California Fish and Game 99(1):42-48; 2013

Sympatry in California tiger salamander and California red-legged frog breeding habitat within their overlapping range

Jeff A. Alvarez*, Mary A. Shea, Jeffery T. Wilcox, Mark L. Allaback, Sarah M. Foster, Gretchen E. Padgett-Flohr, and Jennifer L. Haire

The Wildlife Project, P.O. Box 188888, Sacramento, CA 95818, USA (JAA)

P.O. Box 1632, Brentwood, CA 94513, USA (MAS)

Sonoma Mountain Ranch Preservation Foundation, 537 East Pete Rose Way, Suite 400, Cincinnati, OH, 45202, USA (JTW)

Biosearch Associates, P.O. Box 1220, Santa Cruz, CA 95061, USA (MLA)

Foster Wildlife Surveys, 774 5th Avenue, Sacramento, CA 95818, USA (SMF)

California Environmental Services, 3170 Crow Canyon Road, Suite 250, San Ramon, CA 94583, USA (GEP)

ICF International, Inc., 630 K Street, Sacramento, CA 95818, USA (JLH)

**Correspondent: Jeff@thewildlifeproject.com*

Key Words: amphibian, aquatic, bi-phasic, California red-legged frog, *Rana draytonii*, California tiger salamander, *Ambystoma californiense*, management, protected, range, sympatry

---

Co-occurrence of two or more species of bi-phasic amphibians—those whose larvae develop in aquatic habitats and become terrestrial, air-breathing adults at metamorphosis—is extremely common in North America (Petranka 1998, Lannoo 2005, Stebbins and McGinnis 2012). In California, sympatry in amphibians occurs among a wide range of genera and species, including various assemblages of *Ambystoma, Taricha, Dicamptodon*, *Pseudacris, Spea, Anaxyrus, Rana, Lithobates,* and others (Storer 1925, Petranka 1998, Stebbins 2003, Lannoo 2005). The terrestrial stages of northwestern salamander (*Ambystoma gracile*) and California giant salamander (*Dicamptodon ensatus*), for instance, are commonly found under the same cover and often breed in the same aquatic habitats (Storer 1925, Stebbins 2003). Similarly, the rough-skinned newt (*Taricha granulosa*) and California newt (*T. torosa*) are often found together in both terrestrial and aquatic breeding habitat where the species overlap (Stebbins 2003, Stebbins and McGinnis 2012).

The California tiger salamander (*Ambystoma californiense*) is associated with uplands within grasslands, oak savanna, open oak woodlands, and localized areas of coastal scrub and chaparral in central California (Storer 1925, Trenham 2001, Wang et al. 2009). This species is known to reproduce in vernal pools, stock ponds, artificial wetlands and, occasionally, in slow-flowing swales and creeks situated near other suitable breeding habitat (Storer 1925, Twitty 1941, Trenham et al. 2001, Alvarez 2004a, Alvarez et al. impress). The range of California tiger salamanders overlaps other native amphibians including Santa Cruz long-toed salamander (*A. macrodactylum croceum*), Sierran treefrog (*Pseudacris sierra* [= Pacific treefrog; *P. regilla*]), western toad (*Anaxyrus boreas*), western spadefoot toad (*Spea hammondii*), and others (Storer 1925, Twitty 1941, Anderson 1968, Feaver 1971, USFWS 2003).

The California red-legged frog is closely associated with aquatic freshwater habitats surrounded by grasslands, chaparral, woodlands, and other forest habitat types (Storer 1925, Hayes and Jennings 1988, Bulger et al. 2003, Allaback et al. 2010). Like the California tiger salamander, the range of the California red-legged frog overlaps, and the species is frequently sympatric with, other native amphibians in their aquatic breeding habitat, including California newt, rough-skinned newt, Sierran treefrog, western toad, and American bullfrog (*Lithobates catesbeianus*) (Storer 1925, Feaver 1971, Hayes and Tennant 1985, Rathbun 1998, Cook and Jennings 2007).

Distinct population segments of the California tiger salamander are listed as either endangered or threatened under the federal Endangered Species Act, and threatened under the California Endangered Species Act. The California red-legged frog is listed as threatened under the federal Endangered Species Act and is a species of concern within California. Both species are in decline (Fisher and Shaffer 1996; USFWS 2002, 2003), and mitigation development and land management decisions for one species may affect both.

