California Fish and Game 103(2): 66-71; 2017

Traditional surveys may underestimate *Rana draytonii* egg-mass counts in perennial stock ponds

Jeffery T. Wilcox*, Marina L. Davies, Keith D. Wellstone, and Mary F. Keller

Sonoma Mountain Ranch Preservation Foundation, 3124 Sonoma Mountain Road, Petaluma, CA 94594, USA (JTW)

Department of Biology, 200 Darwin Hall, Sonoma State University, 1801 East Cotati Avenue, Rohnert Park, CA 94928, USA (MLD, KDW, MFK)

** Correspondent: jtwilcox@comcast.net*

Key words: California red-legged frog, *Rana draytonii*, ranid, depth, distance, egg mass, grazing, microhabitat, stock pond, survey

---

Understanding growth potential in populations is essential to the recovery of species in decline such as California red-legged frogs (*Rana draytonii*). Quantifying frog egg masses can be an effective method for estimating population trends of pond-breeding frogs, and a measure of habitat quality as well (Crouch and Paton 2000; Grant et al. 2005). Female ranids deposit one egg mass per breeding season (Storer 1925; Zweifel 1955), although poor environmental conditions may preclude breeding in any given year (Wells 1977). The relative reproductive output of each female is influenced environmentally (Ryser 1989; Veysey et al. 2011), and each egg mass represents energy redirected from growth and survival to the energy demands of vitellogenesis (provisioning egg yolks with nutrients) (Wells 2007). These energy needs are met by *R. draytonii*, at least partially, through foraging in uplands (Bishop et al. 2014). Annual egg-mass deposition may reflect not only population trends, but also the quality of foraging habitat near the immediate oviposition site. Radio-telemetry studies have demonstrated that female *R. draytonii* make extended terrestrial forays during summer and between the onset of seasonal rains in the fall and the winter breeding season (Tatarian 2008; Fellers and Kleeman 2007; Bulger et al. 2002). Tatarian (2008) hypothesized that female *R. draytonii* venture farther and longer than males to forage in order to meet the energetic needs of egg production.

Knowing where female frogs are likely to deposit egg masses is critical to quantifying annual oviposition. In a comprehensive report of *R. draytonii* egg-mass deposition sites, Alvarez et al. (2013) described microhabitats used for oviposition of 747 egg masses at eight localities in California, categorizing microhabitats within four major habitat types: artificial pond, artificial channel, natural creek, and seasonal marsh. Although attachment substrates varied widely throughout the four habitats (45 different substrates), Alvarez et al. (2013) found decadent cattail (*Typha spp*.) to be the preferred attachment site for *R. draytonii* in artificial ponds, such as stock ponds. Whatever the substrate, the distance from shore to the point of oviposition in all habitats was less than 1 m, except within the seasonal marsh habitat. The mean water depth at oviposition sites over all four habitats was 38 cm, and mean distance from the water surface to the top of submerged egg masses ranged from 9.5 cm to a maximum of 65 cm (Alvarez et al. 2013). Given the sample size and the broad range of habitat types, these parameters could be said to define only a narrow area in which investigators might be expected to find egg masses in the littoral zone of ponds and streams. Here, we report on new parameters for *R. draytonii* oviposition sites in two proximal artificial ponds over two winters, 2016 and 2017.

The Mitsui Ranch, owned and operated by the Sonoma Mountain Ranch Preservation Foundation, is a 256-ha working cattle ranch located atop Sonoma Mountain in Sonoma County, California (Figure 1). Approximately 60% of the property is located within designated California red-legged frog Critical Habitat Unit SON-2 (USFWS 2010). The ranch consists of more than 80% open rangelands, within which lie two perennial stock (artificial) ponds: Leaky Lake and Bonnie's Pond. *Rana draytonii* reproduce successfully each year on the ranch, but prior to February 2016 *R. draytonii* egg masses had only been detected in Bonnie's Pond (Figure 1). At nearby Leaky Lake, for several years, *R. draytonii* oviposition could only be inferred from the presence of larvae and metamorphic frogs. Leaky Lake has a maximum surface area of 0.5 ha and is relatively shallow (2.5–3.0 m). Bonnie's Pond has a surface area of 0.15 ha and the maximum depth is approximately 5 m. The littoral zone in both ponds is dominated (approximately 90% coverage) by stands of common spikerush (*Eleocharus macrostachya)*, and both have a few small patches of California bulrush (*Schoenoplectus californicus*) slightly deeper in the littoral zone that makes up the remaining 10% of emergent vegetation. In the season of oviposition,

