



Monitoring Aquatic Amphibians and Invasive Species in the Mediterranean Coast Network, 2011 Project Report

Santa Monica Mountains National Recreation Area

Natural Resource Data Series NPS/MEDN/NRDS—2012/369



ON THE COVER

Juvenile Pacific treefrog (*Psuedacris regilla*)

Photograph by: K. S. Delaney, Santa Monica Mountains National Recreation Area

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Introduction

Because of their proximity to the Los Angeles Metropolitan area, which hosts a regional population of over 17 million people, the Santa Monica Mountains (SMM) and Simi Hills are subjected to the stressors and impacts associated with urban areas. Ecosystem changes that result from urban encroachment include the destruction and fragmentation of breeding habitat for aquatic amphibians, degradation of air and water quality, altered stream discharge regimes, and the introduction and spread of non-native invasive species. Urbanization of as little as 8-10 percent of a watershed can have significant impacts on the distribution and abundance of native amphibian (Paul & Meyer 2001; Riley et al. 2005). A reduction in the distribution of native amphibians in the Santa Monica Mountains in association with increasing levels of urbanization and invasive species has been documented in the Santa Monica Mountains (Gamradt & Kats 1996; Goodsell & Kats 1999; Riley et al. 2005).

Aquatic amphibian species in the SMM include California newts (*Taricha torosa*), Pacific treefrogs (*Pseudacris regilla*), California treefrogs (*P. cadaverina*), western toads (*Bufo boreas*), and red-legged frogs (*Rana draytonii*). Red-legged frogs, formerly common in a number of streams in the region (De Lisle et al. 1987), now occur only in one small population within the park. Non-native species within the SMM include red swamp crayfish (*Procambarus clarkii*) from the southeastern United States, bullfrogs (*R. catesbeiana*), and a number of fish species including bass (*Micropterus* spp.), bluegill (*Lepomis macrochirus*), and mosquitofish (*Gambusia affinis*).

Monitoring of aquatic amphibians in the Mediterranean Coast Inventory and Monitoring Network (Delaney et al. 2011a) focuses on two metrics: occupancy (MacKenzie et al. 2003) and indices of abundance. Occupancy modeling provides a statistical framework for assessing changes in species occurrence while explicitly accounting for differences in detectability (MacKenzie et al. 2003, 2006). Information from repeated observations at sample units (streams) is used to estimate detectability and adjust occupancy rates for imperfect detection (failure to observe a species that is actually present).

The objectives of our long-term monitoring program are to 1) determine the status and long-term trends in abundance indices and percent area occupied by juvenile and adult aquatic amphibians in streams during the reproductive season, 2) determine the status and long-term trends in occupancy and abundance indices of non-native species, and 3) characterize the relationship between urbanization, non-native species and the occupancy and abundance indices of the focal native aquatic amphibians.

This report summarizes data collected during 2011, the 12th year of monitoring stream amphibians and invasive aquatic species in Santa Monica Mountains NRA. In this report, we present single-season occupancy and detectability estimates, naïve occupancy data, and abundance data.

Methods

A detailed description of methods for the long-term monitoring of aquatic amphibians in Santa Monica Mountains National Recreation Area can be found in Delaney et al. (2011a).

Sampling Design and Site Selection

In all, 58 unique locations have been identified for long-term monitoring (Figure 1). These sites include a mix of sites that have been monitored since 2000 (sentinel sites, N=22) and a suite of sites selected using generalized random tessellation stratified sampling (GRTS) (Stevens & Olsen 1999, 2003, 2004) that have been monitored on a rotating basis since 2006 (“R” sites, N=36). The “R” streams are visited following a serially rotating panel design. The 36 sites are divided into 3 panels consisting of 12 monitoring sites (R1, R2, and R3). One panel is visited each year for three years. In the fourth year, R1 panel sites are revisited and so on. In 2011, sentinel sites and the R2 panel of stream sites were surveyed by the National Park Service and collaborators (Table 1).

