729	12-Apr-2022	12-Apr-2022	Dry
	San Mateo Creek	Reach 44A-A	Core	33.41948	-117.54049	12-Apr-2022	12-Apr-2022	Dry
	San Mateo Creek	Reach 44A-B	Core	33.41914	-117.53852	12-Apr-2022	12-Apr-2022	Dry
	San Mateo Creek	Reach 45A-A	Core	33.42488	-117.52748	12-Apr-2022	12-Apr-2022	Dry
	San Mateo Creek	Reach 45A-B	Core	33.42592	-117.52699	12-Apr-2022	12-Apr-2022	Dry
	San Mateo Creek	Reach 46F-A	Core	33.44312	-117.51217	12-Apr-2022	12-Apr-2022	Dry
	San Mateo Creek	Reach 46F-B	Core	33.44417	-117.51161	12-Apr-2022	12-Apr-2022	Dry
	San Mateo Creek	Reach 47D-A	Core	33.44869	-117.50459	12-Apr-2022	12-Apr-2022	Dry
	San Mateo Creek	Reach 47D-B	Core	33.44955	-117.50478	12-Apr-2022	12-Apr-2022	Dry
	San Mateo Creek	Reach 48C-A	Core	33.45765	-117.49781	12-Apr-2022	12-Apr-2022	Dry
	San Mateo Creek	Reach 48C-B	Core	33.45818	-117.49583	12-Apr-2022	12-Apr-2022	Dry
	San Mateo Creek	Reach 49F-A	Core	33.46846	-117.47964	12-Apr-2022	12-Apr-2022	Dry
	San Mateo Creek	Reach 49F-B	Core	33.46834	-117.47813	12-Apr-2022	12-Apr-2022	Dry
	San Mateo Creek	Reach 50A-A	Core	33.46936	-117.47755	12-Apr-2022	12-Apr-2022	Dry
	San Mateo Creek	Reach 50A-B	Core	33.46927	-117.47577	12-Apr-2022	12-Apr-2022	Dry
	San Onofre Creek	Reach 27B-A	Core	33.38315	-117.57207	12-Apr-2022	12-Apr-2022	Dry
	San Onofre Creek	Reach 27B-B	Core	33.38281	-117.57083	12-Apr-2022	12-Apr-2022	Dry
	San Onofre Creek	Reach 28A-A	Core	33.38456	-117.55955	12-Apr-2022	12-Apr-2022	Dry
	San Onofre Creek	Reach 28A-B	Core	33.38485	-117.55852	12-Apr-2022	12-Apr-2022	Dry
	San Onofre Creek	Reach 29D-A	Core	33.38760	-117.54652	12-Apr-2022	12-Apr-2022	Dry
	San Onofre Creek	Reach 29D-B	Core	33.38745	-117.54534	12-Apr-2022	12-Apr-2022	Dry
	San Onofre Creek	Reach 30B-A	Core	33.39406	-117.53240	12-Apr-2022	12-Apr-2022	Dry
	San Onofre Creek	Reach 30B-B	Core	33.39228	-117.53170	12-Apr-2022	12-Apr-2022	Dry
	San Onofre Creek	Reach 31F-A	Core	33.39005	-117.50945	12-Apr-2022	12-Apr-2022	Dry
	San Onofre Creek	Reach 31F-B	Core	33.39094	-117.50862	12-Apr-2022	12-Apr-2022	Dry
	San Onofre Creek	Reach 32A-A	Core	33.39139	-117.50766	12-Apr-2022	12-Apr-2022	Dry
	San Onofre Creek	Reach 32A-B	Core	33.39248	-117.50731	12-Apr-2022	12-Apr-2022	Dry
	San Onofre Creek	Reach 33C-A	Core	33.39932	-117.49191	12-Apr-2022	12-Apr-2022	Dry
	San Onofre Creek	Reach 33C-B	Core	33.39824	-117.49129	12-Apr-2022	12-Apr-2022	Dry
	San Onofre Creek	Reach 34C-A	Core	33.39583	-117.47778	12-Apr-2022	12-Apr-2022	Dry
	Talega Canyon	Reach 54C-A	Core	33.45163	-117.55909	12-Apr-2022	12-Apr-2022	Dry
	Talega Canyon	Reach 54C-B	Core	33.45177	-117.55798	12-Apr-2022	12-Apr-2022	Dry
	Talega Canyon	Reach 55B-A	Core	33.45254	-117.54607	12-Apr-2022	12-Apr-2022	Dry
	Talega Canyon	Reach 55B-B	Core	33.45240	-117.54547	12-Apr-2022	12-Apr-2022	Dry
	Talega Canyon	Reach 56A-A	Core	33.45794	-117.53495	12-Apr-2022	12-Apr-2022	Dry
Talega Canyon	Reach 56A-B	Core	33.45915	-117.53480	12-Apr-2022	12-Apr-2022	Dry	
Talega Canyon	Reach 57F-A	Core	33.46979	-117.51195	12-Apr-2022	12-Apr-2022	Dry	
Talega Canyon	Reach 57F-B	Core	33.47041	-117.51102	12-Apr-2022	12-Apr-2022	Dry	
Santa Margarita	De Luz Creek	Reach 21B-A	Core	33.36622	-117.32354	12-Apr-2022	12-Apr-2022	Dry
	De Luz Creek	Reach 21B-B	Core	33.36702	-117.32514	12-Apr-2022	12-Apr-2022	Dry
	De Luz Creek	Reach 22E-A	Core	33.38275	-117.32059	12-Apr-2022	12-Apr-2022	Dry
	De Luz Creek	Reach 22E-B	Core	33.38363	-117.32038	12-Apr-2022	12-Apr-2022	Dry
	De Luz Creek	Reach 23D-A	Core	33.39191	-117.32080	12-Apr-2022	12-Apr-2022	Dry

Appendix 1. (continued).