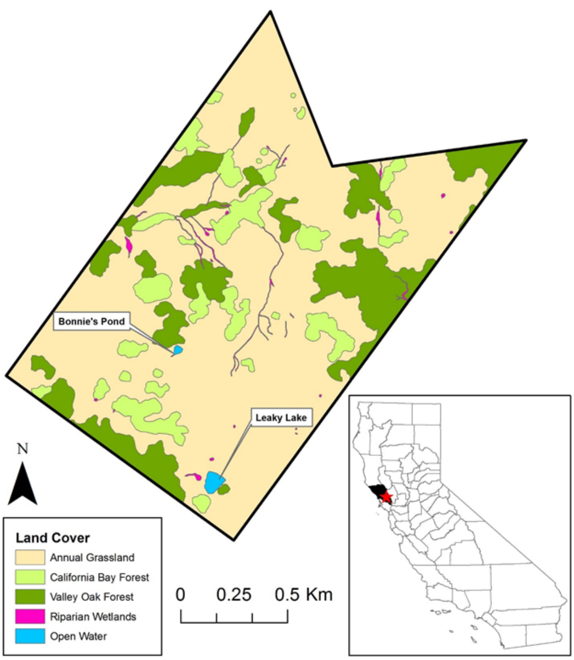

FIGURE 1.—*R. draytonii* breeding ponds and surrounding habitats on the Mitsui Ranch (Sonoma Mountain), Sonoma County, CA.

decadent littoral vegetation is inundated as reservoirs fill. Unless turbulence obscures visibility in the water column, much of the vegetative structure is visible beneath the water surface. At Leaky Lake on 29 February 2016, incidental to a student research project, a dark mass was detected associated with a submerged stand of decadent California bulrush many meters from shore. When investigated from a canoe, the dark area was found to be an attached egg mass of *R. draytonii*, located 12.2 m from shore at a water column depth of 3.2 m. We searched the lake's remaining stands of submerged California bulrush by canoe and discovered four additional egg masses. At each location we measured distance from shore, water column depth, and the water depth at top of egg mass (Table 1).

Table 1.—Oviposition parameters of 21 egg masses from two artificial ponds over two breeding seasons on the Mitsui Ranch.

	Depth at Oviposition (cm)		**Depth at Top of Egg Mass (cm)**		**Distance From Shore (m)**	
	Mean	Range	Mean	Range	Mean	Range
Leaky Lake (N=9)	210	50–320	38	10–72	5.9	0.8–12.2
Bonnie's Pond (N=12)	68	49– 84	38.5	0–73	5.82	1.7– 8.95

Our observations at Leaky Lake prompted a canoe search of nearby Bonnie's Pond that revealed an egg mass in California bulrush that had previously gone undetected due to its depth (38 cm) and distance (5.3 m) from shore. This winter (2017), we recorded 12 *R. draytonii* egg masses at Bonnie's Pond (none at Leaky Lake due to poor visibility), nine of which had not been detectable from shore. Of the three visible from shore, one was attached to a small (six stems) decadent California bulrush, and two were attached to common spikerush. Although some of the nine distant egg masses in Bonnie's Pond might have been detectable by wading into the shallow areas of the pond, this practice is discouraged by guidance measures issued by the U.S. Fish and Wildlife Service (USFWS 2005). The agency's protocol for surveying all life history stages of *R. draytonii* stipulates that "Surveyors should begin by first working along the entire shoreline, then by entering the water (if necessary and no egg masses would be crushed or disturbed), and visually scanning all shoreline areas and all aquatic habitats identified in the site assessment (USFWS 2005)."

