Western Wildlife 6:45–49 • 2019
Submitted: 12 July 2019; Accepted: 11 October 2019.

Notes

California Red-Legged Frog Response to Pond Restoration

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***Abstract.*—The California Red-legged Frog (*Rana draytonii*) is federally listed as threatened. Habitat alteration is a significant contributing factor in their decline. Pond restoration and enhancement efforts are tools that can reverse this trend by improving habitat conditions that support recovery goals for the species. We removed excess sediment and emergent vegetation at the Garin Newt Pond Wildlife Area in central California to determine if these actions benefited this species. After sediment removal in 2017, the hydroperiod of the pond improved resulting in California Red-legged Frog egg masses and tadpoles increasing by 99% and 97%, respectively, compared to 2008–2016. We also found significant increases in number of adult and larvae sampled pre-restoration (2008 to 2017) and post-restoration (2018 to 2019). Although only one pond, this site-specific information on California Red-legged Frog response to pond hydroperiod improvements in a central California rangeland may assist recovery efforts designed to preserve and manage habitat for this threatened species.**

Key Words.—amphibian breeding; conservation; pond hydroperiod improvements; *Rana draytonii*

The California Red-legged Frog (*Rana draytonii*) was once abundant in central California, ranging from the coast to the Sierra Nevada foothills, but is now considered a threatened species (U.S Fish and Wildlife Service [USFWS] 1996). This frog inhabits permanent and seasonal water sources (streams, lakes, marshes, natural and human-made ponds, and ephemeral drainages) in valley bottoms and foothills up to 1,500 m in elevation (Bulger et al. 2003; Jennings and Hayes 1994). The terrestrial habitat used by this species generally includes an abundance of cover (e.g., burrows, wood debris, and vegetation) in close proximity to water (Fellers and Kleeman 2007; Tatarian 2008; USFWS 2002). Its diet is dependent on prey availability, but mostly consists of terrestrial invertebrates (Bishop et al. 2014).

Breeding adult California Red-legged Frogs (Fig. 1) make use of a variety of aquatic habitats, while larvae use streams, deep pools, and the backwater areas of creeks, ponds, marshes and lagoons (Thomson, et al. 2016). Livestock ponds commonly serve as breeding sites when they provide the proper hydroperiod and pond and vegetative structure (Ford et al. 2013). From November through April, breeding adults may be observed in still or slow-moving water with light to dense riparian or emergent vegetation, such as cattails (*Typha* spp.), tules (*Scirpus* spp.) and willows (*Salix* spp.; Hayes and Jennings 1988). Their egg masses are attached to plants below the surface of the water and hatch after 6–14 d (Jennings and Hayes 1994; Storer 1925). Following hatching, larvae undergo metamorphosis within 3.5–7 mo and reach sexual maturity at 2–3 y of age (Thomson et al. 2016; Jennings and Hayes 1994).

The California Red-legged Frogs is the largest native frog in California but has disappeared from over 70% of its historical range (Fisher and Shaffer 1996; Hayes and Jennings 1986). Major factors that have contributed to this decline include habitat loss, habitat fragmentation, and introduction of the invasive American Bullfrog (*Lithobates catesbeiana*; Hayes and Jennings 1986; Lawler et al.1999). Altered pond sedimentation loading and inundation period are two other leading stressors associated with amphibian declines (Richter et al. 1997).

Restoration efforts aimed at improving the conditions for native species should be judged by how successful wildlife species respond to such attempts (Morrison

Figure 1. California Red-legged Frog (*Rana draytonii*) from the Garin Regional Park, California. (Photographed by Daniel I. Riensche).

