

Use of Novel Upland Refugia by Foothill Yellow-legged Frogs in the San Benito River Watershed, California

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Population declines in the Foothill Yellow-legged Frog (*Rana boylii*) have led to California State and federal listing (CDFW 2020, USFWS 2023). The Foothill Yellow-legged Frog has been the focus of much work related to habitat use, with the majority of work specifying that the species is a lotic habitat obligate (Storer 1925, Zweifel 1955, Kupferberg 1996, Bourque 2008). More recently Alvarez and Wilcox (2021) found that lentic habitats are also used by this species for both refuge and breeding. Nevertheless, whether associated with lotic or lentic habitats, limited reporting has resulted in a paucity of information on the upland habit use by this species. Zweifel (1955) wrote, when characterizing Foothill Yellow-legged Frog behavior, that they could be found “two hops” from the water. However, Nussbaum et al. (1983) found adult Foothill Yellow-legged Frogs up to 50 m from flowing water, and Cook et al. (2010) encountered Foothill Yellow-legged Froglets apparently dispersing 331 m from their natal stream. Bourque (2008) tracked Foothill Yellow-legged Frogs using radio telemetry and noted that males and females were found in upland areas 38% and 66% of observations, respectively. Bourque (2008) also indicated that uplands appear critical for seasonal use of habitat for this species, yet it is seldom studied or reported (Thomson et al. 2016). Further, Alvarez et al. (2023) reported on novel upland microhabitat where Foothill Yellow-legged Frogs were frequently found in small bedrock niches adjacent to a perennial river. Nevertheless, the emerging revelation that Foothill Yellow-legged Frog habitat extends far beyond two hops from water, and deeper into upland areas than formerly thought, does little to explain how the frogs interact with these surroundings. Here we report on observations of upland habitat use by *R. boylii*, and specifically, use of woodrat (*Neotoma* sp.) houses as upland refugia.

We conducted daytime and nighttime visual encounter surveys for Foothill Yellow-legged Frogs along a perennial section of Clear Creek—tributary to the San Benito River. The 1.1 km (0.68 mi) surveyed section began at the Clear Creek Campground and was directed upstream to an arbitrary stopping point. The creek in that portion of the run, was approximately 1 m (3.2 ft) across, and ranged from several centimeters deep to approximately 1 m (3.2 ft) deep. The creek bed alternated from areas of 100% imbedded

conglomerated rock and ancient muds to areas with a bedrock base with patches of small, scattered cobble and pebble. Banks were lined with shrubby vegetation and patches of annual grasses, intermixed with single trees and large rock outcrops. The habitat adjacent to the creek was primarily chamise chaparral inter-mixed with gray pines (*Pinus sabiniana*). Our surveys were conducted by biologists walking the margins of the creek. Surveys during the daytime efforts were conducted with binoculars, while night surveys included binoculars and 450-lumen hand-held flashlights.

During our surveys, post-metamorphic young-of-the-year Foothill Yellow-legged Frogs, and adults, were found at a rate of approximately 1 frog per 10 m. During the daylight survey, we encountered a single adult Foothill Yellow-legged Frog facing the stream on the wet edge of the creek. As we approached, it abruptly turned away from the water and faced away from the water. It then hopped directly toward (in a single hop) a woodrat nest that lay adjacent to the creek and that was intermixed with Brewer’s willow (*Salix breweri*). The frog took an immediate second leap directly toward an entryway in the woodrat house and then made several small hops into the entryway, eventually finding refuge well within the structure (Fig. 1).

Based on this experience, as we moved upstream, we encountered a second woodrat house that was constructed at the base of a gray pine approximately 2 m (6.5 ft) upland of the creek. While we visually investigated the interstices—using care not to disturb the nest—we found an adult Foothill Yellow-legged Frog approximately 10 cm (3.9 in) deep in the mix of branches, well within the outer layer of the woodrat house (Fig. 2). The frog was perched on small branches within the structure, suggesting that it climbed to that location.

Our observations are significant for several reasons. First, when aquatic habitat is shallow, drying, intermittent, or absent, frogs have the ability to seek refuge in the numerous woodrat houses and other refugia that are found in riparian areas. The first frog we encountered sought refuge (facultatively) from potential predators (i.e., us), choosing the interstices of a nearby woodrat house over the more proximate refuge of the stream-covered cobbles. Terrestrial habitats, no matter their proximity to

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Fig. 1. Jeffery T. Wilcox investigating a woodrat house intermixed with Brewer's willow (*Salix breweri*) adjacent to Clear Creek where an adult Foothill Yellow-legged Frog sought refuge, San Benito County, California. Photo by Jeff A. Alvarez.

water, appear to provide refuge, food, and structure to support development of recently transformed frogs to adulthood in addition to supporting adults between annual breeding periods (Burrow and Lance 2022). Second, vegetation structure, in particular, may afford protection from predators, refuge from thermal challenges, and surfaces from which to glean insect or vertebrate prey (Burrow and Maerz 2022). Wilcox and Alvarez (2019) reported on the climbing ability of Foothill Yellow-legged Frogs, which were observed to climb a wet, vertical concrete surface. Alvarez et al. (2023) later reported that the climbing ability of this species was exceptional under many circumstances. Here, we witnessed a Foothill Yellow-legged Frog adult that almost certainly climbed into the interwoven external structure of the second woodrat nest high above and away from a stream. We can only speculate the frog's purpose in seeking out these types of locations because reports on the upland behavior and habitat use of this species are rare.

Finally, in many places, woodrat houses are common along the landscape gradient away from ponds and streams (pers. obs.) Although not investigated here, there may also be a microclimate benefit in some woodrat houses, which may provide a humid refuge (Peterman et al. 2012) to frogs that



Fig. 2. Foothill Yellow-legged Frog seeking refuge on small twigs approximately 1 m high and 10 cm deep into the outer edge of a woodrat house along Clear Creek, San Benito, County, California. Photo by Pedro Garcia.

utilize them. They could greatly add to the successful movement of the species through the terrestrial matrix of habitats that support potential predators and provide important steppingstone refugia (Stemle et al., in press), with elevated humidity, to avoid desiccation.

We are aware that woodrat house removal or relocation is a common activity as part of mitigation activities. These activities are often guided or permitted by resource agencies following CEQA analysis that is expected to conserve one or more special-status subspecies. At Clear Creek, San Benito County, two or more species likely co-occur/hybridize/converge (i.e., *Neotoma macrotis*, *N. bryanti*, and *N. fuscipes*; Wilson et al. 2017), with one of the subspecies considered a species of special concern by the California Department of Fish and Wildlife (CDFW Special Animals List: <https://wildlife.ca.gov/Data/CNDDB/Plants-and-Animals>). We contend that agencies should use caution when woodrat houses designated for removal or relocation are in areas where Foothill Yellow-legged Frogs are known or suspected to occur and should consider those houses potentially occupied by Foothill Yellow-legged Frogs. Specific permitting should be part of any removal plan where Foothill Yellow-legged Frogs are anticipated or known to occur.

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Acknowledgements—We are grateful to Allister Dobson, Allie Sennett, Armando J. Valencia, Bianca Ramirez, Christian Knowlton, Morgan Broad, Ross Wilming, Samuel Kille, Sofía C. Zaragoza, and Wyatt Petersen for field assistance and capturing Foothill Yellow-legged Frogs. Rebecca Cosmoro assisted us with the identification of plants for this manuscript. We also acknowledge permits from the USFWS and CDFW for both Jeff Alvarez (ES-027427 and SCP-192240005, respectively), and for Jeff Wilcox (TE-069745).

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