When rare animals are sympatric and also protected by state or federal law, the management implications may be substantial. This is particularly true when management activities require actions within aquatic breeding sites for a specific listed species. If management activities are focused on one species and the other is not considered, the actions may result in changes to reproductive success, elimination of habitat for one or more life stages, or direct or indirect harm of the untargeted, but sympatric, species.

We report here numerous accounts of sympatry in the breeding habitat of two protected amphibians that have not been reported elsewhere that may affect management of both species. We used data collected during various independent amphibian larval survey projects over a large area within the range of California tiger salamander and California red-legged frog (Figure 1, Table 1). The data in this report came from sites where each of us worked ≥2 years, and where we visited sample sites multiple times. During our respective investigations, each of us considered the phenology of both species in order to increase their potential detection within habitat that was surveyed. Specifically, our surveys were timed such that both species were known to be, or presumed to be, in their larval life stages during sampling efforts (i.e., typically March through July), which occurred prior to drying of most ephemeral ponds in each drainage.

Our sampling sites included ponds with a wide range of physical characteristics including: perennial and ephemeral; natural and constructed water bodies; turbid to clear waters; large and small aquatic sites (0.1 acres–8.1 acres); deep and shallow water bodies (0.4 m–15 m); low to high elevation sites (25 m–1000 m); sites nested within grasslands, woodlands, and chaparral; water bodies that were grazed and ungrazed; and

