



Monitoring Aquatic Amphibians and Invasive Species in the Mediterranean Coast Network, 2012 Project Report

Santa Monica Mountains National Recreation Area

Natural Resource Data Series NPS/MEDN/NRDS—2013/579



ON THE COVER

California newt (*Taricha torosa*)

Photograph by: Mark Ziman, Santa Monica Mountains National Rereation Area

Monitoring Aquatic Amphibians and Invasive Species in the Mediterranean Coast Network, 2012 Project Report

Santa Monica Mountains National Recreation Area

Natural Resource Data Series NPS/MEDN/NRDS—2013/579

Kathleen Semple Delaney

Seth P. D. Riley

National Park Service
Santa Monica Mountains National Recreation Area
401 W. Hillcrest Dr.
Thousand Oak, CA 91360

November 2013

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado, publishes a range of reports that address natural resource topics. These reports are of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Data Series is intended for the timely release of basic data sets and data summaries. Care has been taken to assure accuracy of raw data values, but a thorough analysis and interpretation of the data has not been completed. Consequently, the initial analyses of data in this report are provisional and subject to change.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner. Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

This report is available in digital format from the Mediterranean Coast Network of the Inventory and Monitoring Program (<http://science.nature.nps.gov/im/units/medn/>) and the Natural Resource Publications Management website (<http://www.nature.nps.gov/publications/nrpm/>). To receive this report in a format optimized for screen readers, please email irma@nps.gov

Please cite this publication as:

Delaney, K. S. and S. P. D. Riley. 2013. Monitoring aquatic amphibians and invasive species in the Mediterranean Coast Network, 2012 project report: Santa Monica Mountains National Recreation Area. Natural Resource Data Series NPS/MEDN/NRDS—2013/579. National Park Service, Fort Collins, Colorado.

Contents

	Page
Figures.....	iv
Tables.....	v
Acknowledgments.....	vi
Introduction.....	1
Methods.....	2
Sampling Design and Site Selection.....	2
Sampling Frequency and Replication.....	2
Data Collection.....	3
Physical Data.....	3
Biological Data.....	3
Data Analysis.....	3
Results.....	5
Physical Data.....	5
Biological Data.....	5
Naïve Occupancy.....	5
Occupancy and Detectability.....	7
Abundance.....	7
Notable Detections.....	8
Discussion.....	9
Literature Cited.....	11

Figures

	Page
Figure 1. Study area and stream sites for all surveys monitored.	2
Figure 2. Single season (2012) estimate of occupancy and detectability for native amphibians	7
Figure 3. The proportion of stops averaged over streams with or without crayfish that contained the various categories of Pacific treefrogs.....	8

Tables

	Page
Table 1. Presence or absence/not detected of each target species at each NPS stream site in 2012	6

Acknowledgments

We would like to thank the following: Justin Brown, Cathy Schoonmaker, Joanne Moriarty, Jeff Sikich, Justin Fowler, Steve Bustamante, Andrew Marx, Ralph Flores, Jeff Brown, Deidre Hayward, Sarah Smayda, and many wildlife interns and student volunteers working with Pepperdine University and the Resource Conservation District of the Santa Monica Mountains for invaluable help with field work; California State Parks, Conejo Open Space Conservation Authority, and many other city and private landholders for land access; Stacey Ostermann-Kelm for project support on all levels; Lena Lee with data management; and Stephen Hayes for providing R code for occupancy and detectability estimation and helpful discussions on the data analysis.

Introduction

Santa Monica Mountains National Recreation Area (SAMO) is adjacent to the second largest city in the United States. Ecosystem changes that result from urban development 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).

Native aquatic amphibian species in SAMO 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 aquatic species within the SAMO include red swamp crayfish (*Procambarus clarkii*) native to 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. 2011) 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 2012, the 13th 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 “R” 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 2012, sentinel sites and the R3 panel of stream sites were surveyed by the National Park Service and collaborators (Figure 1).

Sampling Frequency and Replication

Sampling occurs from April to July to capture the breeding seasons of target amphibians. Each sampling location is 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.

