CALIFORNIA RED-LEGGED FROG

Rana draytonii Baird and Girard 1852

Status Summary

Rana draytonii is a Priority 1 Species of Special Concern, receiving a Total Score/Total Possible of 76% (84/110). During the previous evaluation, it was also considered a Species of Special Concern (Jennings and Hayes 1994a), and it has been listed as federally Threatened since 1996.

Identification

Rana draytonii is a relatively large (2.5–13.8 cm SVL) brown, gray, olive, or reddish-brown frog (Jennings and Hayes 1994a, USFWS 2002, Stebbins 2003). Prominent dorsolateral folds are usually present. Many small black flecks and larger irregular blotches are present on the back, and these occasionally form a network (Baird and Girard 1852). The larger black spots on the back often have a whitish or light center. The ventral surface is whitish or cream with extensive gray or black mottling, often overlain with red or reddish-orange coloration, particularly in the groin (Baird and Girard 1852, Stebbins 2003). In general, the red coloration in this species is individually and ontogenetically variable, with the undersides of the feet almost always red in adult animals, although the extent of red elsewhere on the legs and belly varies

California Red-Legged Frog: Risk Factors

Ranking Criteria (Maximum Score)	Score
i. Range size (10)	5
ii. Distribution trend (25)	20
iii. Population concentration/ migration (10)	10
iv. Endemism (10)	7
v. Ecological tolerance (10)	3
vi. Population trend (25)	25
vii. Vulnerability to climate change (10)	7
viii. Projected impacts (10)	7
Total Score	84
Total Possible	110
Total Score/Total Possible	0.76