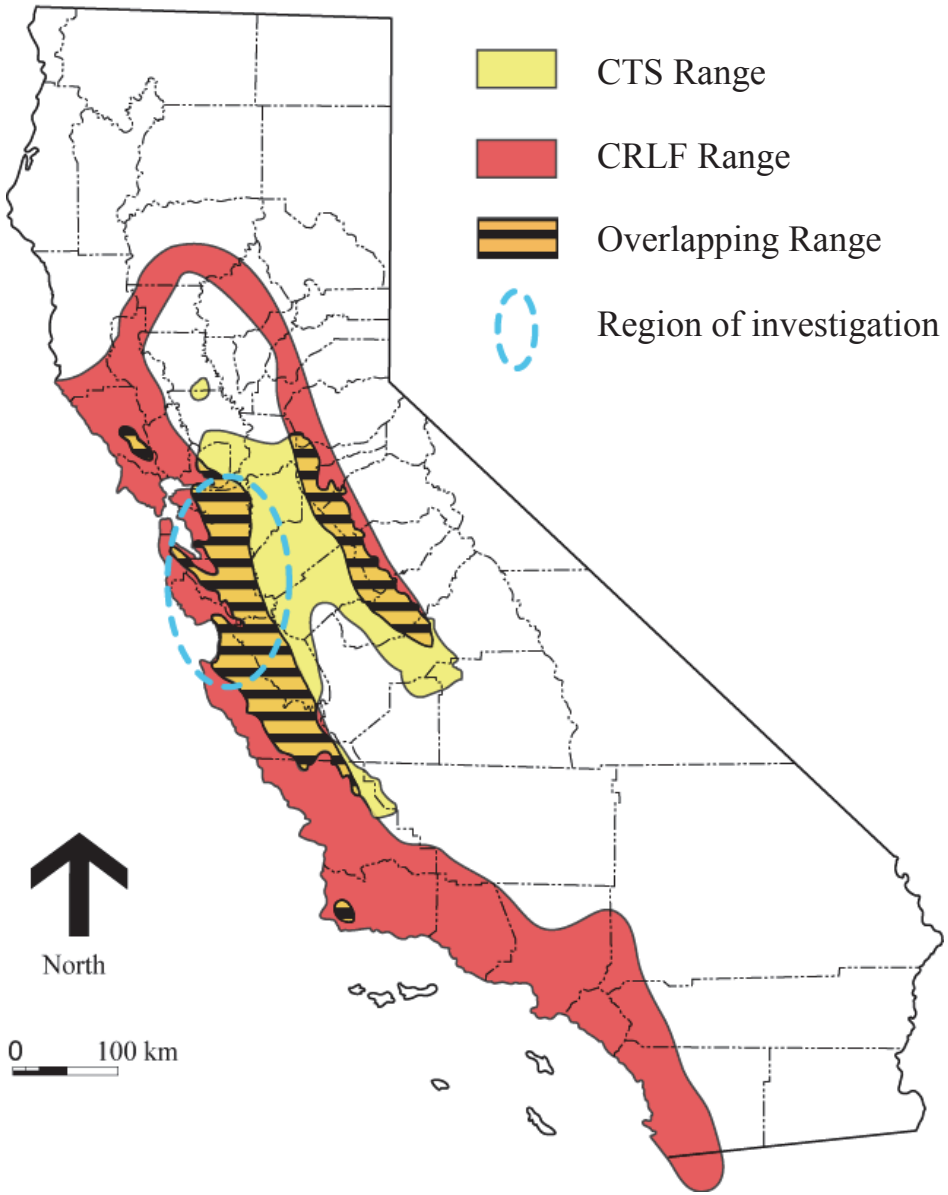

Figure 1.—The ranges of California tiger salamander (CTS) and California red-legged frog (CRLF), areas of overlapping range, and the region of our sites of investigation in Alameda, Amador, Butte, Calaveras, Colusa, Contra Costa, El Dorado, Fresno, Glenn, Kern, Kings, Lake, Los Angeles, Madera, Marin, Mariposa, Mendocino, Merced, Monterey, Napa, Nevada, Orange, Placer, Plumas, Riverside, Sacramento, San Benito, San Bernardino, San Diego, San Francisco, San Joaquin, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Solano, Sonoma, Stanislaus, Tehama, Tulare, Tuolumne, Ventura, Yolo, and Yuba, counties, California, 2012. Geographical distributions of CTS and CRLF were adapted from Fisher and Shaffer 1996, USFWS 2002, USFWS 2003, and Stebbins 2003.

Table 1.—Location and frequency of observed sympatry of California tiger salamanders (CTS) and California red-legged frogs (CRLF) in Alameda, Contra Costa, Monterey, and Santa Clara counties, California, 2012. The number of water bodies surveyed within each watershed (*n*) are categorized by major habitat type.

County	Watershed	Water Body	*n*	CTS and CRLF Sympatric
Alameda	Corral Hollow	stock pond	2	1
	Corral Hollow	creek	1	1
Contra Costa	Bethany	stock pond	11	10
	Brushy	creek	1	1
	Brushy	stock pond	9	6
	Cayetano	stock pond	4	1
	Kellogg	stock pond	90	76
	Marsh	stock pond	5	2
	Tassajara	stock pond	3	3
Monterey	Robinson Canyon	stock pond	5	3
	Potrero Canyon	stock pond	7	3
Santa Clara	Arroyo Aguaje	stock pond	42	4
	Las Animas	stock pond[a]	22	6
	Shingle Valley	stock pond[b]	18	11
Total			220	128

[a] four ponds in this watershed were categorized by MLA as "stock pond/impoundment"

[b] all ponds in this watershed were categorized by MLA as "stock pond/impoundment"

those characterized by large amounts of emergent vegetation (~75% cover) to no emergent vegetation (0% cover), as well as other characteristics. We made no effort, however, to analyze physical characteristics because we did not always measure those characteristics during the surveys. We included all ponds surveyed within a watershed without regard to a subjective standard for suitability. In most cases, investigators used seines and hand-held dip nets to capture specimens; occasionally, species were detected visually during site visits.

This investigation was not originally coordinated among the respective authors. Data sets from each author were collected in different or overlapping years, and our data were assembled by the lead author and analyzed *a posteriori*. Therefore, specific methodologies were not necessarily consistent among our respective sites. Some investigators used systematic timed surveys that were concluded if target species and numbers were collected, while other investigators dip-netted or seined a specific number of times per linear distance of pond edge. We also recognize that these species do not naturally occur in ponds to the extent we see them today, yet the majority of sites at which we focused survey efforts were of this habitat type. Further, we recognized the inherent bias in analyzing these disparate data, and acknowledge that our analyses may result in an underestimation of the phenomenon of overlapping breeding habitats.