Sampling Frequency and Replication

Sampling occurs from April to July to capture the breeding seasons of target amphibians. Each sampling location are visited twice in the season: once for an intensive sampling visit, when a full suite of biological and environmental data is collected, and another visit for observation of occupancy by target species (native amphibians and non-native fauna). Either survey type can be done first during the season. The timing of the sampling events are scheduled to coincide with species specific breeding seasons of the target amphibians, and is somewhat dependent upon year-to-year climate patterns. In very wet years the overall season for sampling may be longer than normal or drier years. Inland low elevation, low gradient streams are most likely to harbor the egg masses and/or larvae of Western toads and are sampled early in the season as these often dry up sooner than higher elevation high gradient streams. High gradient or coastal streams are most likely to harbor the larvae of California treefrogs and may be sampled later in the season.

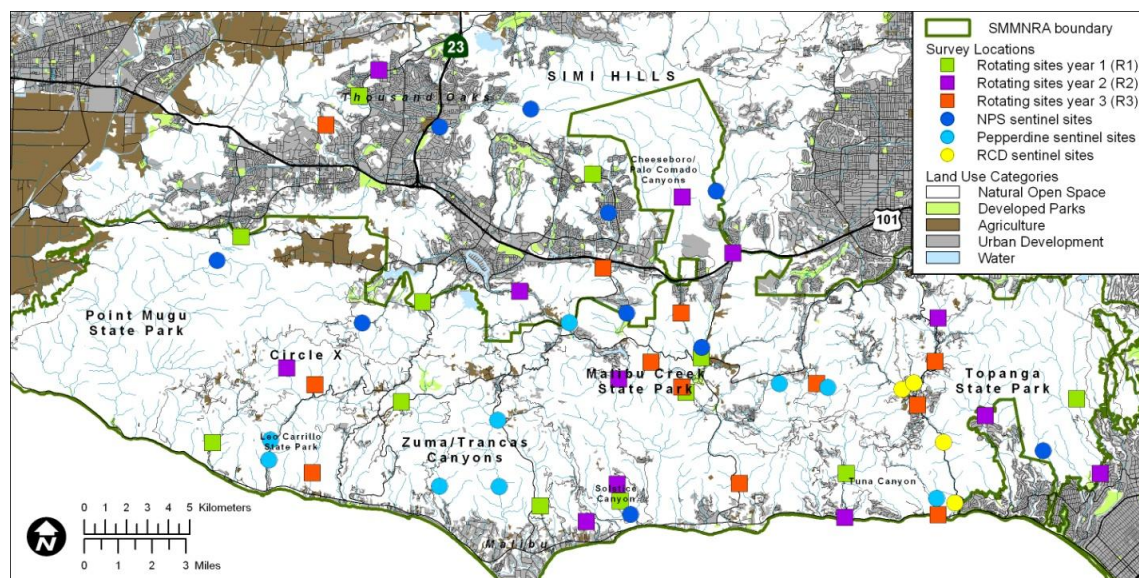


Figure 1. Study area and stream sites for all surveys monitored. Note that in 2011, NPS sentinel and “R2” sites were surveyed.

Table 1. Survey site names, stream codes, and dates for the intensive survey visit for NPS in 2011 (Cheeseboro Canyon intensive survey was not done, therefore date is occupancy survey, see text).

Stream Name	Stream Code	Date of Intensive Survey
Big Sycamore	S_BIGSYC	June 21, 2011
Carlisle	S_CARLISLE	April 19, 2011
Lang Ranch (North)	S_LANRNCHN	June 30, 2011
Erbes	S_LANRNCHS	June 22, 2011
Las Virgenes (Lower)	S_LLASVIR	July 6, 2011
Medea Creek (Lower)	S_LMEDCRK	June 21, 2011
Solstice Canyon	S_SOLSCRK	June 22, 2011
Temescal Canyon	S_TEMECYN	July 7, 2011
Las Virgenes (Upper)	S_ULASVIR	May 16, 2011
Medea Creek (Upper)	S_UMEDCRK	June 20, 2011
Bulldog	R2_BULLDOG	July 8, 2011
Cheeseboro Canyon	R2_CHEESEBORO	May 24, 2011
Circle X	R2_CIRCLEX	June 27, 2011
Escondido	R2_ESCONDIDO	July 14, 2011
Las Flores (R2)	R2_LASFLORES	June 28, 2011
Las Virgenes (R2)	R2_LASVIRGENES	May 11, 2011
Olsen	R2_OLSEN	July 13, 2011
Rustic Canyon	R2_RUSTIC	June 29, 2011
Santa Ynez	R2_SANTAYNEZ	July 1, 2011
Sostoma	R2_SOSTOMA	June 23, 2011
Sutthphur	R2_SUTTPHUR	July 19, 2011
Triunfo Canyon	R2_TRIUNFO	July 15, 2011

Data Collection

There are two types of surveys done each year at each stream site; presence/absence (not detected) or occupancy sampling and intensive sampling. To confirm observations, dip nets, aquascopes, or mask and snorkel are used to find and capture larvae and adults and to verify species identification. Undersides of rocks, submerged logs and floating vegetation are searched for amphibian egg masses. Banks, exposed rocks and floating vegetation are also scanned for juvenile and adult amphibians.