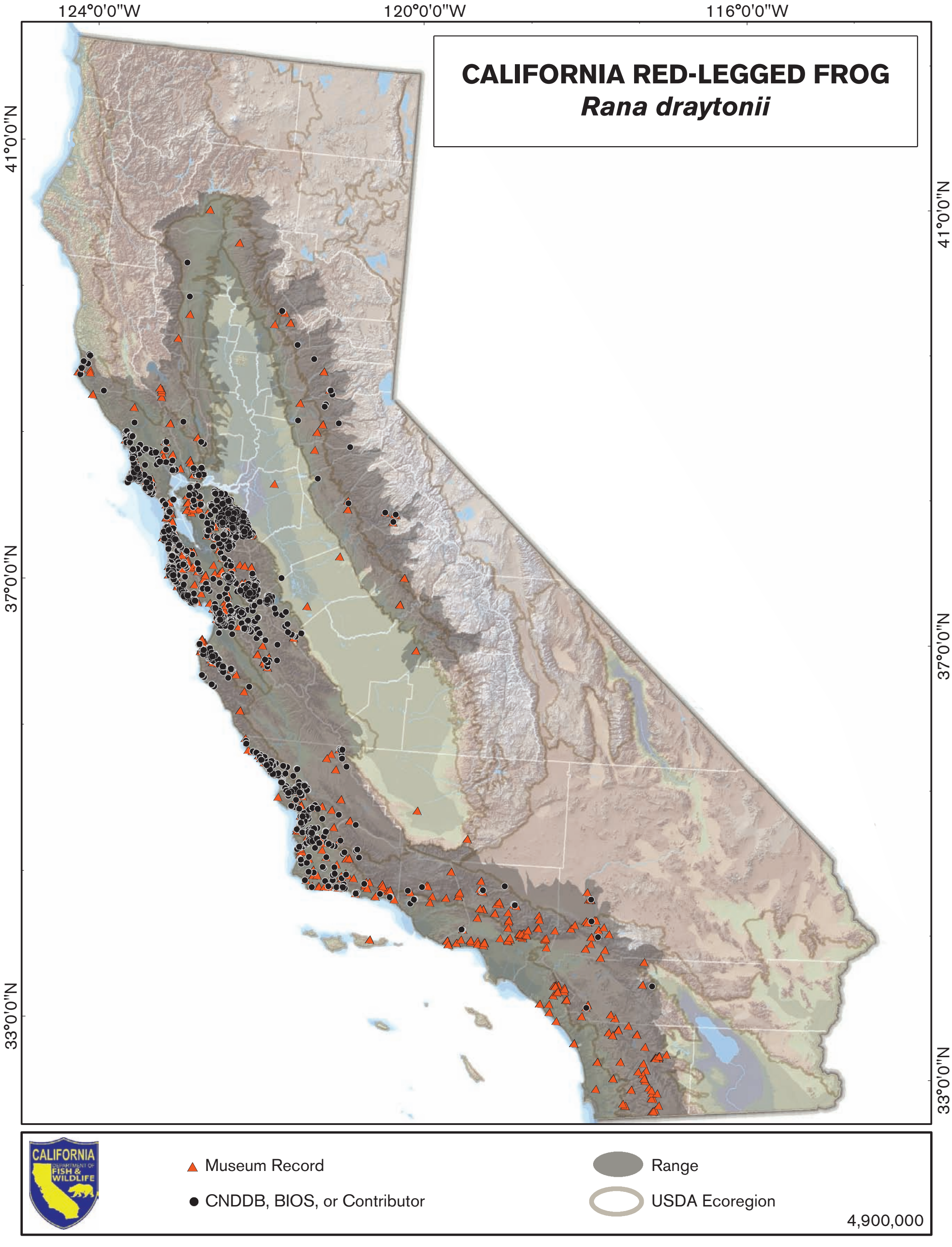

PHOTO ON PREVIOUS PAGE: California red-legged frog, Alameda County, California. Courtesy of Adam Clause.

from extensive to absent (S. Barry, pers. comm.). The advertisement call is a series of low guttural chucks sometimes followed by a low groan (Elliott et al. 2009).

This species could be confused with the northern red-legged frog (*R. aurora*) where their ranges meet in southern Mendocino County (Shaffer et al. 2004). *Rana aurora* is about 3.5–4.0 cm (SVL) smaller than *R. draytonii*, generally lacks light areas in the centers of dorsal blotches, has proportionally smaller eyes, and lacks vocal sacs (Baird and Girard 1852, Hayes and Krempels 1986, Stebbins 2003).

Taxonomic Relationships

Rana draytonii was initially described as a distinct species, although the original description notes that it is similar in appearance to *R. aurora* (Baird and Girard 1852). Subsequent to the original description, Camp (1917) reclassified the two red-legged frogs as subspecies of a polytypic *R. aurora*. This arrangement persisted, occasionally also including the Cascades frog (*R. cascadae*) as a third subspecies, until the mid-1980s. At this time, a series of studies emerged suggesting that a substantial amount of differentiation between the two forms was present in allozymes, morphology, calling behavior, and oviposition behavior, leading several authors to suggest that they may be distinct lineages with a broad zone of contact (Hayes and Miyamoto 1984, Green 1986a, Green 1986b, Hayes and Kremples 1986). Subsequent analyses of mitochondrial DNA variation supported this view but characterized a narrow zone of contact in southern Mendocino County (Shaffer et al. 2004). Based on both DNA and morphological differentiation, Shaffer et al. (2004) suggested that the two be recognized as distinct species, and since then *R. draytonii* has increasingly been recognized as a species distinct from both *R. aurora* and *R. cascadae*.

Life History

Few data are available on seasonal activity patterns, but coastal populations are probably active throughout much of the year due to the moderating effect that the Pacific Ocean has on temperature. The timing of reproduction varies from year to year and according to site but occurs from late November to late April (Storer 1925, Fellers 2005b). Breeding occurs in the water, and eggs are attached to emergent vegetation (in clusters of 300 to >4000; Storer 1925, Hayes and Miyamoto 1984). Hatching occurs in 6–14 days depending on water temperature, after which larvae metamorphose in 3.5–7 months (Storer 1925, Wright and Wright 1949). Larvae are known to overwinter at several sites, metamorphosing the following spring (Fellers et al. 2001). *Rana draytonii* is a generalist predator that feeds predominantly on invertebrates but has also been documented to take vertebrate prey including Pacific treefrogs (*Pseudacris regilla*), western toads (*Bufo boreas*), and California mice (*Peromyscus californicus*) (Hayes and Tennant 1985, Arnold and Halliday 1986, USFWS 2002, Davidson 2010). The prey types taken appear to be determined by the size of the frogs, with individual frogs taking most prey types that they can successfully swallow (Jennings and Hayes 1994a) and large frogs taking proportionally more vertebrate prey than small ones. Baldwin and Stanford (1987) reported a large adult preying upon California tiger salamander (*Ambystoma californiense*) larvae. *Rana draytonii* feed both in the water and by foraging in dense riparian vegetation. *Rana draytonii* is active both diurnally and nocturnally, although adults are generally more active at night (Hayes and Tennant 1985; G. Fellers, pers. comm.).

Wading birds, raccoons, and garter snakes (*Thamnophis sirtalis* and *T. hammondii*) are important native predators on this species (Cunningham 1959b, Jennings and Hayes 1994a). Nonnative fishes are also important predators on larvae and recent metamorphs (Schmieder and Nauman 1994, USFWS 1999).

Habitat Requirements

Rana draytonii chiefly inhabits ponds, although it also uses marshes, streams, lagoons, and other waterways throughout most of its range.