Watershed	Stream	Reach	Site Type	Start Latitude	Start Longitude	First Survey	Last Survey	Survey Result
Santa Margarita	De Luz Creek	Reach 23D-B	Core	33.39288	-117.32014	12-Apr-2022	12-Apr-2022	Dry
	De Luz Creek	Reach 24D-A	Core	33.40320	-117.32003	12-Apr-2022	12-Apr-2022	Dry
	De Luz Creek	Reach 24D-B	Core	33.40395	-117.31907	12-Apr-2022	12-Apr-2022	Dry
	De Luz Creek	Reach 25B-A	Core	33.41091	-117.32150	12-Apr-2022	12-Apr-2022	Dry
	De Luz Creek	Reach 25B-B	Core	33.41199	-117.32103	12-Apr-2022	12-Apr-2022	Dry
	Roblar Creek	Reach 26B-A	Core	33.38717	-117.32336	12-Apr-2022	12-Apr-2022	Dry
	Roblar Creek	Reach 26B-B	Core	33.38703	-117.32433	12-Apr-2022	12-Apr-2022	Dry
	Sandia Canyon	Reach 008-A	Rotating	33.42843	-117.24898	15-Jul-2022	1-Aug-2022	AT not present
	Sandia Canyon	Reach 008-B	Rotating	33.42912	-117.24792	15-Jul-2022	1-Aug-2022	AT not present
	Temecula Creek Trib (Block 0642)	Reach 011-A	Rotating	33.41158	-116.85095	19-Apr-2022	19-Apr-2022	Dry
	Temecula Creek Trib (Block 0642)	Reach 011-B	Rotating	33.41072	-116.85026	19-Apr-2022	19-Apr-2022	Dry
	Arroyo Seco Creek (Block 0987)	Reach 061-A	Rotating	33.40696	-116.94956	19-Apr-2022	19-Apr-2022	Dry
	Arroyo Seco Creek (Block 0987)	Reach 061-B	Rotating	33.40626	-116.95049	19-Apr-2022	19-Apr-2022	Dry
	Santa Margarita River	Reach 01B-A	Core	33.23762	-117.39344	15-Apr-2022	15-Apr-2022	AT not present
	Santa Margarita River	Reach 01B-B	Core	33.23768	-117.39211	15-Apr-2022	15-Apr-2022	AT not present
	Santa Margarita River	Reach 02C-A	Core	33.24630	-117.38089	23-May-2022	23-May-2022	AT not present
	Santa Margarita River	Reach 02C-B	Core	33.24748	-117.38058	23-May-2022	23-May-2022	AT not present
	Santa Margarita River	Reach 04F-A	Core	33.27704	-117.37723	12-Apr-2022	12-Apr-2022	Dry
	Santa Margarita River	Reach 04F-B	Core	33.27783	-117.37774	12-Apr-2022	12-Apr-2022	Dry
	Santa Margarita River	Reach 05E-A	Core	33.28674	-117.37513	12-Apr-2022	12-Apr-2022	Dry
	Santa Margarita River	Reach 05E-B	Core	33.28789	-117.37349	12-Apr-2022	12-Apr-2022	Dry
	Santa Margarita River	Reach 06E-A	Core	33.29782	-117.36747	12-Apr-2022	12-Apr-2022	Dry
	Santa Margarita River	Reach 06E-B	Core	33.29756	-117.36480	12-Apr-2022	12-Apr-2022	Dry
	Santa Margarita River	Reach 07A-A	Core	33.30133	-117.36408	12-Apr-2022	12-Apr-2022	Dry
	Santa Margarita River	Reach 07A-B	Core	33.30083	-117.36162	12-Apr-2022	12-Apr-2022	Dry
	Santa Margarita River	Reach 08F-A	Core	33.31392	-117.33984	14-Apr-2022	23-May-2022	AT present
	Santa Margarita River	Reach 08F-B	Core	33.31484	-117.33916	14-Apr-2022	23-May-2022	AT present
	Santa Margarita River	Reach 09E-A	Core	33.32478	-117.33656	14-Apr-2022	9-May-2022	AT not present
	Santa Margarita River	Reach 09E-B	Core	33.32610	-117.33695	14-Apr-2022	9-May-2022	AT present
	Santa Margarita River	Reach 10B-A	Core	33.33067	-117.33330	14-Apr-2022	9-May-2022	AT present
	Santa Margarita River	Reach 10B-B	Core	33.33177	-117.33276	14-Apr-2022	9-May-2022	AT not present
	Santa Margarita River	Reach 11E-A	Core	33.34915	-117.32931	25-Apr-2022	23-May-2022	AT present
	Santa Margarita River	Reach 11E-B	Core	33.35059	-117.32988	25-Apr-2022	23-May-2022	AT not present
	Santa Margarita River	Reach 12C-A	Core	33.35726	-117.32646	25-Apr-2022	23-May-2022	AT present
	Santa Margarita River	Reach 12C-B	Core	33.35818	-117.32502	25-Apr-2022	23-May-2022	AT not present
	Santa Margarita River	Reach 139-A	Core	33.40864	-117.23813	15-Jul-2022	1-Aug-2022	AT not present
	Santa Margarita River	Reach 139-B	Core	33.40769	-117.23686	15-Jul-2022	1-Aug-2022	AT not present
	Santa Margarita River	Reach 13D-A	Core	33.36684	-117.31730	19-May-2022	17-Jun-2022	AT not present
	Santa Margarita River	Reach 13D-B	Core	33.36766	-117.31710	19-May-2022	17-Jun-2022	AT present
	Santa Margarita River	Reach 14F-A	Core	33.37962	-117.30648	19-May-2022	17-Jun-2022	AT not present
	Santa Margarita River	Reach 14F-B	Core	33.38024	-117.30527	19-May-2022	17-Jun-2022	AT not present
	Santa Margarita River	Reach 15C-A	Core	33.38440	-117.30247	19-May-2022	17-Jun-2022	AT present
	Santa Margarita River	Reach 15C-B	Core	33.38524	-117.30158	19-May-2022	17-Jun-2022	AT not present
	Santa Margarita River	Reach 16C-A	Core	33.39048	-117.29485	19-May-2022	17-Jun-2022	AT present
	Santa Margarita River	Reach 16C-B	Core	33.39207	-117.29493	19-May-2022	17-Jun-2022	AT present
	Santa Margarita River	Reach 17D-A	Core	33.39877	-117.28185	19-May-2022	17-Jun-2022	AT not present
	Santa Margarita River	Reach 17D-B	Core	33.39840	-117.27954	19-May-2022	17-Jun-2022	AT not present
	Santa Margarita River	Reach 18C-A	Core	33.39023	-117.27863	19-May-2022	17-Jun-2022	AT not present
	Santa Margarita River	Reach 18C-B	Core	33.39083	-117.27719	19-May-2022	17-Jun-2022	AT not present
	Santa Margarita River	Reach 19D-A	Core	33.39884	-117.26754	21-Jun-2022	29-Jul-2022	AT not present
	Santa Margarita River	Reach 19D-B	Core	33.39800	-117.26668	21-Jun-2022	29-Jul-2022	AT not present
	Santa Margarita River	Reach 20B-A	Core	33.39808	-117.26261	21-Jun-2022	29-Jul-2022	AT not present
	Santa Margarita River	Reach 20B-B	Core	33.39891	-117.26340	21-Jun-2022	29-Jul-2022	AT not present
	San Luis Rey	Agua Caliente Creek Trib (Block 3213)	Reach 002-A	Rotating	33.35443	-116.58431	24-Jun-2022	24-Jun-2022
Agua Caliente Creek Trib (Block 3213)		Reach 002-B	Rotating	33.35494	-116.58537	24-Jun-2022	24-Jun-2022	Dry
Canada Verde (Block 3234)		Reach 001-A	Rotating	33.26770	-116.61946	16-May-2022	1-Jul-2022	AT not present
Canada Verde (Block 3234)		Reach 001-B	Rotating	33.26877	-116.61920	16-May-2022	1-Jul-2022	AT not present
Agua Caliente Creek Trib (Block 3767)		Reach 005-A	Rotating	33.27282	-116.68344	16-May-2022	16-May-2022	Dry

Appendix 1. (continued)