- During occupancy sampling, a team of at least two surveyors begins at the designated starting point and travels upstream 250 m while recording the presence of any native amphibians or non-native target species.
- During intensive sampling, a team of at least two surveyors begins at the designated starting point, travels upstream for 250 m and collects physical and biological stream data as outlined below.

Physical Data

The field crew measures physical variables of each habitat along the length of the 250-meter stream transect. Habitat is categorized into one of four types: pool (slow to non-moving bodies of water); riffle (quick shallow moving water); run (deeper slow moving water); and dry. Every change in habitat is considered a “stop” and is recorded as a number sequentially on the field data form. Length and depth of habitat are recorded for the stream segment between stops. Length (m) is measured using a 100m tape-measure, and depth (cm) is taken at the deepest point in the habitat segment using a meter stick. Habitat conditions (e.g. vegetation type, boulders, erosion) are recorded at each site.

Biological Data

For each target amphibian species, the following are determined and recorded at each stop:

- Abundance estimates (<5, 5-20, 21-100, 101-500, >500) for larvae and juveniles; complete counts for adults and egg masses,
- Age class counts (egg, larvae, juvenile, adult).

For each invasive species, the following are determined at each stop and recorded:

- Presence/absence of fish
- Presence/absence of crayfish
- Abundance estimates using indices (<5, 5-20, 21-100, 101-500, >500) of adult and juvenile crayfish

Data Analysis

Naïve occupancy for 2011 was simply estimated from presence/absence data taken during the occupancy and intensive surveys conducted at each site. For analysis of occupancy, data from intensive surveys was collapsed to resemble the format of data from occupancy surveys. Single season occupancy estimates were made for each species using intercept-only, zero-inflated binomial mixture models. Occupancy and detection probabilities were estimated using maximum likelihood (MLE's) and numerical optimization. R code, adapted from Royle and Dorazio (2008; p. 117, Panel 3.8), was used to generate point estimates for occupancy and detection. Single season occupancy and detection did not include co-variates, therefore no model selection was needed.

Abundance data was used by calculating the number of stops in the stream that had the same abundance category. For example, we calculated the number of stops in a stream that had an abundance category of 21-100 divided by the total number of stops in a stream, resulting in a proportion of stops in a stream with an abundance category of 21-100. For Pacific treefrog tadpole abundance, we compared the proportion of stream stops in each category in streams with crayfish and without. Significance between crayfish and non-crayfish streams was tested with a paired t-test using R.

Also, the average number of larvae per meter was calculated for streams with and without crayfish. This was calculated by taking the lowest number from our abundance categories (e.g. 5-20), adding the numbers together, and dividing by 250m (the length of stream surveyed).

Results

Physical Data

One stream surveyed (Cheeseboro Canyon, R2_CHEESEBORO) was dry at the time of the first survey, and was not re-visited as there was no rain after the first visit of 2011. This stream was dropped from the analyses, and when R2 streams will be surveyed again, this site location will be re-visited. If it is dry again, it will be replaced with a new randomly-selected oversample site (from existing GRTS points).

Biological Data

Naïve Occupancy

Pacific treefrogs had the widest distribution of all of the target amphibian species, and were present in 18 of 21 (86%) streams surveyed in 2011 (Table 2). California treefrogs were found in 6 (29%) and California newts were found in 9 (43%) of the 21 streams. The rarest species, western toads, were only found in 3 of the 21 (14%) streams surveyed. Invasive crayfish were present in 6 (29%) streams and invasive fish were present in 6 (29%). Bullfrogs were found at only one site (5%). New Zealand mudsnails were found in 4 (19%) of our sites.

Occupancy appeared to be related to the presence of non-native species in our stream surveys. California newts and California treefrogs were not present in streams that had invasive crayfish, fish, or bullfrogs (Table 2).

