

*Rana draytonii* Baird and Girard, 1852(b)

## CALIFORNIA RED-LEGGED FROG

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**1. Historical versus Current Distribution.** California red-legged frogs (*Rana draytonii*) once ranged throughout the Sierra Nevada foothills and Coast Range Mountains (south of Elk Creek, Mendocino County) in California (M.R. Jennings, 1995; H.B. Shaffer et al., 2004). These frogs also were found in northwestern Baja California, Mexico, south to the San Domingo River drainage (Linsdale, 1932). It is unlikely that populations of California red-legged frogs persisted on the floor of the Central Valley due to extensive flooding that occurred during heavy winter storms or during spring snowmelt.

The current distribution is considerably smaller. There are only five–six known populations in the Sierra foothills, ranging from Butte to El Dorado County. All of the Sierra populations were discovered in 1997 or later (Barry, 1999; personal observations). A small population found near Coulterville in 1992 (Drost and Fellers, 1996) was apparently extirpated by 1993, but it is always difficult to confirm the absence of a species. In the central California coast range, California red-legged frogs are still present throughout much of their former range, though the number of extant populations has been reduced substantially by the loss of suitable habitat. In southern California (south of Santa Barbara) there are only two extant populations.

California red-legged frogs have been introduced in Ely, Nye, and White Pine counties in Nevada (Green, 1985a; Reaser, 2003), but the populations are largely inaccessible, and their current status is uncertain (A. Cook, personal communication). There is a 1919 record of an introduced population near Pelican Bay on Santa Cruz Island off Southern California (Jennings, 1988c), but that population has not existed for more than 50 yrs and probably died out shortly after 1919 (P. Collins, personal communication).

**2. Historical versus Current Abundance.** California red-legged frogs were once abundant throughout much of California (Jennings and Hayes, 1985). Now the species is nearly extirpated in both the Sierra Nevada foothills and in the southern 1/4 of its range. The Sierra Nevada populations consist of one site in El Dorado County with < 10 frogs (and no reproduction in 1999), one site in Yuba County with < 5 adult frogs, and another site in Butte County with < 25 adult frogs (Barry, 1999; personal observations). The two southern California populations consist of one site in Riverside County with < 10 frogs (U.S.F.W.S., 1999b) and one site in Ventura County with < 25 adult frogs. The status of California red-legged frogs in Mexico is uncertain, but single frogs were caught in

the Sierra San Pedro Martir of Baja, California, in both 1997 and 1998 (B. Christman, personal communication). It is unlikely that populations south of Santa Barbara County will survive without intervention, and perhaps not even then.

In a few parts of the central coast range, there are still large, vigorous populations of California red-legged frogs, some of which probably rival what was present 200 yr ago. The largest populations are in Marin County (north of San Francisco), where there are > 120 breeding sites with a total adult population of several thousand frogs. Most of these sites are artificial stock ponds constructed on lands that have been grazed by cattle for 150 yr.

Though not as concentrated, there are good populations elsewhere in the San Francisco Bay area (especially Alameda and Contra Costa counties) and in the coastal drainages from San Mateo County (just south of San Francisco) south to Santa Barbara County. One of the largest single populations consists of an estimated 350 adult frogs at Pescadero Marsh (San Mateo County).

## 3. Life History Features.

**A. Breeding.** Reproduction is aquatic.

i. Breeding migrations. California red-legged frogs do not have a distinct breeding migration. Adult frogs are nearly always associated with permanent bodies of water. Some frogs remain at breeding sites all year while others disperse. Dispersal distances are typically < 0.5 km, with a few individuals moving up to 2–3 km (G.M.F., in preparation; G. Rathbun, personal communication). Movements are typically along riparian corridors, but some individuals (especially on rainy nights) move directly from one site to another through normally inhospitable habitats (e.g., heavily grazed pastures or oak-grassland savannas).

In the central coast range, California red-legged frogs spend a highly variable amount of time at breeding sites (radiotelemetry data; G.M.F., in preparation). Some individuals remain at breeding ponds throughout the year, moving only if the pond dries up. Other individuals spend only a few weeks at breeding sites before dispersing back to non-breeding habitat where they spend up to 11 mo.

ii. Breeding habitat. Historically, California red-legged frogs were found from sea level to  $\leq$  about 1,525 m in the Sierra Nevada (Swamp Lake, Yosemite National Park). The highest known extant population is at 975 m in El Dorado County.