Watershed	Stream	Reach	Site Type	Start Latitude	Start Longitude	First Survey	Last Survey	Survey Result
San Luis Rey	Agua Caliente Creek Trib (Block 3767)	Reach 005-B	Rotating	33.27232	-116.68224	16-May-2022	16-May-2022	Dry
	Ward Canyon (Block 3764)	Reach 014-A	Rotating	33.28903	-116.68348	16-May-2022	16-May-2022	Dry
	Ward Canyon (Block 3764)	Reach 014-B	Rotating	33.28968	-116.68251	16-May-2022	16-May-2022	Dry
	Agua Caliente Creek (Block3747)	Reach 038-A	Core	33.29687	-116.63828	1-Jun-2022	1-Jun-2022	Dry
	Agua Caliente Creek (Block3747)	Reach 038-B	Core	33.29771	-116.63740	1-Jun-2022	1-Jun-2022	Dry
	Agua Caliente Creek (Block3747)	Reach 046-A	Core	33.30879	-116.63141	1-Jun-2022	1-Jun-2022	AT not present
	Agua Caliente Creek (Block3747)	Reach 046-B	Core	33.30987	-116.63026	1-Jun-2022	1-Jun-2022	AT not present
	Agua Caliente Creek (Block3747)	Reach 078-A	Rotating	33.34569	-116.58570	24-Jun-2022	24-Jun-2022	Dry
	Agua Caliente Creek (Block3747)	Reach 078-B	Rotating	33.34681	-116.58567	24-Jun-2022	24-Jun-2022	Dry
	Cañada Aguanga	Reach 06-A	Core	33.31852	-116.69535	2-Jun-2022	2-Jun-2022	Dry
	Cañada Aguanga	Reach 06-B	Core	33.31890	-116.69659	2-Jun-2022	2-Jun-2022	Dry
	Cañada Aguanga	Reach 10-A	Core	33.32574	-116.70012	2-Jun-2022	2-Jun-2022	Dry
	Cañada Aguanga	Reach 10-B	Core	33.32669	-116.70089	2-Jun-2022	2-Jun-2022	Dry
	Cañada Aguanga	Reach 17-A	Core	33.33463	-116.71419	2-Jun-2022	2-Jun-2022	Dry
	Cañada Aguanga	Reach 17-B	Core	33.33521	-116.71536	2-Jun-2022	2-Jun-2022	Dry
	WF San Luis Rey River	Reach 06-A	Core	33.27621	-116.74223	16-May-2022	1-Jul-2022	Dry
	WF San Luis Rey River	Reach 06-B	Core	33.27705	-116.74214	16-May-2022	1-Jul-2022	Dry
	WF San Luis Rey River	Reach 11-A	Core	33.28487	-116.74670	16-May-2022	1-Jul-2022	AT not present
	WF San Luis Rey River	Reach 11-B	Core	33.28515	-116.74798	16-May-2022	1-Jul-2022	AT not present
	WF San Luis Rey River	Reach 17-A	Core	33.29163	-116.75867	16-May-2022	16-May-2022	AT not present
	WF San Luis Rey River	Reach 17-B	Core	33.29240	-116.75981	16-May-2022	16-May-2022	AT not present
	WF San Luis Rey River	Reach 22-A	Core	33.30102	-116.76349	16-May-2022	1-Jul-2022	Dry
	WF San Luis Rey River	Reach 22-B	Core	33.30185	-116.76418	16-May-2022	1-Jul-2022	Dry
	San Luis Rey Tributary (Block3707)	Reach 001-A	Core	33.34960	-116.66518	13-May-2022	13-May-2022	Dry
	San Luis Rey Tributary (Block3707)	Reach 001-B	Core	33.34861	-116.66493	13-May-2022	13-May-2022	Dry
	San Luis Rey River Trib (Block 3749)	Reach 001-A	Rotating	33.26703	-116.73955	16-May-2022	1-Jul-2022	AT not present
	San Luis Rey River Trib (Block 3749)	Reach 001-B	Rotating	33.26803	-116.73895	16-May-2022	1-Jul-2022	AT not present
	Upper San Luis Rey River	Reach 13-A	Core	33.25934	-116.74666	16-May-2022	1-Jul-2022	AT present
	Upper San Luis Rey River	Reach 13-B	Core	33.26043	-116.74695	16-May-2022	1-Jul-2022	AT present
	Upper San Luis Rey River	Reach 44-A	Core	33.30422	-116.69517	27-May-2022	10-Jun-2022	Dry
	Upper San Luis Rey River	Reach 44-B	Core	33.30530	-116.69511	27-May-2022	10-Jun-2022	Dry
	Upper San Luis Rey River	Reach 60-A	Core	33.32972	-116.68603	13-May-2022	13-May-2022	Dry
	Upper San Luis Rey River	Reach 60-B	Core	33.33060	-116.68567	13-May-2022	13-May-2022	Dry
	Upper San Luis Rey River	Reach 68-A	Core	33.34268	-116.67283	13-May-2022	13-May-2022	Dry
	Upper San Luis Rey River	Reach 68-B	Core	33.34268	-116.67283	13-May-2022	13-May-2022	Dry
	Upper San Luis Rey River	Reach 73-A	Core	33.34960	-116.66576	13-May-2022	13-May-2022	Dry
	Upper San Luis Rey River	Reach 73-B	Core	33.34960	-116.66576	13-May-2022	13-May-2022	Dry
	Lower San Luis Rey River	Reach 091-A	Core	33.28730	-117.22394	31-May-2022	21-Jun-2022	AT not present
	Lower San Luis Rey River	Reach 091-B	Core	33.28882	-117.22385	31-May-2022	21-Jun-2022	AT not present
	Lower San Luis Rey River	Reach 104-A	Core	33.30801	-117.20277	31-May-2022	21-Jun-2022	AT not present
	Lower San Luis Rey River	Reach 104-B	Core	33.30849	-117.20145	31-May-2022	21-Jun-2022	AT not present
	Lower San Luis Rey River	Reach 110-A	Core	33.31138	-117.18719	31-May-2022	21-Jun-2022	AT not present
Lower San Luis Rey River	Reach 110-B	Core	33.31163	-117.18597	31-May-2022	21-Jun-2022	AT not present	
Lower San Luis Rey River	Reach 113-A	Core	33.31284	-117.17933	31-May-2022	31-May-2022	Dry	
Lower San Luis Rey River	Reach 113-B	Core	33.31319	-117.17810	31-May-2022	31-May-2022	AT not present	
San Dieguito	Upper Santa Ysabel Creek Trib11A	Reach 04-A	Core	33.12441	-116.71493	17-May-2022	17-May-2022	Dry
	Upper Santa Ysabel Creek Trib11A	Reach 04-B	Core	33.12400	-116.71375	17-May-2022	17-May-2022	Dry
	Upper Santa Ysabel Creek Trib11A1	Reach 1-A	Rotating	33.12844	-116.71223	17-May-2022	17-May-2022	Dry
	Upper Santa Ysabel Creek Trib11A1	Reach 1-B	Rotating	33.12933	-116.71137	17-May-2022	17-May-2022	Dry
	Upper Santa Ysabel Creek	Reach 016-A	Core	33.10619	-116.76324	28-Apr-2022	21-Jun-2022	AT not present
	Upper Santa Ysabel Creek	Reach 016-B	Core	33.10636	-116.76191	28-Apr-2022	21-Jun-2022	AT not present
	Upper Santa Ysabel Creek	Reach 022-A	Core	33.11407	-116.75174	28-Apr-2022	21-Jun-2022	AT not present
	Upper Santa Ysabel Creek	Reach 022-B	Core	33.11334	-116.75051	28-Apr-2022	21-Jun-2022	AT not present
	Upper Santa Ysabel Creek	Reach 037-A	Core	33.11098	-116.71638	17-May-2022	23-Jun-2022	Dry
	Upper Santa Ysabel Creek	Reach 037-B	Core	33.11334	-116.75051	17-May-2022	23-Jun-2022	AT not present
	Upper Santa Ysabel Creek	Reach 041-A	Core	33.11352	-116.70858	17-May-2022	23-Jun-2022	AT not present
Upper Santa Ysabel Creek	Reach 041-B	Core	33.11397	-116.70728	17-May-2022	23-Jun-2022	AT not present	