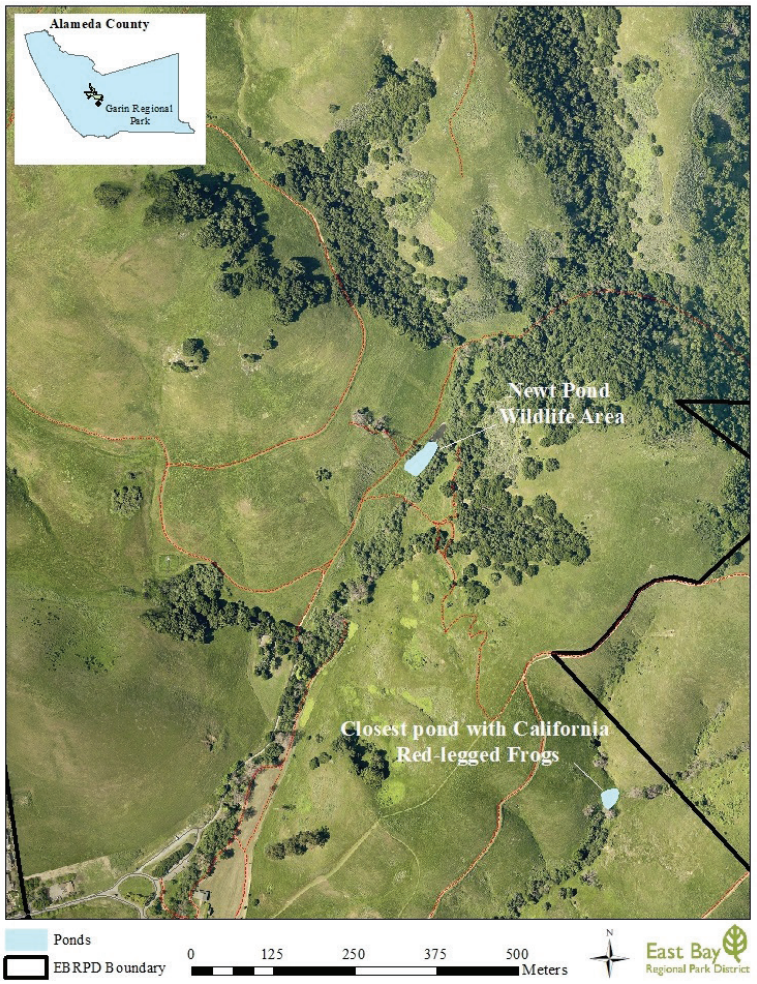

Figure 2. Site map of the Garin Regional Park, Hayward, California, where we conducted a pond restoration project at the Newt Pond Wildlife Area.

2002). The benefits of restoration may increase over time due to system stability and generation succession (Rowe and Garcia 2014). After almost a decade (2008–2016) of us observing only the occasional adult California Red-legged Frog in the seasonal pond known as the Garin Newt Pond Wildlife Area (GNPWA; managed by the East Bay Regional Park District) with no evidence of reproduction except in the 2017 season, we embarked on an effort to improve the breeding habitat and larvae survival of the species. Here we report on how the California Red-legged Frog responds to improved pond hydroperiod resulting from the removal of excess sediment and emergent vegetation.

We studied frogs at the GNPWA (37°38'7.02"N, 122°1'28.44"W), which is part of the Garin Regional Park (a wildlands area) located in Hayward, California (Fig. 2). This lentic environment (0.2 ha) is situated between the transition of Oak Woodland, Grassland, and Riparian habitat types. Earning its name from its importance to California Newts (*Taricha torosa*), Auza (1969) reported that more than 1,600 newts annually traveled 3.2 km (2 mi) or more to breed at the GNPWA. Other wildlife species making use of this seasonal pond area included: Black-tailed Deer (*Odocoileus hemionus*), Golden Eagles (*Aquila chrysaetos*), Western Fence Lizards (*Sceloporus occidentalis*), Pacific Tree Frogs (*Pseudacris regilla*), and California Red-legged Frogs (Cogswell 1966; Samuel McGinnis, unpubl. report). This site is within the California Red-legged Frog critical habitat unit ALA-1B (USFWS 2010). Due to the seasonal nature of the pond, there are no American Bullfrogs found at this site.