Table 2. Presence (1) or absence/not detected (0) of each target species at each NPS stream site in 2011 (intensive and occupancy surveys combined). The following codes were used for each species: BUBO (Western toad), HYRE (Pacific treefrog), HYCA (California treefrog), TATO (California newt), CRAY (crayfish), FISH (any non-native fish species), RACA (bullfrog), and NZMS (New Zealand mudsnail); the number of streams where each species was present; and the percentage of streams [(number of streams with a species present/total number of streams surveyed)*100].

Stream Name	Stream Code	BUBO	HYCA	HYRE	TATO	CRAY	FISH	RACA	NZMS
Bulldog	R2_BULLDOG	0	1	1	0	0	0	0	0
Circle X	R2_CIRCLEX	0	1	1	1	0	0	0	0
Escondido	R2_ESCONDIDO	0	0	1	0	0	0	0	0
Las Flores (R2)	R2_LASFLORES	0	1	1	0	0	0	0	0
Las Virgenes (R2)	R2_LASVIRGENES	1	0	1	0	1	1	0	0
Olsen	R2_OLSEN	0	0	0	0	0	0	0	0
Rustic Canyon	R2_RUSTIC	0	0	1	1	0	0	0	0
Santa Ynez	R2_SANTAYNEZ	0	0	1	1	0	0	0	0
Sostoma	R2_SOSTOMA	0	1	1	1	0	0	0	0
Suttphur	R2_SUTTPHUR	0	0	1	0	0	0	0	0
Triunfo Canyon	R2_TRIUNFO	0	0	0	0	1	1	1	1
Big Sycamore	S_BIGSYC	0	0	1	1	0	0	0	0
Carlisle	S_CARLISLE	1	1	1	1	0	0	0	0
Lang Ranch (North)	S_LANRNCHN	0	0	1	1	0	0	0	0
Erbes	S_LANRNCHS	0	0	0	0	1	1	0	1
Las Virgenes (Lower)	S_LLASVIR	0	0	1	0	1	1	0	0
Medea Creek (Lower)	S_LMEDCRK	0	0	1	0	1	1	0	1
Solstice Canyon	S_SOLSCRK	0	1	1	1	0	0	0	0
Temescal Canyon	S_TEMECYN	0	0	1	1	0	0	0	0
Las Virgenes (Upper)	S_ULASVIR	1	0	1	0	0	0	0	0
Medea Creek (Upper)	S_UMEDCRK	0	0	1	0	1	1	0	1
Total number of streams where present		3	6	18	9	6	6	1	4
Percentage of streams		14%	29%	86%	43%	29%	29%	5%	19%

Occupancy and Detectability

Estimated occupancy was high for Pacific treefrogs (HYRE), and lower for the other three species. Detectability was high for two of the four native species, with California treefrogs (HYCA) and toads (BUBO) having lower detectabilities (Figure 2).