Appendix 1. (continued)

Watershed	Stream	Reach	Site Type	Start Latitude	Start Longitude	First Survey	Last Survey	Survey Result
San Dieguito	Black Canyon	Reach 03-A	Rotating	33.12823	-116.80225	14-Jun-2022	14-Jun-2022	AT not present
	Black Canyon	Reach 03-B	Rotating	33.12897	-116.80144	14-Jun-2022	14-Jun-2022	Dry
	Carney Canyon Trib (Block 2217)	Reach 003-A	Rotating	33.19006	-116.81931	14-Apr-2022	14-Apr-2022	AT not present
	Carney Canyon Trib (Block 2217)	Reach 003-B	Rotating	33.18961	-116.81812	14-Apr-2022	14-Apr-2022	AT not present
	Carney Canyon Trib (Block 2234)	Reach 005-A	Rotating	33.16472	-116.83290	14-Apr-2022	14-Apr-2022	Dry
	Carney Canyon Trib (Block 2234)	Reach 005-B	Rotating	33.16467	-116.83157	14-Apr-2022	14-Apr-2022	Dry
	Carney Canyon	Reach 27-A	Rotating	33.20010	-116.82889	14-Apr-2022	14-Apr-2022	AT not present
	Carney Canyon	Reach 27-B	Rotating	33.20088	-116.82807	14-Apr-2022	14-Apr-2022	Dry
	Temescal Creek Trib (SY; Block 2243)	Reach 001-A	Rotating	33.14995	-116.86361	12-May-2022	12-May-2022	Dry
	Temescal Creek Trib (SY; Block 2243)	Reach 001-B	Rotating	33.14943	-116.86478	12-May-2022	12-May-2022	Dry
	Temescal Creek (Santa Ysabel)	Reach 09-A	Core	33.13585	-116.85576	12-May-2022	12-May-2022	Dry
	Temescal Creek (Santa Ysabel)	Reach 09-B	Core	33.13679	-116.85506	12-May-2022	12-May-2022	AT not present
	Temescal Creek (Santa Ysabel)	Reach 17-A	Core	33.15134	-116.85118	12-May-2022	12-May-2022	Dry
	Temescal Creek (Santa Ysabel)	Reach 17-B	Core	33.15230	-116.84982	12-May-2022	12-May-2022	Dry
	Temescal Creek (Santa Ysabel)	Reach 20-A	Core	33.15739	-116.85135	12-May-2022	12-May-2022	Dry
	Temescal Creek (Santa Ysabel)	Reach 20-B	Core	33.15918	-116.85308	12-May-2022	12-May-2022	Dry
	Santa Ysabel Creek Trib (Block 2506)	Reach 002-A	Rotating	33.11951	-116.85695	12-May-2022	12-May-2022	Dry
	Santa Ysabel Creek Trib (Block 2506)	Reach 002-B	Rotating	33.11999	-116.85816	12-May-2022	12-May-2022	Dry
	Boden Canyon	Reach 08-A	Core	33.10490	-116.89297	24-May-2022	24-May-2022	Dry
	Boden Canyon	Reach 08-B	Core	33.10519	-116.89423	24-May-2022	24-May-2022	Dry
	Boden Canyon	Reach 12-A	Core	33.11223	-116.89299	24-May-2022	24-May-2022	AT not present
	Boden Canyon	Reach 12-B	Core	33.11291	-116.89445	24-May-2022	24-May-2022	AT not present
	Boden Canyon	Reach 15-A	Core	33.11854	-116.89494	24-May-2022	24-May-2022	Dry
	Boden Canyon	Reach 15-B	Core	33.11978	-116.89497	24-May-2022	24-May-2022	Dry
	Boden Canyon	Reach 25-A	Rotating	33.14032	-116.89494	24-May-2022	24-May-2022	Dry
	Boden Canyon	Reach 25-B	Rotating	33.14130	-116.89433	24-May-2022	24-May-2022	Dry
	Santa Maria Creek	Reach 006-A	Core	33.08048	-116.98943	2-May-2022	2-May-2022	Dry
	Santa Maria Creek	Reach 006-B	Core	33.08024	-116.98810	2-May-2022	2-May-2022	Dry
	Santa Maria Creek	Reach 025-A	Core	33.06072	-116.95152	19-May-2022	19-May-2022	AT not present
	Santa Maria Creek	Reach 025-B	Core	33.05988	-116.95086	19-May-2022	19-May-2022	Dry
	Santa Maria Creek	Reach 029-A	Core	33.05444	-116.94578	19-May-2022	19-May-2022	AT not present
	Santa Maria Creek	Reach 029-B	Core	33.05313	-116.94597	19-May-2022	19-May-2022	AT not present
	Santa Maria Creek	Reach 034-A	Core	33.04498	-116.94966	19-May-2022	19-May-2022	AT not present
	Santa Maria Creek	Reach 034-B	Core	33.04365	-116.94919	19-May-2022	19-May-2022	AT not present
	Santa Maria Creek	Reach 039-A	Core	33.03703	-116.94184	19-May-2022	19-May-2022	Dry
	Santa Maria Creek	Reach 039-B	Core	33.03668	-116.94030	19-May-2022	19-May-2022	Dry
	Santa Maria Creek	Reach 044-A	Core	33.02999	-116.93184	19-May-2022	19-May-2022	Dry
	Santa Maria Creek	Reach 044-B	Core	33.02992	-116.93021	19-May-2022	19-May-2022	Dry
	Lower Santa Ysabel Creek	Reach 008-A	Core	33.08185	-117.00777	2-May-2022	2-May-2022	Dry
	Lower Santa Ysabel Creek	Reach 008-B	Core	33.08253	-117.00647	2-May-2022	2-May-2022	Dry
	Lower Santa Ysabel Creek	Reach 025-A	Core	33.09069	-116.96426	2-May-2022	2-May-2022	Dry
	Lower Santa Ysabel Creek	Reach 025-B	Core	33.09098	-116.96305	2-May-2022	2-May-2022	Dry
	Lower Santa Ysabel Creek	Reach 035-A	Core	33.09335	-116.93890	2-May-2022	2-May-2022	Dry
	Lower Santa Ysabel Creek	Reach 035-B	Core	33.09270	-116.93792	2-May-2022	2-May-2022	Dry
	Lower Santa Ysabel Creek	Reach 046-A	Core	33.08561	-116.91708	2-May-2022	6-Jun-2022	AT not present
	Lower Santa Ysabel Creek	Reach 046-B	Core	33.08652	-116.91628	2-May-2022	6-Jun-2022	AT not present
	Lower Santa Ysabel Creek	Reach 057-A	Core	33.09220	-116.89717	6-Jun-2022	6-Jun-2022	Dry
	Lower Santa Ysabel Creek	Reach 057-B	Core	33.09149	-116.89618	6-Jun-2022	6-Jun-2022	Dry
	Lower Santa Ysabel Creek	Reach 064-A	Core	33.09471	-116.88378	6-Jun-2022	6-Jun-2022	Dry
	Lower Santa Ysabel Creek	Reach 064-B	Core	33.09513	-116.88254	6-Jun-2022	6-Jun-2022	Dry
Lower Santa Ysabel Creek	Reach 071-A	Core	33.10381	-116.87040	6-Jun-2022	6-Jun-2022	Dry	
Lower Santa Ysabel Creek	Reach 071-B	Core	33.10474	-116.86944	6-Jun-2022	6-Jun-2022	Dry	
Lower Santa Ysabel Creek	Reach 096-A	Rotating	33.12504	-116.82363	14-Jun-2022	14-Jun-2022	Dry	
Lower Santa Ysabel Creek	Reach 096-B	Rotating	33.12505	-116.82221	14-Jun-2022	14-Jun-2022	Dry	