At Leaky Lake, despite the dominant presence of common spikerush (Figure 2), female *R. draytonii* oviposited most often in stands of dead, submerged California bulrush that had been cropped by grazing cattle. Cattle are allowed access to the lake for a period of a few days each spring, and in 2016 had grazed the fresh growth of California bulrush leaves down to the water surface, leaving a "trimmed hedge" appearance. The following winter, when water levels in the pond increased (Figure 3), the grazed-down California bulrush formed a submerged wall of dead vegetation. Winter rains of 2017 resulted in prolonged high-water levels in ponds throughout the spring. Although cattle were allowed access to both ponds, they were not able to wade deep enough to crop emergent vegetation. As a result, the egg masses we discovered at Bonnie's Pond in 2017 were attached to submerged decadent California bulrush that had not been grazed by cattle. Our findings over two seasons of oviposition, suggests that in the two ponds surveyed, submerged dead, grazed and ungrazed California bulrush, is more often used by *R. draytonii* for oviposition sites than the far more abundant common spikerush (a posteriori: $\chi^2\alpha=01=6.64$; P=11.10; df=1); and that oviposi-

Figure 2.—Leaky Lake in July, showing common spikerush ringing the littoral zone with a few dense stands of tule in the deeper portion.

Figure 3.—Leaky Lake in early spring, when most littoral vegetation is inundated by rising water and cattle have cropped much of the tule growing close to shore when water levels were lower in late summer.

tion sites could occur at significantly greater distances from shore than previously thought.

Our discovery of previously undetected oviposition sites at two artificial stock ponds is significant because biologists and land managers may use egg-mass counts to estimate population size (Merrell 1968; Crouch and Paton 2000), since female ranid frogs lay one egg mass annually (Storer 1925; Zweifel 1955). Had we not deployed a canoe to search for egg masses in the two water bodies, we would have underestimated egg mass totals by 75% at Bonnie's Pond (9 of 12) in 2017, and by 77% at Leaky Lake (7 of 9) in 2016. This leads us to conclude that visual egg-mass surveys of artificial pond habitats conducted in the traditional way (on foot around the perimeter, or wading only into the shallows), may potentially underestimate the abundance of breeding female *R. draytonii* significantly. This is particularly likely when emergent vegetation grows distant from shore, in water too deep to wade or too turbid to permit detection from a distance.

Artificial stock ponds are common within the range of *R. draytonii* and are readily used as breeding habitat (USFWS 2002). However, such ponds are built in a wide variety of landscapes, with varying exposure, substrate type, basin shape, and maximum depth, and are colonized by highly variable plant communities. We found *R. draytonii* egg masses deposited well outside of parameters reported by Alvarez et al. (2013) for artificial ponds. Although our sample size is small (N=21), our findings suggest that the varying properties of artificial stock ponds may warrant the use of detection methods beyond shoreline foot surveys (that is, by wading out or by boat) to detect *R. draytonii* egg masses. This is particularly true in shallow ponds where rainfall may seasonally flood or inundate emergent vegetation, creating available oviposition sites far from shore. Water-level changes should therefore be considered when developing schedules and techniques for conducting egg mass surveys for this species. Also, surveys should be conducted during periods of low wind, when water turbidity is reduced and visibility maximized. Finally, like Alvarez et al. (2013), we found tall, robust aquatic plants (cattail in the case of Alvarez, California bulrush on Mitsui Ranch) to be the most frequently used attachment substrate for *R. draytonii* in artificial ponds. Although further study is required, allowing cattle (limited) access to ponds does not appear to eliminate subsurface oviposition structure—and may in fact create favorable deposition substrates for *R. draytonii* on well-managed sites. Finding egg masses at such deposition sites requires greater effort, but may yield a more accurate estimate of reproductive activity by *R. draytonii* on managed lands. Underestimating egg mass counts potentially misinforms management efforts and confounds efforts to understand how habitat quality relates to *R. draytonii* population recruitment.