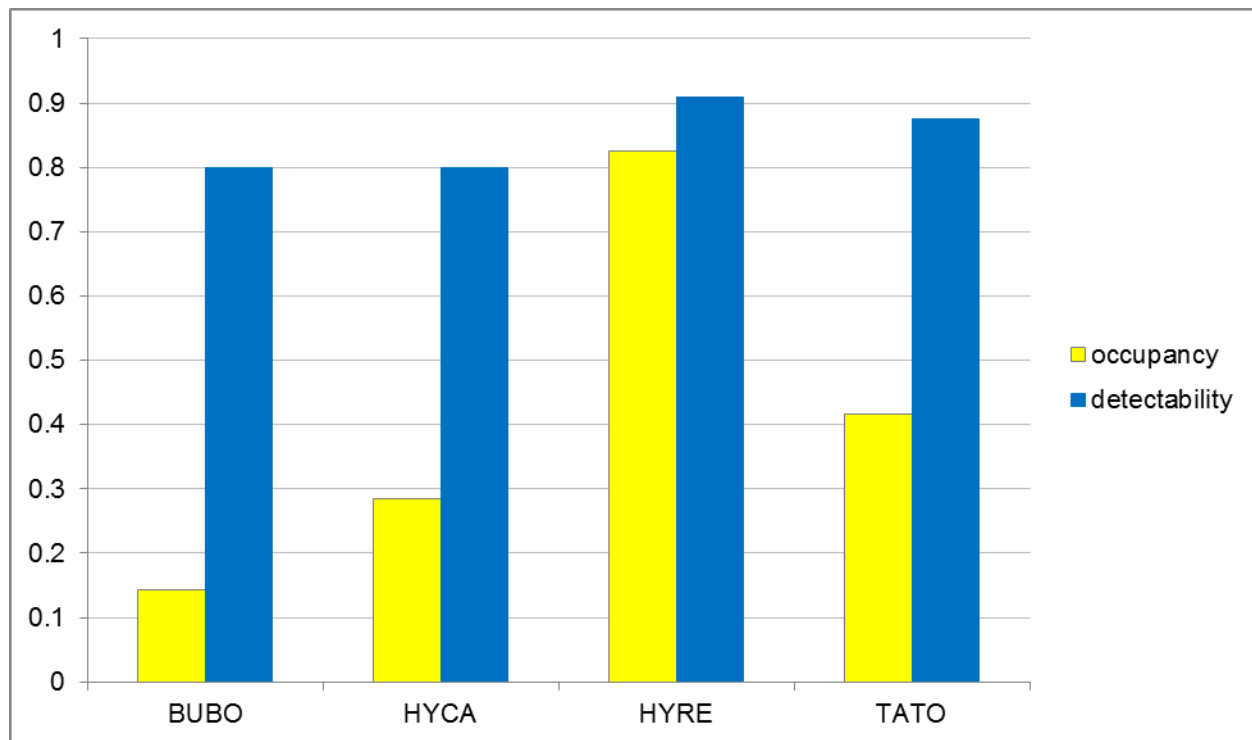


Figure 2. Single season (2011) estimate of occupancy and detectability for native amphibians in 21 streams. The following codes were used for each species: BUBO (Western toad), HYRE (Pacific treefrog), HYCA (California treefrog), and TATO (California newt).

Abundance

The average number of Pacific treefrog tadpoles was 1.4 per meter (N=6, SD=3.15) for streams with crayfish and 1.08 per meter (N=15, SD=1.49) for streams without crayfish. In previous years, we found the opposite pattern. Upon further examination of the data, we found that one site, R2_LASVIRGENES, was driving this pattern. During 2011, there were only crayfish larvae found in R2_LASVIRGENES. When we exclude this site from the analysis, we find that the mean number of Pacific treefrog tadpoles decreases to 0.12 (S.D. 0.15).

Categorical abundance data was recorded at each stream “stop” during the intensive surveys. With these data, we examined how the presence of crayfish affected abundance of Pacific treefrog tadpoles. In streams with crayfish, there were more stops with zero Pacific treefrog tadpoles than in streams without crayfish although the difference was not significant ($t=0.447$, $df=5$, $p>0.05$; Figure 3).