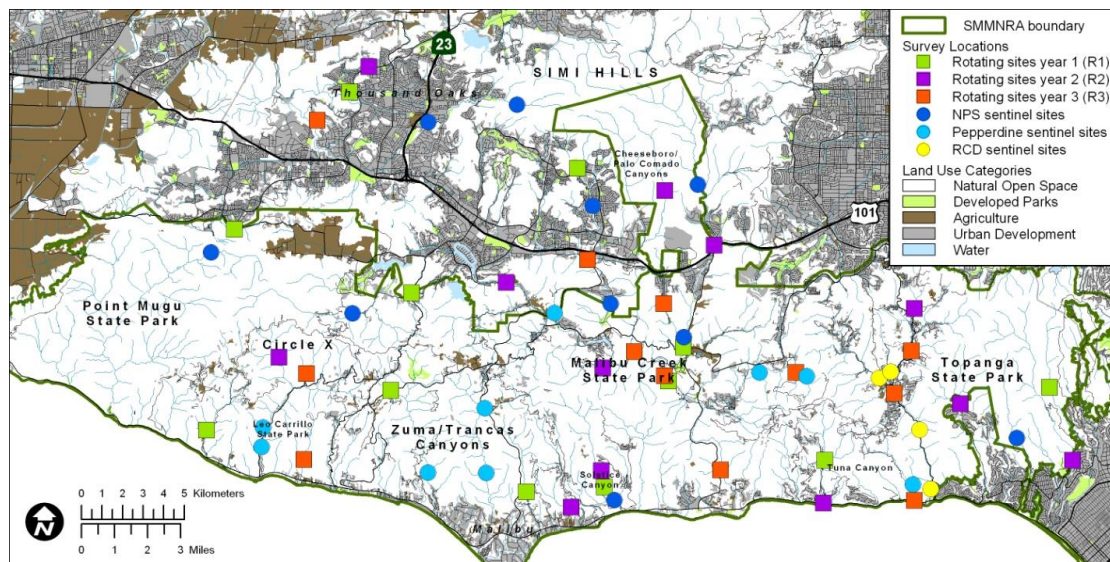


Figure 1. Study area and stream sites for all surveys monitored. Note that in 2012, NPS sentinel and “R3” sites were surveyed.

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 and aquascopes 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 meters (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 m 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 using indices (<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 2012 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 non-parametric Wilcoxon signed-rank 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 was not surveyed because of dry conditions and was dropped from the analyses. This is the second year that this site was too dry to survey. The next time that R3 streams are surveyed, we will drop this site and it will be replaced with a new randomly-selected oversample site (from existing GRTS points) unless we are certain that drought conditions have ceased and water can be detected at this site.

Biological Data

Naïve Occupancy

Pacific treefrogs had the widest distribution of all of the target amphibian species, and were present in 17 of 21 (81%) streams surveyed in 2012 (Table 1). California treefrogs were found in 2 (10%) and California newts were found in 7 (33%) of the 21 streams. The rarest species, western toads, were only found in 1 of the 21 (5%) streams surveyed. Invasive crayfish were present in 10 (48%) streams and invasive fish were present in 11 (52%). Bullfrogs were not found at any site in 2012. New Zealand mudsnails were found in 9 (43%) 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 1).

Table 1. Presence (1) or absence/not detected (0) of each target species at each NPS stream site in 2012 (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/by the total number of streams surveyed)*100].

Stream Name	Stream Code	BUBO	HYCA	HYRE	TATO	CRAY	FISH	RACA	NZMS
Arroyo Sequit	R3_ARRSEQOV	0	0	1	1	0	0	0	0
Cold Creek (Stunt Rd.)	R3_COLDCKRK	0	1	1	1	0	0	0	1
Conejo Creek	R3_CONCRK	0	0	1	0	1	1	0	0
Malibu Creek (Craggs Rd.)	R3_CRAGSRD	0	0	0	0	1	1	0	0
Malibu Creek (at Cross Creek)	R3_CROSSCRK	0	0	1	0	1	1	0	1
Lady Face	R3_LADYFACE	0	0	0	0	1	1	0	1
Liberty Canyon	R3_LIBCYN	0	0	0	0	0	0	0	1
Malibu Creek (rock pool)	R3_MALICRKSP	0	0	1	0	1	1	0	1
Topanga	R3_TOPACRK	0	0	1	0	0	0	0	0
Topanga (off Topanga Cyn Blvd.)	R3_TOPANGA	0	0	1	0	1	1	0	0
Tuna Canyon	R3_TUNACYN	0	0	1	0	0	1	0	0
Big Sycamore	S_BIGSYC	0	0	1	1	0	0	0	0
Carlisle	S_CARLISLE	0	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	1
Medea Creek (Lower)	S_LMEDCRK	0	0	1	0	1	1	0	1
Solstice Canyon	S_SOLSCRK	0	0	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		1	2	17	7	10	11	0	9
Percentage of streams		5%	10%	81%	33%	48%	52%	0%	43%