California red-legged frogs breed primarily in ponds (Stebbins, 1985), though individuals also breed in slow-moving, pond-like parts of streams, marshes, and lagoons. There is usually some emergent vegetation, most often cattails (*Typha* sp.), rushes (*Scirpus* sp.), or willows (*Salix* sp.). Water depth is generally > 0.5 m, but California red-legged frogs occasionally reproduce successfully in ponds with a maximum depth of only 0.25 m. California red-legged frogs breed in both

ephemeral and permanent bodies of water. Ponds and streams that dry up in the fall at least every few years are ideal since fish and introduced American bullfrogs (*Rana catesbeiana*; which have tadpoles that require > 1 yr to metamorphose) do not survive periodic drying.

## B. Eggs.

i. Egg deposition sites. Egg masses are typically attached to emergent vegetation near the water surface (Storer, 1925), unlike the closely related northern red-legged frogs (*R. aurora*), which are known to oviposit at depths exceeding 3 m (C. Pearl, personal communication).

ii. Clutch size. California red-legged frogs lay eggs in clusters. The total number of eggs laid/female ranges between 300–4,000 (Storer, 1925; personal observation) with an average of about 2,000.

As with other species of *Rana*, the timing of breeding for California red-legged frogs varies geographically. Across their range, breeding takes place from late November to late April (Jennings and Hayes, 1994a). In Marin County, the range is from 9 December–14 March, with an average of 12 January.

## C. Larvae/Metamorphosis.

i. Length of larval stage. Larval development is variable and probably temperature dependent. Typically, tadpoles metamorphose from May–September, 3.5–7 mo after hatching (Storer, 1925; Wright and Wright, 1949; Jennings and Hayes, 1989), but there are several sites where tadpoles overwinter and metamorphose the following summer (Fellers et al., 2004).

ii. Larval requirements.

a. Food. The diet of tadpoles has apparently not been studied, but their diet is probably similar to other ranid frogs that feed on algae, diatoms, and detritus by grazing the surface of rocks and vegetation (Kupferberg, 1996a,b).

b. Cover. California red-legged frog tadpoles are often less conspicuous than other anuran larvae, but the role and importance of cover has not been investigated.

iii. Larval polymorphisms. None.

iv. Features of metamorphosis. California red-legged frogs metamorphose at a size of 1.6–2.0 cm SUL and a weight of 0.3–0.9 g (personal observations).

v. Post-metamorphic migrations. The movements of post-metamorphic frogs are similar to that of adults (see "Breeding Migrations" above).

**D. Juvenile Habitat.** Similar to adults, but there is some spatial segregation of adult and juveniles in riparian areas during the non-breeding part of the year. It is not known whether this represents active exclusion from preferred areas by adult frogs or whether there are subtle differences in habitat preference.

**E. Adult Habitat.** California red-legged frogs are primarily pond frogs (Stebbins, 1985), but they also inhabit marshes, streams, and lagoons during the breeding season. During other parts of the year, some frogs

remain at breeding sites while others disperse to other areas. Non-breeding habitat includes nearly any area within 2–3 km of a breeding site that stays moist and cool through the summer. This includes coyote bush (*Baccharis pilularis*) and California blackberry (*Rubus ursinus*) thickets, and root masses associated with willow (*Salix* sp.) and California bay trees (*Umbellularia californica*). Sometimes the non-breeding habitat used by California red-legged frogs is extremely limited in size, e.g., a 1–2 m wide *Baccharis* thicket growing along a tiny, intermittent creek surrounded by heavily grazed grassland.

**F. Home Range Size.** Unknown, but Calef (1973b) reported males of the closely related northern red-legged frogs calling from within a few cm of each other without showing signs of aggression.

**G. Territories.** Unknown, but other ranid frogs are well known to defend breeding areas (Wells, 1977).

#### **H. aestivation/Avoiding**

**Dessication.** Does not occur.

**I. Seasonal Migrations.** See "Breeding migrations" above.

**J. Torpor (Hibernation).** None reported.

**K. Interspecific Associations/Exclusions.** California red-legged frogs frequently are associated with Pacific treefrogs (*Hyla regilla*), rough-skinned newts (*T. granulosa*), and American bullfrogs. Less frequent associates include western toads (*Bufo boreas*), Pacific pond turtles (*Clemmys marmorata*), California newts (*Taricha torosa*), Sierra garter snakes (*Thamnophis couchi*), terrestrial garter snakes (*Thamnophis elegans*), and common garter snakes (*T. sirtalis*). There are records of California red-legged frogs co-occurring with arroyo toads (*B. californicus*), California giant salamanders (*Dicamptodon ensatus*), and California treefrogs (*Hyla cadaverina*; personal observations).