Appendix 1. (continued)

Watershed	Stream	Reach	Site Type	Start Latitude	Start Longitude	First Survey	Last Survey	Survey Result	
San Dieguito	Lower Santa Ysabel Creek	Reach 099-A	Rotating	33.12096	-116.81918	14-Jun-2022	14-Jun-2022	AT not present	
	Lower Santa Ysabel Creek	Reach 099-B	Rotating	33.12003	-116.81796	14-Jun-2022	14-Jun-2022	AT not present	
	Upper San Dieguito River B	Reach 03-A	Core	33.06478	-117.03226	2-May-2022	2-May-2022	Dry	
	Upper San Dieguito River B	Reach 03-B	Core	33.06609	-117.03099	2-May-2022	2-May-2022	Dry	
	Upper San Dieguito River B	Reach 09-A	Core	33.07702	-117.02876	2-May-2022	2-May-2022	Dry	
	Upper San Dieguito River B	Reach 09-B	Core	33.07790	-117.02833	2-May-2022	2-May-2022	Dry	
San Diego	Temescal Creek	Reach 01-A	Core	33.05613	-116.69135	24-May-2022	24-May-2022	AT not present	
	Temescal Creek	Reach 01-B	Core	33.05599	-116.69024	24-May-2022	24-May-2022	AT not present	
	Chocolate Canyon (Block 1408)	Reach 005-A	Rotating	32.86054	-116.79892	13-May-2022	15-Jun-2022	AT not present	
	Chocolate Canyon (Block 1408)	Reach 005-B	Rotating	32.85958	-116.79961	13-May-2022	15-Jun-2022	AT not present	
	Upper San Diego River	Reach 061-A	Core	32.97844	-116.74135	18-May-2022	18-May-2022	AT not present	
	Upper San Diego River	Reach 061-B	Core	32.97916	-116.74248	18-May-2022	18-May-2022	AT not present	
	Upper San Diego River	Reach 069-A	Core	32.99233	-116.73565	18-May-2022	18-May-2022	Dry	
	Upper San Diego River	Reach 069-B	Core	32.99340	-116.73547	18-May-2022	18-May-2022	Dry	
	Upper San Diego River	Reach 078-A	Core	33.00969	-116.72597	24-May-2022	24-May-2022	Dry	
	Upper San Diego River	Reach 078-B	Core	33.01112	-116.72559	24-May-2022	24-May-2022	Dry	
	Upper San Diego River	Reach 085-A	Core	33.02063	-116.71989	24-May-2022	24-May-2022	Dry	
	Upper San Diego River	Reach 085-B	Core	33.02164	-116.71966	24-May-2022	24-May-2022	AT not present	
	Upper San Diego River	Reach 088-A	Core	33.02622	-116.71613	24-May-2022	24-May-2022	AT not present	
	Upper San Diego River	Reach 088-B	Core	33.02720	-116.71587	24-May-2022	24-May-2022	AT not present	
	Upper San Diego River	Reach 093-A	Core	33.03578	-116.71026	24-May-2022	24-May-2022	AT not present	
	Upper San Diego River	Reach 093-B	Core	33.03644	-116.70926	24-May-2022	24-May-2022	AT not present	
	Upper San Diego River	Reach 106-A	Core	33.05731	-116.69056	24-May-2022	24-May-2022	AT not present	
	Upper San Diego River	Reach 106-B	Core	33.05788	-116.69177	24-May-2022	24-May-2022	AT not present	
	Upper San Diego River	Reach 121-A	Rotating	33.08252	-116.67065	22-Jun-2022	21-Jul-2022	AT not present	
	Upper San Diego River	Reach 121-B	Rotating	33.08358	-116.67045	22-Jun-2022	21-Jul-2022	AT not present	
	San Vicente Creek	Reach 045-A	Core	32.95341	-116.90686	17-May-2022	22-Jun-2022	AT not present	
	San Vicente Creek	Reach 045-B	Core	32.95437	-116.90602	17-May-2022	22-Jun-2022	AT not present	
	San Vicente Creek	Reach 048-A	Core	32.95851	-116.90206	17-May-2022	22-Jun-2022	AT not present	
	San Vicente Creek	Reach 048-B	Core	32.95924	-116.90099	17-May-2022	22-Jun-2022	AT not present	
	San Vicente Creek	Reach 058-A	Core	32.97365	-116.88614	17-May-2022	22-Jun-2022	AT not present	
	San Vicente Creek	Reach 058-B	Core	32.97368	-116.88490	17-May-2022	22-Jun-2022	AT not present	
	San Vicente Creek	Reach 068-A	Core	32.98392	-116.86679	17-May-2022	17-May-2022	Dry	
	San Vicente Creek	Reach 068-B	Core	32.98454	-116.86578	17-May-2022	17-May-2022	AT not present	
	San Vicente Creek	Reach 071-A	Core	32.98849	-116.86222	17-May-2022	17-May-2022	AT not present	
	San Vicente Creek	Reach 071-B	Core	32.98915	-116.86122	17-May-2022	17-May-2022	AT not present	
	Sweetwater	Upper Sweetwater River (Block 1425)	Reach 003-A	Rotating	32.97392	-116.53180	2-May-2022	2-May-2022	Dry
		Upper Sweetwater River (Block 1425)	Reach 003-B	Rotating	32.97372	-116.53054	2-May-2022	2-May-2022	Dry
		Japacha Creek Trib (Block 1460)	Reach 009-A	Rotating	32.93913	-116.57979	2-May-2022	2-May-2022	Dry
Japacha Creek Trib (Block 1460)		Reach 009-B	Rotating	32.94010	-116.58042	2-May-2022	2-May-2022	Dry	
Arroyo Seco (SW; Block 1475)		Reach 004-A	Rotating	32.91003	-116.58935	2-May-2022	2-May-2022	Dry	
Arroyo Seco (SW; Block 1475)		Reach 004-B	Rotating	32.91083	-116.59025	2-May-2022	2-May-2022	Dry	
Descanso Creek (Block 1597)		Reach 010-A	Rotating	32.86345	-116.59300	2-May-2022	2-May-2022	Dry	
Descanso Creek (Block 1597)		Reach 010-B	Rotating	32.86445	-116.59316	2-May-2022	2-May-2022	Dry	
Upper Sweetwater River		Reach 13-A	Core	32.88436	-116.59941	13-Jun-2022	30-Jun-2022	AT not present	
Upper Sweetwater River		Reach 13-B	Core	32.88556	-116.59985	13-Jun-2022	30-Jun-2022	AT not present	
Upper Sweetwater River		Reach 19-A	Core	32.89592	-116.59546	22-Jun-2022	30-Jun-2022	AT not present	
Upper Sweetwater River		Reach 19-B	Core	32.89693	-116.59391	22-Jun-2022	30-Jun-2022	AT not present	
Upper Sweetwater River		Reach 2-A	Core	32.87343	-116.61515	13-Jun-2022	30-Jun-2022	AT not present	
Upper Sweetwater River		Reach 2-B	Core	32.87372	-116.61197	13-Jun-2022	30-Jun-2022	AT not present	
Upper Sweetwater River		Reach 32-A	Core	32.91018	-116.57540	14-Jun-2022	30-Jun-2022	AT not present	
Upper Sweetwater River		Reach 32-B	Core	32.91108	-116.57450	14-Jun-2022	30-Jun-2022	AT not present	
Upper Sweetwater River		Reach 42-A	Core	32.92439	-116.55936	14-Jun-2022	30-Jun-2022	AT not present	
Upper Sweetwater River		Reach 42-B	Core	32.92538	-116.55881	14-Jun-2022	30-Jun-2022	Dry	