Occupancy and Detectability

Western toads (BUBO) were only found at one site during 2012 (Table 1), and then only during one of the two surveys done. Because of this, the occupancy model could not estimate occupancy or detectability for the 2012 Western toad data. Estimated occupancy was high for Pacific treefrogs (HYRE), and lower for the other three species. Detectability was highest for Pacific treefrogs (HYRE) and California newts (TATO), with a slightly lower detectability for California treefrogs (HYCA) (Figure 2).

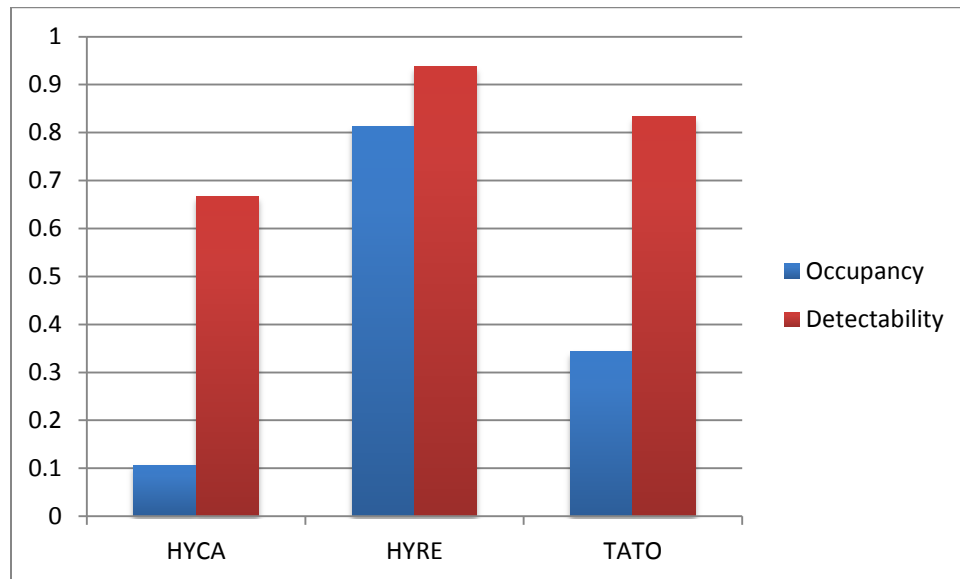


Figure 2. Single season (2012) estimate of occupancy and detectability for native amphibians in 21 streams. The following codes were used for each species: HYRE (Pacific treefrog), HYCA (California treefrog), and TATO (California newt).

Abundance

There was a significant difference in the average number of Pacific treefrog larvae between streams with crayfish and streams without crayfish (Wilcoxon signed-rank test: $V = 0$, $p\text{-value} = 0.036$). The average number of HYRE tadpoles was 0.06 per meter ($N=10$, $SD=0.09$) for streams with crayfish and 0.65 per meter ($N=11$, $SD=1.01$) for streams without crayfish.

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 (Figure 3), however, this difference was not significant. In contrast, we did find a significant difference between streams with and without crayfish for stops containing 21-100 Pacific treefrog larvae. Streams with crayfish had significantly fewer stops with the 21-100 abundance index than streams without crayfish (Wilcoxon signed-rank test: $V = 0$, $p\text{-value} = 0.036$) (Figure 3).