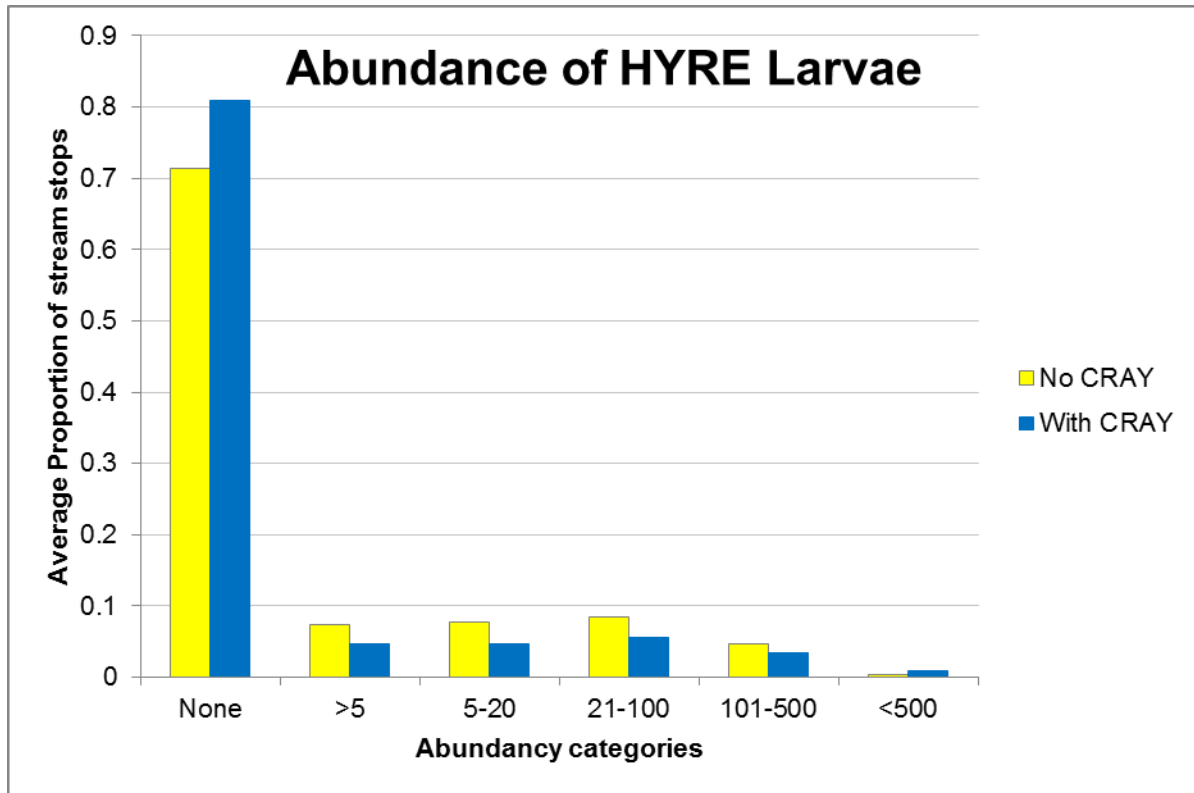


Figure 3. The proportion of stops averaged over streams with or without crayfish that contained the various categories of Pacific treefrogs.

Notable Detections

For the third year in a row, a single adult red-legged frog, a federally threatened species, was detected in 2011 at the sentinel site Upper Las Virgenes (S_ULASVIR). This detection was in the same stream reach that a different adult red-legged frog was found in 2009 and 2010 (Delaney et al. 2011b). Only one population of red-legged frogs exists in SAMO, therefore new sightings in nearby streams indicates successful dispersal.

Discussion

Occupancy data from 2011 suggests that the introduction of exotic species may be negatively affecting amphibians in the SMM. The naïve occupancy data clearly show that native California newts and California treefrogs were not found in streams with crayfish or fish in 2011 (Table 2). A similar result was found for newts in SMM streams where crayfish and mosquitofish were introduced (Gamradt & Kats 1996). In that study, predation of newt larvae by the invasive species had a huge negative effect on survival.

Pacific treefrogs persist in almost all of our streams, suggesting that non-native predators do not severely affect the distribution of this species (Table 2). In 2011, the mean density of Pacific treefrog (HYRE) tadpoles was higher in streams with crayfish. This is the opposite pattern from that found in the two previous years (Delaney et. al. 2011b, Delaney and Riley 2012). There were six streams in 2011 that had invasive crayfish. One of those stream sites, R2_LASVIRGENES, also had a high abundance of Pacific treefrog tadpoles which drove the pattern of mean tadpole density in 2011. At the R2_LASVIRGENES site we did not detect any adult crayfish, which are voracious predators of tadpoles and other larvae. Therefore we considered this site an outlier and calculated mean tadpole density in streams with adult crayfish only. There was a 9-fold decrease (1.08 vs. 0.12 tadpoles/meter) in the density of tadpoles when R2_LASVIRGENES was removed. However, we do not want to disregard R2_LASVIRGENES because it is a very interesting site in that Pacific treefrogs seem to be breeding successfully despite the presence of crayfish. The presence of non-native crayfish also appears to affect abundance categories (Figure 3). In streams with crayfish there were more stream stops with zero Pacific treefrog tadpoles than in streams without crayfish, however this relationship was not statistically significant.

In 2009 and 2010, we detected and reliably identified an adult red-legged frog in Upper Las Virgenes (S_LLASVIR). In 2011, we detected a different individual farther downstream than the two previous years. This federally threatened species was once widespread throughout the region, but in recent times the only known population in or near the park was a small population of about 50 adults in East Las Virgenes creek, a tributary of Upper Las Virgenes. Detection of red-legged frogs in Upper Las Virgenes confirms the successful dispersal of individuals from East Las Virgenes. The detection and location were reported to the U.S. Fish and Wildlife Service (USFWS) and the California Natural Diversity Database.

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