In southern California (from Ventura County southward) it seems to favor slow-flowing streams rather than ponds or pools. Breeding takes place primarily in ponds (at least in central and northern California) and less frequently in quiet pools in streams (Stebbins 2003, Fellers 2005b). This species will also utilize ephemeral water bodies for breeding, although nearby permanent water is probably required to maintain populations over the long term (Jennings 1988a). After breeding, adults often disperse along nearby shaded streams. Similar to *R. boylii*, whose vulnerable early life stages (embryos and tadpoles) are susceptible to ill-timed flow fluctuations controlled by upstream dams and diversions, *R. draytonii* populations breeding in stream habitats suffer from decreased recruitment after anthropogenic perturbation of natural flow regimes (S. Kupferberg, pers. comm.).

Optimal aquatic habitat has traditionally been thought to include dense riparian vegetation overhanging deep (>0.7 m) slow-moving pools (Hayes and Jennings 1988). More recent work has documented an additional, more complex relationship between aquatic vegetation and introduced bullfrogs. D'Amore et al. (2009) documented that *R. draytonii* spend more time in vegetative cover when bullfrogs are present and more time in the open when bullfrogs are removed from ponds, suggesting that the optimal amount of vegetation is somewhat context-dependent for *R. draytonii*. In addition, surveys of 85 ponds occupied by *R. draytonii* in the East Bay Regional Park District showed that there were no significant differences in adult frog density among ponds with 0%, ≤15%, or >15% emergent vegetation, but tadpoles and metamorphs were more abundant in the most open ponds (Bobzien and DiDonato 2007). Outside of the breeding season when conditions are wet, and especially during rainfall, adult frogs will disperse from the breeding habitat and will move to upland sites, where they are often found under logs, rocks, and other debris (USFWS 2002, Bulger et al. 2003, Fellers and Kleeman 2007). At some sites, populations appear to consist of both migratory (11–22% of the adult population) frogs that move 200–2800 m and resident frogs that remain at the breeding site (Bulger et al. 2003). Fellers and Kleeman (2007) found that adult female frogs were more frequently migratory than males, although migration behavior did not differ between the sexes among those individuals that did migrate.

Distribution (Past and Present)

Historically, *Rana draytonii* ranged throughout the Sierra Nevada foothills and the Coast Range mountains south of Elk Creek in southern Mendocino County, California, southward to the Arroyo Santo Domingo, Baja California Norte, Mexico (Hayes and Krempels 1986, Jennings and Hayes 1994a, Grismer 2002, Shaffer et al. 2004). In California, this taxon historically ranged through at least 46 counties, but it is now apparently extirpated from 24 of these (USFWS 1996). It is unclear whether reproductive populations of *R. draytonii* were present in most of the Central Valley, and it is possible that the few valley records represent waifs washed downstream from Sierran populations (G. Fellers, pers. comm.; S. Barry, pers. comm.). If they were present in the Central Valley, they were extirpated before 1960. Populations in the Sierra Nevada may have been connected to the largest remaining populations of the species in the Coast Ranges through the lower Cascade and Tehachapi Ranges (S. Barry, pers. comm.), but today they are isolated (USFWS 2002). A recent comprehensive survey of museum specimens and historical records identified 21 historical localities for this species in the Sierra Nevada. Follow-up surveys at 20 of these 21 sites found that the species persists in large numbers in at least 1 site, there are populations at 6 additional sites, and at least a single individual documented at 3 more sites (Barry and Fellers 2013).

Strong overall declines have clearly occurred across most of the large range of this species, particularly in the southern portion of the range. In the Bay Area and Coast Ranges, populations are more robust, although severe localized declines have been documented (reviewed in USFWS 2002). In southern California, *R. draytonii* has declined drastically through the Transverse and Peninsular Ranges, and very few populations now persist in Los Angeles, Riverside, and Ventura Counties (USFWS 2002, and references therein). One population is known from Santa Cruz Island, although this apparently is an introduction (Sweet and Leviton 1983, Jennings 1988b). The known elevational range of *R. draytonii* occurs from near sea level to 1500 m, although most populations occur below 1050 m (USFWS 2002, Barry and Fellers 2013). Some higher-elevation populations may be introductions (unpublished data reported in Jennings and Hayes 1994a).