Hayes and Jennings (1986) argue that predation by introduced fish is an important factor contributing to the decline of western ranids, including California red-legged frogs. Though American bullfrogs have been widely implicated as being responsible for declines of California red-legged frogs, their relationship with California red-legged frogs is largely unknown.

**L. Age/Size at Reproductive Maturity.** Males 2 yr, females 3 yr (Jennings and Hayes, 1985).

**M. Longevity.** Unknown.

**N. Feeding Behavior.** Baldwin and Stanford (1987) report a large (about 11 cm SVL) California red-legged frog feeding on a California tiger salamander (*Ambystoma californiense*) larva, and Arnold and Halliday (1986) observed a California red-legged frog (8 cm SVL) with an adult male Pacific treefrog (*Pseudacris regilla*) in its jaws. Hayes and Tennant (1985) found that California red-legged frogs feed on 42 different taxa.

Invertebrates make up the majority of the diet, including Arachnida, Amphipoda, Isopoda, Insecta (including nine orders), and Mollusca. California red-legged frogs also feed to a limited extent on three-spined stickleback fish (*Gasterosteus aculeatus*), Pacific treefrogs, and California mice (*Peromyscus californicus*).

**O. Predators.** Rathbun (1998) reported newts (*Taricha* sp.) feeding on California red-legged frog eggs. Fellers and Freel (unpublished data) have regularly observed rough-skinned newts (*T. granulosa*) feeding on California red-legged frog eggs. Recently metamorphosed individuals are particularly vulnerable to fish predation (U.S.F.W.S., 1999b). Adult frogs and tadpoles have been preyed upon by opossums (*Didelphis virginiana*), raccoons (*Procyon lotor*), striped skunks (*Mephitis mephitis*), spotted skunks (*Spilogale putorius*), great blue herons (*Ardea herodias*), American bitterns (*Botaurus lentiginosus*), black-crowned night herons (*Nycticorax nycticorax*), red-shouldered hawks (*Buteo lineatus*), garter snakes (*Thamnophis* sp.), American bullfrogs, various native and non-native species of fish, red swamp crayfish (*Procambarus clarkii*), and signal crayfish (*Pacifastacus leniusculus*; Fitch, 1940; Fox, 1952; Lowery, 1966; Calef, 1973a; Jennings and Hayes, 1989; Rathbun and Murphey, 1996; Lawler et al., 1999; U.S.F.W.S., 1999b; personal observations).

**P. Anti-Predator Mechanisms.** Gregory (1979) examined responses of the closely related northern red-legged frog to humans and common garter snakes (*Thamnophis sirtalis*) and found that frogs mostly relied on being immobile, but would jump into the water with close approach.

**Q. Diseases.** Mao et al. (1999) report northern red-legged frogs infected with an iridovirus, which was also present in sympatric three-spined stickleback fish (*Gasterosteus aculeatus*) in northwestern California. The virus had caused some mortality in the frog population.

**R. Parasites.** Ingles reported four species of trematodes from California red-legged frogs, but later synonymized two of the species he described (Ingles, 1932a,b, 1933c).

**4. Conservation.** *Rana draytonii* was Federally listed as a Threatened species in June 1996 (U.S.F.W.S., 1996c). The most serious threats to this frog are loss of habitat from urbanization and agriculture and exposure to pesticides. Historically, much of the prime habitat for California red-legged frogs occurred in the grasslands and rolling hills of the Coast Range and the lower elevations of the Sierra Nevada. Substantial portions of the original range have been converted to other land uses, especially in the Los Angeles and San Francisco Bay areas, and in the Sierra foothills.

In California, pesticides are contributing to amphibian declines, especially in the Sierra Nevada, an area immediately downwind from the highly agriculturalized Central Valley in

California (LeNoir et al., 1999; Davidson et al., 2001; Sparling et al., 2001). As a result, California red-legged frog populations are almost entirely gone from the foothills east of the Central Valley.

Many nonnative species are likely to be California red-legged frog competitors and/or predators (U.S.F.W.S., 2002c), but the population-level impact of most nonnatives is unknown. For example, American bullfrogs are widespread within the range of California red-legged frogs, and predation and competition would seem to be inevitable. But there are almost no studies that evaluate this relationship, even though bullfrogs are routinely cited as a serious problem. There is little doubt that warm-water fish and mosquitofish have an impact. Chytrid fungus has been detected in California red-legged frogs, but the role of this disease in population declines is entirely unknown. The *R. draytonii* recovery plan lists many other potential causes for observed declines (U.S.F.W.S., 2002c).

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