Appendix 1. (continued)

Watershed	Stream	Reach	Site Type	Start Latitude	Start Longitude	First Survey	Last Survey	Survey Result
Sweetwater	Upper Sweetwater River	Reach 48-A	Core	32.93473		2-May-2022	2-May-2022	Dry
	Upper Sweetwater River	Reach 48-B	Core	32.93577	32.93577	2-May-2022	2-May-2022	Dry
	Upper Sweetwater River	Reach 52-A	Core	32.94089	-116.55037	2-May-2022	2-May-2022	Dry
	Upper Sweetwater River	Reach 52-B	Core	32.94189	-116.54974	2-May-2022	2-May-2022	Dry
	Upper Sweetwater River	Reach 5-A	Core	32.86988	-116.60916	13-Jun-2022	30-Jun-2022	AT not present
	Upper Sweetwater River	Reach 5-B	Core	32.87085	-116.60831	13-Jun-2022	30-Jun-2022	AT not present
	Sweetwater River-Loveland	Reach 068-A	Rotating	32.83089	-116.67407	29-Jun-2022	29-Jun-2022	Dry
	Sweetwater River-Loveland	Reach 068-B	Rotating	32.83114	-116.67338	29-Jun-2022	29-Jun-2022	AT not present
	Middle San Luis Rey River	Reach 055-A	Core	33.35489	-117.03913	9-Feb-2022	9-Feb-2022	Dry
	Middle San Luis Rey River	Reach 055-B	Core	33.35439	-117.03774	9-Feb-2022	9-Feb-2022	Dry
	Middle Sweetwater River	Reach 058-A	Core	32.75544	-116.89814	15-Jun-2022	15-Jun-2022	Dry
	Middle Sweetwater River	Reach 058-B	Core	32.75681	-116.89885	15-Jun-2022	15-Jun-2022	Dry
	Middle Sweetwater River	Reach 066-A	Core	32.76537	-116.88099	15-Jun-2022	15-Jun-2022	Dry
	Middle Sweetwater River	Reach 066-B	Core	32.76647	-116.88016	15-Jun-2022	15-Jun-2022	Dry
	Middle Sweetwater River	Reach 116-A	Core	32.77252	-116.80873	15-Jun-2022	15-Jun-2022	Dry
Middle Sweetwater River	Reach 116-B	Core	32.77220	-116.80745	15-Jun-2022	15-Jun-2022	AT not present	
Tijuana	Pine Valley Creek Trib (Block 0165)	Reach 002-A	Rotating	32.91073	-116.51709	22-Jun-2022	22-Jun-2022	Dry
	Pine Valley Creek Trib (Block 0165)	Reach 002-B	Rotating	32.91152	-116.51798	22-Jun-2022	22-Jun-2022	Dry
	Pine Valley Creek Trib (Block 0229)	Reach 005-A	Rotating	32.83047	-116.56567	13-Jun-2022	13-Jun-2022	Dry
	Pine Valley Creek Trib (Block 0229)	Reach 005-B	Rotating	32.83100	-116.56675	13-Jun-2022	13-Jun-2022	Dry
	Agua Dulce Creek (Block 0385)	Reach 003-A	Rotating	32.86960	-116.44119	3-May-2022	3-May-2022	Dry
	Agua Dulce Creek (Block 0385)	Reach 003-B	Rotating	32.86870	-116.44039	3-May-2022	3-May-2022	Dry
	Los Rasalies Ravine (Block 0441)	Reach 002-A	Rotating	32.87322	-116.46499	3-May-2022	3-May-2022	Dry
	Los Rasalies Ravine (Block 0441)	Reach 002-B	Rotating	32.87338	-116.46382	3-May-2022	3-May-2022	Dry
	Espinosa Creek (Block0003)	Reach 001-A	Core	32.74430	-116.65040	13-Jun-2022	13-Jun-2022	Dry
	Espinosa Creek (Block0003)	Reach 001-B	Core	32.74487	-116.64930	13-Jun-2022	13-Jun-2022	Dry
	Horsethief Canyon (SD)	Reach 01-A	Core	32.75192	-116.65009	13-Jun-2022	13-Jun-2022	Dry
	Horsethief Canyon (SD)	Reach 01-B	Core	32.75298	-116.65061	13-Jun-2022	13-Jun-2022	Dry
	Horsethief Canyon (SD)	Reach 06-A	Core	32.75332	-116.66184	13-Jun-2022	13-Jun-2022	Dry
	Horsethief Canyon (SD)	Reach 06-B	Core	32.75467	-116.66177	13-Jun-2022	13-Jun-2022	Dry
	Pine Valley Creek	Reach 034-A	Core	32.74530	-116.65090	13-Jun-2022	28-Jun-2022	Dry
	Pine Valley Creek	Reach 034-B	Core	32.74641	-116.65050	13-Jun-2022	28-Jun-2022	AT not present
	Pine Valley Creek	Reach 038-A	Core	32.75317	-116.64851	13-Jun-2022	13-Jun-2022	Dry
	Pine Valley Creek	Reach 038-B	Core	32.75415	-116.64779	13-Jun-2022	13-Jun-2022	Dry
	Pine Valley Creek	Reach 105-A	Core	32.82895	-116.55428	13-Jun-2022	29-Jun-2022	AT not present
	Pine Valley Creek	Reach 105-B	Core	32.83003	-116.55462	13-Jun-2022	29-Jun-2022	AT not present
	Pine Valley Creek	Reach 124-A	Core	32.85061	-116.52446	13-Jun-2022	13-Jun-2022	Dry
	Pine Valley Creek	Reach 124-B	Core	32.85166	-116.52383	13-Jun-2022	13-Jun-2022	Dry
	Pine Valley Creek	Reach 134-A	Core	32.86934	-116.51686	13-Jun-2022	13-Jun-2022	Dry
	Pine Valley Creek	Reach 134-B	Core	32.87044	-116.51701	13-Jun-2022	13-Jun-2022	Dry
	Pine Valley Creek	Reach 141-A	Core	32.88172	-116.52394	13-Jun-2022	13-Jun-2022	AT not present
	Pine Valley Creek	Reach 141-B	Core	32.88284	-116.52419	13-Jun-2022	13-Jun-2022	AT not present
	Pine Valley Creek Trib (Block 0014)	Reach 007-A	Rotating	32.74430	-116.65040	5-May-2022	5-May-2022	AT not present
	Pine Valley Creek Trib (Block 0014)	Reach 007-B	Rotating	32.74487	-116.64930	5-May-2022	5-May-2022	AT not present
	Wilson Creek Trib (Block 0020)	Reach 004-A	Rotating	32.70319	-116.70209	5-May-2022	28-Jun-2022	AT not present
	Wilson Creek Trib (Block 0020)	Reach 004-B	Rotating	32.70431	-116.70223	5-May-2022	28-Jun-2022	AT not present
	Wilson Creek Trib (Block 0021)	Reach 001-A	Rotating	32.69441	-116.69925	5-May-2022	5-May-2022	Dry
	Wilson Creek Trib (Block 0021)	Reach 001-B	Rotating	32.69550	-116.69954	5-May-2022	5-May-2022	Dry
	Kitchen Creek (Block 0089)	Reach 012-A	Rotating	32.74193	-116.46731	1-Apr-2022	22-Jun-2022	AT not present
Kitchen Creek (Block 0089)	Reach 012-B	Rotating	32.75071	-116.45847	1-Apr-2022	22-Jun-2022	AT not present	
Kitchen Creek (Block 0089)	Reach 019-A	Rotating	32.74298	-116.46754	1-Apr-2022	22-Jun-2022	AT not present	
Kitchen Creek (Block 0089)	Reach 019-B	Rotating	32.75071	-116.45714	1-Apr-2022	22-Jun-2022	AT not present	
La Posta Creek (Block 0107)	Reach 003-A	Core	32.71363	-116.49436	27-Apr-2022	27-Apr-2022	Dry	
La Posta Creek (Block 0107)	Reach 003-B	Core	32.71328	-116.49312	27-Apr-2022	27-Apr-2022	Dry	