Each investigator was able to identify larvae of both species during single survey efforts. On numerous occasions, both species were present within the same dip net or seine haul. Among the four counties in which we worked, the larvae of California tiger salamanders and California red-legged frogs were sympatric in 12% to 100% of water bodies investigated. When our data were combined, within the 218 ponds and two creeks, we detected sympatry between these two species at 58.2% of sites. We found California tiger salamanders and California red-legged frogs to be sympatric within breeding habitat in 12 watersheds in four counties in California in the same year.

Methodological differences could have resulted in the underestimation of aquatic breeding habitat overlap—a bias that may further indicate sympatry of breeding habitat between the two species. Our data generally came from observations conducted during other work, which resulted in some confounding factors, as follows: (1) California tiger salamanders rarely breed in creeks (Alvarez et al., in press), and we encountered them only while surveying for California red-legged frogs. Creek habitats were not surveyed with the same regularity, seasonal timing, and thoroughness as were ponds, and this may have caused us to underestimate co-occurrence in lotic habitat. (2) California red-legged frogs are only rarely observed in vernal pools, which often have short hydroperiods, so efforts to detect specimens in ephemeral pools may have underestimated their use of that habitat type. (3) In some pond habitats (i.e., warm-water ponds), the relatively compressed ontogeny of the California tiger salamander allows some individuals to reach a large size relatively early in the season. This is especially true in perennial ponds and under certain conditions where overwintering members of this species can grow very large (Alvarez 2004b, Wilcox et al. in press). These large individuals can, and will, feed on the larvae of anurans, and predation could contribute to an underestimate of the presence of California red-legged frogs (see Feaver 1971). (4) Perennial and long-lived ephemeral pond systems can accumulate large amounts of submergent aquatic vegetation, which can reduce detection rates of one or both species. Finally, (5) recent work has shown that California tiger salamanders can persist in uplands surrounding aquatic breeding habitat and may breed only intermittently (once in two to eight years), causing the species to be undetectable during aquatic breeding habitat surveys over multiple-years (Trenham et al. 2000; J. A. Alvarez and M. A. Shea, unpublished data).

In addition to breeding-period sympatry within the aquatic breeding habitat type, California red-legged frogs and California tiger salamanders, which are known to overwinter as larvae in separate locations, may also overwinter together (Fellers et al. 2001, Alvarez 2004b, Wilcox et al. in press). The presence of overwintering larvae of one or both species should be considered in the timing of management actions affecting aquatic breeding habitat or adjacent areas. Other management concerns, such as hydroperiod, extent of emergent vegetation, presence of potential predators, or intermittent breeding, may also vary between the two species. Nonetheless, our observations suggest that aquatic breeding habitat that is preserved or created within the range of both species—although frequently developed and managed for only one species—may well be utilized by both. In our aggregate observations we detected both species in the same aquatic breeding habitat 58.2% of the time, and over a large geographic area. This degree of overlap suggests that management techniques used for one species may very well benefit, or potentially harm, the other when both species are present. As a result, habitat requirements of both species should be carefully considered when developing or managing aquatic breeding sites, particularly ponds, within the overlapping range of these amphibians. Additional investigations may further validate the pattern

of sympatry among California tiger salamanders and California red-legged frogs within different aquatic habitats, and over a large area within their overlapping geographic ranges.

Acknowledgments

We are indebted to N. Parizeau for editorial assistance with a rewrite of the manuscript, and without whose assistance this work would not have progressed. We also acknowledge editorial suggestions from D. Laabs and anonymous reviewers, whose comments and suggestions improved the manuscript. We gratefully acknowledge The Nature Conservancy, Contra Costa Water District, and Santa Clara County Parks, for access to ponds.

Literature Cited

Allaback, M. L., D. M. Laabs, D. S. Keegan, and J. D. Harwayne. 2010. *Rana draytonii* (California red-legged frog). Dispersal. Herpetological Review 41:204.

Alvarez, J. A. 2004a. Use of artificial egg-laying substrate to detect California tiger salamanders (*Ambystoma californiense*). Herpetological Review 35:45-46.

Alvarez, J. A. 2004b. Overwintering California tiger salamander (*Ambystoma californiense*) larvae. Herpetological Review 35:344.

Alvarez, J. A., M. A. Shea, S. M. Foster, and J. T. Wilcox. In press. *Ambystoma californiense* (California tiger salamander). Atypical habitat. Herpetological Review.