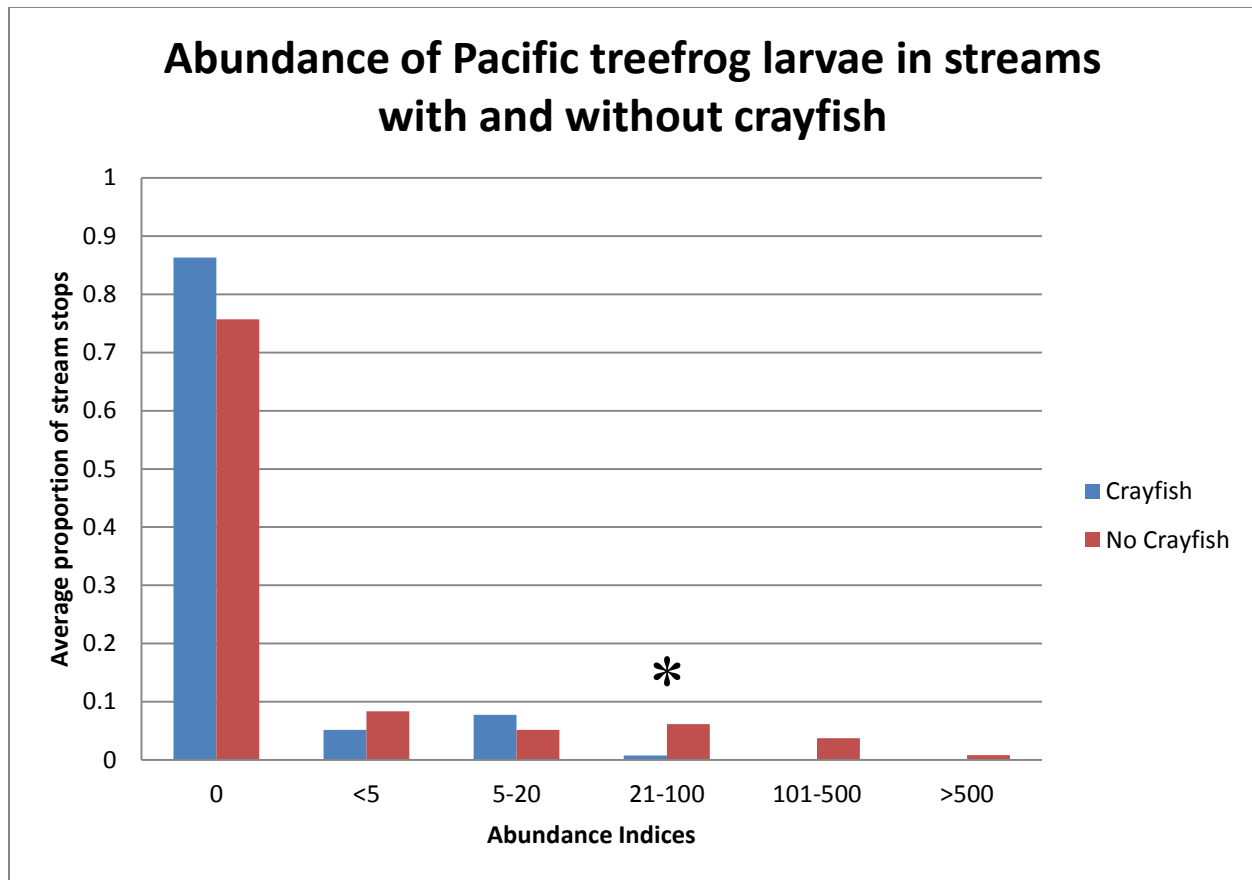


Figure 3. The proportion of stops averaged over streams with or without crayfish that contained the various categories of Pacific treefrogs. A significant difference is indicated with an asterisk (*).

Notable Detections

For the 4th year in a row, California red-legged frogs (*Rana draytonii*), a federally threatened species, were detected at the sentinel site, Upper Las Virgenes (S_ULASVIR). This detection was in the same stream reach that an adult California red-legged frog was found in 2009, 2010, and 2011 (Delaney et al. 2011; Delaney & Riley 2012a, 2012b). In 2012, a California red-legged frog egg mass was detected indicating at least two individual frogs living at this site.

Discussion

Occupancy data from 2012 suggests that the introduction of exotic species, particularly fish and crayfish, may be negatively affecting amphibians at SAMO. Almost half of the streams surveyed in 2012 had invasive fish and crayfish (Table 1). The naïve occupancy data clearly show that native California newts and California treefrogs were not found in streams with crayfish or fish in 2012 (Table 1). 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 1). In 2012, the mean density of Pacific treefrog (HYRE) tadpoles was significantly lower in streams with crayfish. The presence of non-native crayfish also appears to affect abundance categories (Figure 3). Streams without crayfish had significantly more stops with high indices (21-100 tadpoes) of Pacific treefrog tadpoles than streams with crayfish. Streams with crayfish had more stream stops with zero Pacific treefrog tadpoles than in streams without crayfish, though this relationship was not significant.