We conducted surveys for all life stages of the California Red-legged Frog from 2008 to 2019, from January through June, using the standardized habitat assessment and protocol-level survey guidelines (USFWS 2005). Daytime visual encounter surveys for egg masses and adults occurred twice monthly (January through June, ≥ eight visits), with no more than 14 d between visits (we did not conduct nighttime surveys). During these assessments, we used binoculars (10 × 42 mm) to search the pond bank, water, floating and emergent vegetation, and woody debris, to sight adult frogs or egg masses.

Due to staffing limitation, from 2008–2019, we conducted one survey annually in the pond for the presence of larval amphibians (in early May). Prior to restoration, the

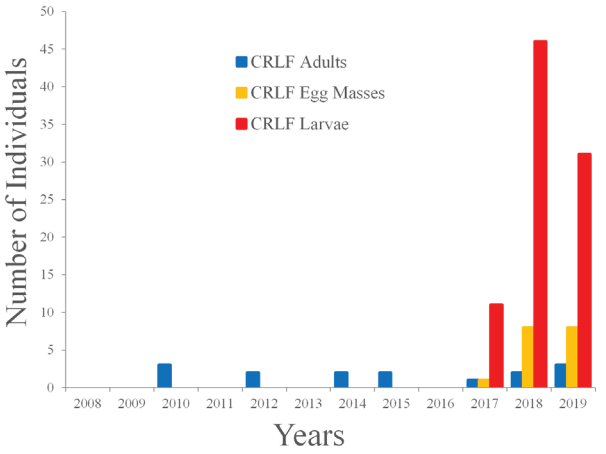

Figure 3. Adults, egg masses, and larvae of California Red-legged Frog (*Rana draytonii*; CRLF) at the Newt Pond Wildlife Area, California, before (2010–2017) and following pond restoration (2018–2019).

GNPWA pond was very shallow (ranging from 0.25–0.5m in depth), choked with Cattails (100% vegetative cover), and did not maintain water throughout the spring (the pond typically dried by mid-to-late June) and supported few adult frogs (Fig. 1). Due to the exceptional rainfall in 2017, when the site received 150% of its normal annual precipitation (https://water.weather.gov/precip/index), this was the only record of larval production in a decade (Fig. 2). In all years, we sampled the pond using D-shaped (radius 23 cm), long-handled dipnets (3.2 mm mesh). Dipnet sweeps consisted of moving a net 1.5 m through representative portions of aquatic features, thus sampling 28 L of larval amphibian habitat per sweep. To minimize disturbance of pond flora and fauna, we stopped sampling after 10 dipnet sweeps if we found California Red-legged Frog tadpoles. We recorded all life stages of frogs, the number of individuals found, and size classes.

The pond restoration efforts that occurred September 2017 included the removal of 199 m3 of sediment and cattails by use of a long-reach excavator, loader, and dump truck. We dredged to improve the hydroperiod of the pond to make it 1–1.5 m in depth (from early April into mid-May) and to remove upwards of 80% of the vegetative cover (thick stand of cattails that covered 100% of the pond surface area). After dredging, the pond held water into late July and early August in 2018 and 2019. We collected population data preceding and following the restoration by using the systematic survey protocols (see above). To compare the reproductive output (average number of egg masses and larvae) before (2008–2017) and after (2018–2019) restoration, we used a two-sample *t*-test with $\alpha = 0.05$. Since the restoration effort in the fall of 2017, the California Red-legged Frog population at the GNPWA significantly increased in the average number of egg masses ($t = -5.73$ df = 10, $P < 0.001$) and the average number of larvae ($t = -6.27$, df = 10, $P < 0.001$; Fig. 3).