Anderson, P. R. 1968. The reproductive and developmental history of the California tiger salamander. M.S. Thesis, Fresno State College, California, USA.

Bulger, J. B., N. J. Scott, and R. B. Seymour. 2003. Terrestrial activity and conservation of adult California red-legged frogs *Rana aurora draytonii* in coastal forests and grasslands. Biological Conservation 110:85-95.

Cook, D. G., and M. R. Jennings. 2007. Microhabitat use of the California red-legged frog and introduced bullfrog in a seasonal marsh. Herpetologica 63:430-440.

Fellers, G. M., A. Launer, G. Rathbun, S. Bobzien, J. Alvarez, D. Sterner, R. Seymour, and M. Westphal. 2001. Overwintering tadpoles in the red-legged frog (*Rana aurora draytonii*). Herpetological Review 32:156-157.

Feaver, P. E. 1971. Breeding pool selection and larval mortality of three California amphibians: *Ambystoma tigrinum californiense*, Gray, *Hyla regilla*, Baird, and *Scaphiopus hammondi hammondi*, Girard. M.S. Thesis, Fresno State College, California, USA.

Fisher, R. N., and H. B. Shaffer. 1996. The decline of amphibians in California's Great Central Valley. Conservation Biology 10:1387-1397.

Hayes, M. P., and M. R. Jennings. 1988. Habitat correlates of distribution of the California red-legged frog (*Rana aurora draytonii*) and the foothill yellow-legged frog (*Rana boylii*): implications for management. Pages 144-158 *in* R. C. Szaro, K. E. Severson, and D. R. Patton, editors. Proceedings of the symposium on the management of amphibians, reptiles, and small mammals in North America. U.S. Forest Service, General Technical Report RM-166.

Hayes, M. P., and M. R. Tennant. 1986. Diet and feeding behavior of the California red-

legged frog *Rana aurora draytonii* (Ranidae). Southwestern Naturalist 30:601-605.

Lannoo, M. (editor). 2005. Amphibian declines: the conservation status of United States species. University of California Press, Berkeley, USA.

Petranka, J. W. 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, D.C., USA.

Rathbun, G. B. 1998. *Rana aurora draytonii* (California red-legged frog). Egg predation. Herpetological Review 29:165.

Stebbins, R. C. 2003. A field guide to western reptiles and amphibians. Third edition. Houghton Mifflin Company, Boston, Massachusetts, USA.

Stebbins, R. C., and S. M. McGinnis. 2012. A field guide to amphibians and reptiles of California. University of California Press, Berkeley, USA.

Storer, T. I. 1925. A synopsis of the amphibia of California. University of California Publications in Zoology 27:1-342.

Trenham, P. C., H. B. Shaffer, W. D. Koenig, and M. S. Stromberg. 2000. Life history and demographic variation in the California tiger salamander (*Ambystoma californiense*). Copeia 2000:365-377.

Trenham, P. C. 2001. Terrestrial habitat use by adult California tiger salamanders. Journal of Herpetology 35:343-346.

Trenham, P. C., W. D. Koenig, and H. B. Shaffer. 2001. Spatially autocorrelated demography and interpond dispersal in the salamander *Ambystoma californiense*. Ecology 82:3519-3530.

Twitty, V. C. 1941. Data on the life history of *Ambystoma tigrinum californiense* Gray. Copeia 1941:1-4.

USFWS (United States Fish and Wildlife Service). 2002. Endangered and threatened wildlife and plants; listing of the central California distinct population segment of the California tiger salamander; proposed rule. Federal Register 68:28647-28670.

USFWS. 2003. Recovery plan for the California red-legged frog (*Rana aurora draytonii*). United States Fish and Wildlife Service, Portland, Oregon, USA.

Wang, I. J., W. K. Savage, and H. B. Shaffer. 2009. Landscape genetics and least-cost path analysis reveals unexpected dispersal routes in the California tiger salamander (*Ambystoma californiense*). Molecular Ecology 18:1365-1374.

Wilcox, J. T., G. E. Padgett-Flohr, and J. R. Johnson. In press. Does paedomorphosis occur in the California tiger salamander (*Ambystoma californiense*)? Southwestern Naturalist.

Received 31 July 2012
Accepted 18 December 2012
Associate Editor was L. Davis