Appendix 1. (continued)

Watershed	Stream	Reach	Site Type	Start Latitude	Start Longitude	First Survey	Last Survey	Survey Result
Tijuana	Morena Creek (Block0306)	Reach 003-A	Core	32.72768	-116.53815	27-Apr-2022	27-Apr-2022	Dry
	Morena Creek (Block0306)	Reach 003-B	Core	32.72821	-116.53930	27-Apr-2022	27-Apr-2022	Dry
	Morena Creek (Block0327)	Reach 011-A	Core	32.71905	-116.53016	27-Apr-2022	27-Apr-2022	Dry
	Morena Creek (Block0327)	Reach 011-B	Core	32.72015	-116.53031	27-Apr-2022	27-Apr-2022	Dry
	Cottonwood Creek (Block 0496)	Reach 169-A	Core	32.71201	-116.50023	27-Apr-2022	27-Apr-2022	Dry
	Cottonwood Creek (Block 0496)	Reach 169-B	Core	32.71281	-116.49940	27-Apr-2022	27-Apr-2022	Dry
	Cottonwood Creek (Block 0496)	Reach 171-A	Core	32.71572	-116.49871	27-Apr-2022	27-Apr-2022	Dry
	Cottonwood Creek (Block 0496)	Reach 171-B	Core	32.71667	-116.49820	27-Apr-2022	27-Apr-2022	Dry
	Potrero Creek (Block0571)	Reach 003-A	Core	32.60733	-116.69460	12-Apr-2022	5-May-2022	AT not present
	Potrero Creek (Block0571)	Reach 003-B	Core	32.60709	-116.69332	12-Apr-2022	5-May-2022	AT not present
	Potrero Creek (Block0571)	Reach 060-A	Core	32.64054	-116.58831	13-Apr-2022	13-Apr-2022	Dry
	Potrero Creek (Block0571)	Reach 060-B	Core	32.64126	-116.58728	13-Apr-2022	13-Apr-2022	Dry
	Potrero Creek (Block0571)	Reach 065-A	Core	32.64900	-116.58030	13-Apr-2022	13-Apr-2022	Dry
	Potrero Creek (Block0571)	Reach 065-B	Core	32.64938	-116.57909	13-Apr-2022	13-Apr-2022	Dry
	Potrero Creek Trib18	Reach 003-A	Core	32.64915	-116.57704	13-Apr-2022	13-Apr-2022	Dry
	Potrero Creek Trib18	Reach 003-B	Core	32.65007	-116.57859	13-Apr-2022	13-Apr-2022	Dry
	Lower Cottonwood Creek	Reach 005-A	Core	32.57302	-116.75736	21-Apr-2022	21-Apr-2022	Dry
	Lower Cottonwood Creek	Reach 005-B	Core	32.57369	-116.75621	21-Apr-2022	21-Apr-2022	Dry
	Lower Cottonwood Creek	Reach 009-A	Core	32.57676	-116.74813	21-Apr-2022	21-Apr-2022	Dry
	Lower Cottonwood Creek	Reach 009-B	Core	32.57700	-116.74684	21-Apr-2022	21-Apr-2022	Dry
	Lower Cottonwood Creek	Reach 014-A	Core	32.58535	-116.74716	21-Apr-2022	21-Apr-2022	Dry
	Lower Cottonwood Creek	Reach 014-B	Core	32.58620	-116.74809	21-Apr-2022	21-Apr-2022	Dry
	Lower Cottonwood Creek	Reach 018-A	Core	32.58812	-116.74012	21-Apr-2022	21-Apr-2022	Dry
	Lower Cottonwood Creek	Reach 018-B	Core	32.58831	-116.73960	21-Apr-2022	21-Apr-2022	AT not present
	Lower Cottonwood Creek	Reach 055-A	Core	32.58812	-116.74012	12-Apr-2022	12-Apr-2022	Dry
	Lower Cottonwood Creek	Reach 055-B	Core	32.58831	-116.73960	12-Apr-2022	12-Apr-2022	Dry
	Lower Cottonwood Creek	Reach 057-A	Core	32.63804	-116.68702	12-Apr-2022	12-Apr-2022	Dry
	Lower Cottonwood Creek	Reach 057-B	Core	32.63940	-116.68724	12-Apr-2022	12-Apr-2022	Dry
	Lower Cottonwood Creek	Reach 067-A	Core	32.65582	-116.67990	12-Apr-2022	18-May-2022	AT not present
	Lower Cottonwood Creek	Reach 067-B	Core	32.65697	-116.68065	12-Apr-2022	18-May-2022	AT not present
	Lower Cottonwood Creek	Reach 068-A	Core	32.65788	-116.68071	12-Apr-2022	18-May-2022	AT not present
	Lower Cottonwood Creek	Reach 068-B	Core	32.65891	-116.68071	12-Apr-2022	18-May-2022	AT not present
	Mine Canyon Trib (Block 0487)	Reach 001-A	Rotating	32.57051	-116.78025	21-Apr-2022	21-Apr-2022	Dry
	Mine Canyon Trib (Block 0487)	Reach 001-B	Rotating	32.57114	-116.78131	21-Apr-2022	21-Apr-2022	Dry
	Campo Creek (Block 0538)	Reach 002-A	Core	32.58509	-116.53923	13-Apr-2022	28-Jun-2022	AT not present
	Campo Creek (Block 0538)	Reach 002-B	Core	32.58512	-116.53790	13-Apr-2022	28-Jun-2022	AT not present
	Tijuana River Trib1	Reach 7-A	Rotating	32.57865	-116.76766	21-Apr-2022	21-Apr-2022	Dry
	Tijuana River Trib1	Reach 7-B	Rotating	32.57961	-116.76834	21-Apr-2022	21-Apr-2022	Dry
	Tijuana River Trib (Block 0506)	Reach 002-A	Rotating	33.11951	-116.85695	21-Apr-2022	21-Apr-2022	Dry
	Tijuana River Trib (Block 0506)	Reach 002-B	Rotating	33.11999	-116.85816	21-Apr-2022	21-Apr-2022	Dry