Excess emergent vegetation is recognized as creating detrimental habitat conditions for the reproductive output of California Red-legged Frogs because it prevents the surface water from reaching suitable temperatures for larvae development (Norman Scott, pers. comm.). Further, sediment removal can create greater seasonal pond depth, thus increasing the inundation period during the spring and early summer, and its potential for successful native amphibian development. American Bullfrogs tend to inhabit ponds changed in some way by humans and they breed in perennial ponds (D'Amore et al. 2010; Doubledee et al. 2003). Apparently, de-sedimentation and the removal of excessive emergent vegetation in seasonal ponds favors the California Red-legged Frog because this species tends to breed and lay its eggs in deep water (Natural Resources Conservation Service 2006; Bradely Shaffer and Robert Fisher, unpubl. report).

To restore a successful breeding population of California Red-legged Frogs at the GNPWA, we removed sediment and cattails to increase the overall depth of the pond and lengthened the amount of time water would be held in this seasonal pond, until early summer. Restoration at this one pond increased the number of egg masses and larvae of California Red-legged Frogs over the two-years following this action, suggesting that regular pond maintenance (sediment and emergent vegetation removal) can be an effective management tool that may benefit this threatened species at similar aquatic sites. Generally, a pond restoration project with the appropriate operations and maintenance has a lifespan of about 20 y (Jackie Charbonneau, pers. comm.).

Such restorative efforts may increase benefits over time because frogs born in a certain pond are likely to remain and have offspring of their own in the same location. Tatarian (2008) reported that most tagged California Red-legged Frogs in her study did not migrate from their source pool over two seasons. Likewise, Feller and Kleeman (2007) reported that only a few of the 123 California Red-legged Frogs studied in Marin County, California, moved farther than the nearest suitable non-breeding habitat. In their study, the furthest distance traveled was 1.4 km and most dispersing frogs moved through grazed pastures to reach the nearest riparian habitat (Feller and Kleeman 2007). Bulger et al. (2003) suggested that breeding sites should take priority in restoration planning because they will allow the species to recover in population size.

Acknowledgments.—Survey efforts and equipment were largely funded by the Regional Parks Foundation, Alameda County Fish & Wildlife Commission, USFWS Partners for Fish & Wildlife Program, and the California Department of Fish and Wildlife. We would also like to express gratitude to many individuals that contributed to this work: N. Beadle, J. Dorcy, A. Dwyer, J. Geoghegan, S. Gidre, T. Groff, N. Hector, S. Lockett, C. Newell, M. Orcutt, M. Pearson, M. Peixoto, M. Riensche, S. Riensche, D. Riensche, N. Riensche, R. Riensche, B.

Singleton, R. Smith, B. Surges, M. Tinoco, and B. Wainwright. This work was conducted in accordance with the terms and conditions of U.S. Fish and Wildlife Service permit #TE-817400-12 and the California Department of Fish and Wildlife permit #SC-2298, California Regional Water Quality Control Board San Francisco Bay Region -CIWQS Reg. Meas. 406893 & CIWQS place ID 825468, USFWS BO Permit No. 08ESMF00-2016-F-2130, VLP Permit No. 2086-2012-001-03, and California Department of Fish and Wildlife-Final Lake or Streambed Alteration Agreement Notification No. 1600-2016-0188-R3.

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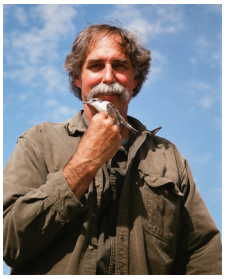

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Connor D. Tutino earned his Bachelor of Science from California State University, East Bay, in 2019. He worked as a Wildlife Intern for the East Bay Regional Park District in 2018 and 2019. During this time, he gained experience working with California Red-legged Frogs, Bald Eagles (*Haliaeetus leucocephalus*), Western Snowy Plovers (*Charadrius alexandrines nivosus*), and California Least Terns (*Sterna antillarum browni*). (Photographed by David L. Riensche).

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