Acknowledgements

We are grateful to the Sonoma Mountain Ranch Preservation Foundation for access to the Mitsui Ranch. J. Stolen and A. Rayburn created the map. I am grateful to J. Alvarez for his insightful discussions and support. Edits by J. Alvarez and N. Parizeau, and reviews by L. Patterson, D. Hacker, and M. van Hattem greatly improved this manuscript.

Literature Cited

Alvarez, J. A., D. G. Cook, J. L. Yee, M. G. Van Hattem, D. R. Fong, and R. N. Fisher. 2013. Comparative microhabitat characteristics at oviposition sites of the California red-legged frog (*Rana draytonii*). Herpetological Conservation and Biology 8(3):539–551.

Bishop, M. R., R. C. Drewes, and V. Vredenburg. 2014. Food web linkages demonstrate importance of terrestrial prey for the threatened California red-legged frog. Journal of Herpetology 48:137–143.

Bulger, J. B., N. J. Scott, Jr., and R. B. Seymour. 2002. Terrestrial activity and conservation of adult California red-legged frogs (*Rana aurora draytonii*) in coastal forests and grasslands. Biological Conservation 10:85–95.

Crouch, W. B., and P. W. C. Paton. 2000. Using egg mass counts to monitor wood frog populations. Wildlife Society Bulletin. 28(4):895901

Fellers, G. M., and Kleeman, P. M. 2007. California red-legged frog (*Rana draytonii*) movement and habitat use: implications for conservation. Journal of Herpetology. 41:276–286.

Grant, E. H. C., R. E. Jung, J. D. Nichols, and J. E. Hinds. 2005. Double observer approach to estimating egg mass abundance of pool-breeding amphibians. Wetlands Ecology and Management. 13(3):305–320.

Merrell, D. J. 1968. A comparison of the estimated size and the "effective size" of breeding populations of the leopard frog, *Rana pipiens*. Evolution 22(2):274-283.

Ryser, J. 1989. Weight loss, reproductive output, and the cost of reproduction in the common frog, *Rana temporaria*. Oecologia 78(2):264–268.

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

Tatarian, P. J. 2008. Movement patterns of California red-legged frogs (*Rana draytonii*) in an inland California environment. Herpetological Conservation and Biology 3:155–169.

USFWS (United States Fish and Wildlife Service). 2002. Recovery Plan for the California red-legged frog (*Rana aurora draytonii*). Portland, Oregon, USA

USFWS. 2005. The Revised Guidance on Site Assessments and Field Surveys for the California Red-legged Frog. U. S. Fish and Wildlife Service, Sacramento, CA. Available at: https://www.fws.gov/sacramento/es/survey-protocols-guidelines/documents/crf_survey_guidance_aug2005.pdf

USFWS. 2010. Endangered and Threatened Wildlife and Plants; Revised Designation of Critical Habitat for the California Red-legged Frog. Federal Register 75(51):12816-12959. Available at: https://www.gpo.gov/fdsys/pkg/FR-2010-03-17/pdf/2010-4656.pdf#page=2.

Veysey, J. S., S. D. Mattfeldt, and J. Babbitt. 2011. Comparative influence of isolation, landscape, and wetland characteristics on egg-mass abundance of two pool-breeding amphibian species. Landscape Ecology. 26(5):661–672.

Wells, K. D. 1997. The social behaviour of anuran amphibians. Animal Behaviour 25:666–693.

Wells, K. D. 2007. The ecology and behavior of amphibians. University of Chicago Press. Chicago, USA.

Zweifel, R. G. 1955. Ecology, distribution, and systematics of frogs of the *Rana boylii* group. University of California Publications in Zoology 54:207–292.

Received 13 February 2017
Accepted 28 March 2017
Associate Editor was L. Patterson