Appendix 2. Native and nonnative aquatic species observed by stream by watershed from north to south, 2022.

Watershed	Stream/River	Native Aquatic species								Nonnative Aquatic Species									
		Arroyo Chub	Arroyo Toad	Baja California Treefrog	California Treefrog	Crayfish	Striped Mullet	Two-Striped Garter Snake	Western Pond Turtle	Western Toad	American beaver	American Bullfrog	Bullhead spp.	Common Carp	Fathead Minnow	Green Sunfish	Largemouth Bass	Mosquitofish	Redeye Bass
San Juan	San Mateo Creek																		
	San Onofre Creek																		
Santa Margarita	Temecula Creek Trib (Block 0642)																		
	Arroyo Seco Creek (Block 0987)																		
	Sandia Canyon	3		5		2													
	Santa Margarita River		12	12	1	12	2				6								
San Luis Rey	Agua Caliente Creek Trib (Block 3213)																		
	Canada Verde (Block 3234)																		
	Agua Caliente Creek Trib (Block 3767)																		
	Ward Canyon (Block 3764)																		
	Agua Caliente Creek (Block3747)																		
	Canada Aguanga																		
	WF San Luis Rey River	2		2				2										1	
	San Luis Rey Tributary (Block3707)																		
	San Luis Rey River Trib (Block 3749)					2													4
	Upper San Luis Rey River		3	5		2		1					1						4
Middle San Luis Rey																			
Lower San Luis Rey River					5						3							1	
San Dieguito	Upper Santa Ysabel Creek Trib11A																		
	Upper Santa Ysabel Creek Trib11A1																		
	Upper Santa Ysabel Creek			5	2	1		1				3							5
	Black Canyon																		
	Carney Canyon Trib (Block 2217)																		
	Carney Canyon Trib (Block 2234)																		
	Carney Canyon																		
	Temescal Creek Trib (SY; Block 2243)																		
	Temescal Creek (Santa Ysabel)			1															2
	Santa Ysabel Creek Trib (Block 2506)																		
	Boden Canyon																		
Santa Maria Creek			2		2		1				3							5	
Lower Santa Ysabel Creek			8	5			1												
Upper San Dieguito River B			1																
San Diego	Temescal Creek				1			2											
	Chocolate Canyon (Block 1408)			4		6													
	Upper San Diego River			5	6			6	3			1		4					
	San Vicente Creek			16		10		3				4							2
Sweetwater	Upper Sweetwater River (Block 1425)																		
	Japacha Creek Trib (Block 1460)																		
	Arroyo Seco (SW; Block 1475)																		
	Descanso Creek (Block 1597)																		
	Upper Sweetwater River			3	7			3											
	Sweetwater River-Loveland						2												
Middle Sweetwater River					1														

Appendix 2. Native and nonnative aquatic species observed, 2022 (continued)

Watershed	Stream/River	Native Aquatic species								Nonnative Aquatic Species									
		Arroyo Chub	Arroyo Toad	Baja California Treefrog	California Treefrog	Crayfish	Striped Mullet	Two-Striped Garter Snake	Western Pond Turtle	Western Toad	American beaver	American Bullfrog	Bullhead spp.	Common Carp	Fathead Minnow	Green Sunfish	Largemouth Bass	Mosquitofish	Redeye Bass
Tijuana	Pine Valley Creek Trib (Block 0165)																		
	Pine Valley Creek Trib (Block 0229)																		
	Agua Dulce Creek (Block 0385)																		
	Los Rasalies Ravine (Block 0441)																		
	Espinosa Creek (Block0003)																		
	Horsethief Canyon (SD)																		
	Pine Valley Creek			1		4		3										2	
	Pine Valley Creek Trib (Block 0014)																		
	Wilson Creek Trib (Block 0020)			2															
	Wilson Creek Trib (Block 0021)																		
	Kitchen Creek (Block 0089)				4														
	La Posta Creek (Block 0107)																		
	Morena Creek (Block0306)																		
	Morena Creek (Block0327)																		
	Cottonwood Creek (Block 0496)																		
	Potrero Creek (Block0571)																		
	Potrero Creek Trib18																		
	Lower Cottonwood Creek			5	1			2	2										
Mine Canyon Trib (Block 0487)																			
Campo Creek (Block 0538)			4																
Tijuana River Trib1																			
Tijuana River Trib (Block 0506)																			