Since 2009, we have detected the presence of California red-legged frogs in Upper Las Virgenes (S_LLASVIR). In 2012, we detected a red-legged frog egg mass indicating that not only are adult frogs colonizing Upper Las Virgenes, but they are breeding there. 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. Our hope is that this stream reach will become a second site where California red-legged frogs will establish a sustainable breeding population. The detection and location of the egg mass was reported to the U.S. Fish and Wildlife Service (USFWS).

Literature Cited

- De Lisle, H. G., G. Gilbert, J. Feldner, P. O'Connor, M. Peterson, and P. Brown. 1987. The distribution and present status of the Herpetofauna of the Santa Monica Mountains of Los Angeles and Ventura Counties, California. Southwest Herpetologist Society, Los Angeles, California.
- Delaney, K. S., S. P. D. Riley, G. Busteed, M. Robertson, S. Ostermann-Kelm, L. Lee, J. L. Cameron, S. Hayes, and K. Irvine. 2011. Protocol for monitoring aquatic amphibians in the Mediterranean Coast Network: Santa Monica Mountains National Recreation Area. NPS/MEDN/NRR—2011/474. National Park Service, Fort Collins, Colorado
- Delaney, K. S., and S. P. D. Riley. 2012a. Monitoring aquatic amphibians and invasive species in the Mediterranean Coast Network, 2010 project report: Santa Monica Mountains National Recreation Area. Natural Resource Data Series. NPS/MEDN/NRDS-2012/229. National Park Service, Fort Collins, Colorado.
- Delaney, K. S., and S. P. D. Riley. 2012b. 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. National Park Service, Fort Collins, Colorado.
- Delaney, K. S., S. P. D. Riley, S. Ostermann-Kelm, and S. Hayes. 2011. Monitoring aquatic amphibians and invasive species in the Mediterranean Coast Network, 2009 project report: Santa Monica Mountains National Recreation Area. Natural Resource Data Series. NPS/MEDN/NRDS-2011/137. National Park Service, Fort Collins, Colorado.
- Gamradt, S. C., and L. B. Kats. 1996. Effect of introduced crayfish and mosquitofish on California newts. *Conservation Biology* 10:1155–1162.
- Goodsell, J. A., and L. B. Kats. 1999. Effect of introduced mosquitofish on pacific treefrogs and the role of alternative prey. *Conservation Biology* 13:921–924.
- MacKenzie, D. I., J. D. Nichols, J. E. Hines, M. G. Knutson, and A. B. Franklin. 2003. Estimating site occupancy, colonization and local extinction probabilities when a species is detected imperfectly. *Ecology* 84:2200–2207.
- MacKenzie, D. I., J. D. Nichols, J. A. Royle, K. H. Pollack, L. L. Bailey, and J. E. Hines. 2006. *Occupancy estimation and modeling: Inferring patterns and dynamics of species occurrence*. Academic Press.
- Paul, M. J., and J. L. Meyer. 2001. Streams in the urban landscape. *Annual review of ecology and systematics* 32:333–365.
- Riley, S. P. D., G. Busteed, L. B. Kats, T. L. Vandergon, L. F. S. Lee, R. G. Dagit, J. L. Kerby, R. N. Fisher, and R. M. Sauvajot. 2005. Effects of urbanization on the distribution and abundance of

amphibians and invasive species in southern California streams. *Conservation Biology* 19:1894–1907.

Royle, J. A., and R. M. Dorazio. 2008. *Hierarchical Modeling and Inference in Ecology*. Academic Press, New York.

Stevens, D. L., and A. R. Olsen. 1999. Spatially restricted surveys over time for aquatic resources. *Journal of Agricultural, Biological, and Environmental Statistics* 4:415–428.

Stevens, D. L., and A. R. Olsen. 2003. Variance estimation for spatially balanced samples of environmental resources. *Environmetrics* 14:593–610.

Stevens, D. L., and A. R. Olsen. 2004. Spatially balanced sampling of natural resources. *Journal of the American Statistical Association* 99:262–278