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Upwardly mobile: vertical movement of California red-legged frogs (*Rana draytonii*) and its management implications

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The natural history of the California red-legged frog (*Rana draytonii* Baird and Girard, 1852) has been studied since the early twentieth century (e.g., Storer, 1925). Since 1996, the species has received significant attention from researchers due to its special status as a federally threatened species in the western United States (USFWS, 2003). Many natural history accounts describe unique behaviours of *R. draytonii* that might collectively contribute to the recovery of populations of this species (Rathbun, 1998; Cook and Jennings, 2007; Fellers and Wood, 2004; Alvarez, 2005; Allaback et al., 2010). In addition, some information was obtained experimentally at percolation ponds in San Luis Obispo County, California, where Rathbun et al. (1997) tested the ability of telemetry-monitored *R. draytonii* to surmount a plastic mesh fence (a Tensar polygrid windbreak). The results were inconclusive because even though radiotelemetry showed that the frogs moved from one side of the barrier to the other, the researchers did not directly observe the frogs' movements. The team inferred the species' ability to cross the barrier only using radio-tracking evidence. Semonsen (2017) reported a single adult *R. draytonii* perched at the top of a metal-mesh fence approximately 0.6 m above the water surface. Here we report additional episodes of *R. draytonii* on unexpected, elevated perches, observed serendipitously during mitigation monitoring and control of American bullfrogs, *Lithobates catesbeianus* (Shaw, 1802), in the lower Kellogg Creek watershed, Contra Costa County, California, USA.

During survey and control efforts of *L. catesbeianus* from 1998–2013, we routinely observed *R. draytonii* as well as other sympatric amphibian and reptile species using the immediate upland areas surrounding Kellogg Creek (Fig. 1). Our survey methods consisted of a two-person team walking along the channel and upper bank of the creek, first during daylight and then at night on the same day. We commonly observed *R. draytonii* on the upper terrace of the deeply incised creek, outside of and above the channel. Our observations ranged from approximately 10 s to more than 10 min, and frogs often remained motionless unless inadvertently disturbed by our proximity. When disturbed, frogs invariably leapt toward the open water of the creek, which could be as far as 3.5 m below their perch. This behaviour typically occurred during night surveys, most frequently when temperatures were ≥ 10°C (50°F). Additionally, during night surveys we frequently encountered *R. draytonii* perched atop small earthen terraces of the steep creek bank and facing the open water, at heights ranging from 1–3 m above the stream surface and on banks with an incline as steep as 73°.

We documented an additional type of vertical movement in 2012, when on numerous occasions we observed *R. draytonii* perched in the upper third (approximately 1.6 m above ground) of dense patches of Olney's three-square bulrush (*Schoenoplectus americanus*) approximately 1.7 m above the soil/water surface of the creek (Fig. 2). At one creek pool we found six adult frogs perched atop the bulrushes during a 5-min scan of the area (Fig. 3). We surmised that these individuals had moved up along intersecting bulrush stems and settled near the tops of the plants, where we observed them. We speculate that the advantage of these high perches is twofold. First, the frogs gain access to a different suite of invertebrate prey while avoiding competition and/or predation from bullfrogs at the water surface (see Bishop et al., 2014). Second, the frogs likely decreased predation risk from raccoons (*Procyon lotor*), which are abundant in the habitat.

Despite the decline of many populations of *R.*

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Figure 1. Kellogg Creek and immediate upland areas, Contra Costa County, California, USA, showing steep banks and upper creek terrace. Red arrows indicate typical locations of *Rana draytonii* on steep banks. Photo by J.A. Alvarez.

draytonii, this species is abundant within the Kellogg Creek watershed (USFWS, 2003). *Rana draytonii* uses numerous microhabitats, including cracks at the bottoms of dry ponds, beaver dams and lodges, rodent burrows, and deep cattle-hoof prints (Alvarez, 2004; Alvarez et al., 2013; Wilcox, 2012). Our observations suggest that *R. draytonii* also uses steep portions of creek banks and the tops of intersecting or matted stems of tall emergent vegetation as foraging and/or refuge sites.

We propose that vertically directed movements of *R. draytonii* should definitely be considered when conducting mitigation monitoring or presence/absence surveys for this species, as observers could underestimate numbers of extant individuals if the entire focus of the surveys is on the wetted or ponded aquatic habitat. Furthermore, our observations validate the ability of *R. draytonii* to reach higher perches, but in contrast to the reports by Rathbun et al. (1998) and Semonsen (2017), frogs at our site ascended natural structures in the habitat. We contend that any anthropogenic structures installed as purposeful barriers to the movement of this species (i.e., those used at construction sites) should be tested for climbability. These frogs' ability to overcome or use vertical structures should be considered prior to and during landscape management actions, restoration efforts, and survey methodologies that might impact microhabitat for this threatened species.

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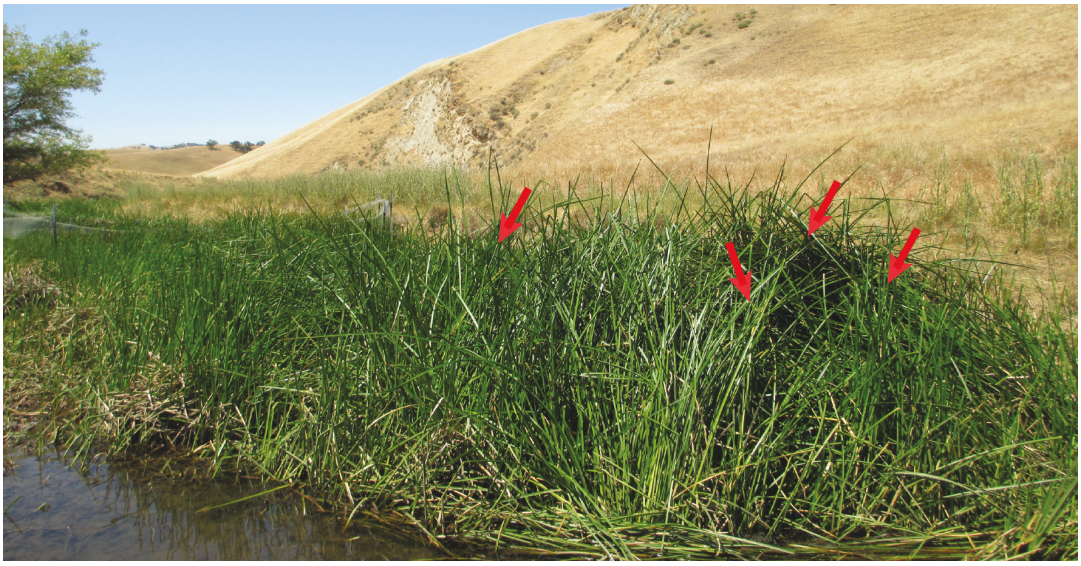

Figure 2. Stand of *Schoenoplectus americanus* in Kellogg Creek, Contra Costa County, California, USA, where *Rana draytonii* were found to perch. Red arrows indicate typical locations of *Rana draytonii*. Photo by J.A. Alvarez.

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Figure 3. *Rana draytonii* perched 1.6 m above the ground, in a patch of *Schoenoplectus americanus*, Contra Costa County, California, USA. Photo by J.T. Wilcox.

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