Trends in Abundance

Drastic and ongoing declines have been documented throughout parts of this species' range. Many of these declines have resulted in extirpation of populations, and in many areas where this taxon persists, declines in abundance have occurred. Food market collection in the late 1800s apparently drove much of the initial declines (Jennings and Hayes 1985). By 1879, the species had already become rare around San Francisco due to the market trade (Lockington 1879). Population trends of the species in the Sierra Nevada foothills are somewhat unclear, since several new, large (>100 breeding adults) populations have recently been discovered (e.g., in Placer County). However, in southern California, population densities are uniformly low (<25 adults frogs) and generally declining (USFWS 2002). The sole remaining population known in Riverside County at the Santa Rosa Plateau, which was at least somewhat genetically distinctive (Shaffer et al. 2004), is now extirpated.

Nature and Degree of Threat

The largest threat facing *Rana draytonii* is probably habitat loss and alteration, resulting from urbanization and agriculture. The large-scale conversion of habitat to agricultural uses has also resulted in an increase in pesticide exposure, which may have strong negative impacts on this species (Davidson et al. 2002). This effect is particularly strong for cholinesterase-inhibiting pesticides (Davidson 2004), although the species still persists in some heavily agricultural settings in Monterey and Santa Cruz Counties. Additional and ongoing fragmentation of habitats, conversion of wetlands to other uses, and modifications to the hydrology of wetlands also likely have detrimental impacts.

The effect of introduced species, in particular bullfrogs, has been studied both empirically (Moyle 1973) and from a modeling perspective (Doubledee et al. 2003). There is a strong overall negative impact of bullfrogs on native *R. draytonii*, although coexistence of the two species can occur in nature. Human-modified aquatic and terrestrial habitats in central California (Elkhorn Slough, Monterey County) favor introduced bullfrogs compared to native *R. draytonii* (D'Amore et al. 2010). The bullfrog is also a strong competitor with, and predator on, multiple life stages of *R. draytonii*. In addition, crayfish, mosquitofish (Lawler et al. 1999), and other introduced predaceous fishes likely have negative impacts on this species, although this also needs further study (Hayes and Jennings 1986, Fisher and Shaffer 1996, Fellers 2005b).

Chytrid fungus (*Bd*) is known to have caused serious declines in many amphibian species and has been detected in *R. draytonii* in nature. However, the direct impact *Bd* has on *R. draytonii* appears to be relatively slight. In a laboratory setting, *R. draytonii* is susceptible to chytrid infection, but frogs can clear their infections, do not die from the infection, and suffer no growth consequences when they have access to unlimited food (Padgett-Flohr 2008). In nature, across a landscape of ponds where *Bd* presence and absence fluctuated between wet and dry years, *R. draytonii* were generally uninfected and found to be significantly associated with uninfected ponds (Padgett-Flohr 2010).

Predicted climate change over much of California will affect *R. draytonii*, as well as most other pond- and stream-breeding amphibians. In particular, warmer average temperatures, generally reduced levels of precipitation, and increased variability in the timing of rainfall are all predicted to occur (PRBO 2011). While the precise effects of these shifts will vary regionally and at the watershed level, the permanence and reliability of breeding sites are generally predicted to decrease under climate change predictions.

Status Determination

Rana draytonii automatically qualifies as a Species of Special Concern because it is listed under the federal but not state Endangered Species Act. However, sharp declines in both range and abundance, coupled with a variety of ongoing threats to long-term survival, also combine to warrant a Priority 1 Species of Special Concern status.

Management Recommendations

Management of *Rana draytonii* should mirror the guidelines in the USFWS recovery plan for this taxon (USFWS 2002). As further management needs are defined and existing management strategies are refined (through 5-year reviews or other avenues), state-level management should be adjusted accordingly.

The most important management needs for this taxon currently are the protection of habitat that supports the species, reduced pesticide exposure, and elimination of nonnative predators. Land conversion and additional fragmentation should be avoided wherever possible, and adequate, complex upland habitat should be available in order to allow migration to occur naturally. Fellers and Kleeman (2007) found that the median distance of movement away from breeding ponds was 150 m and that there were some long-distance movements up to 1400 m. Unpublished radiotelemetry observations from the East Bay Regional Park District (S. Kupferberg, pers. comm.) demonstrated that ground squirrel burrow density, sometimes more than 100 m from the aquatic habitat, was also a key component of habitat quality. Taken together, these studies indicate that large tracts of terrestrial habitat are important (to accommodate both short- and long-distance dispersal) and that a healthy population of ground squirrels (and possibly other burrowing rodents) may be essential for long-term population viability.

Finally, pesticide use should be curtailed in areas where this species occurs, including areas upwind where pesticides are likely to be blown into areas that support this species. Unpublished data from the East Bay Regional Park District (S. Kupferberg, pers. comm.) indicate that cattle-grazing does not appear to negatively impact this species.

Monitoring, Research, and Survey Needs

Further research is needed to determine what the precise impacts many of these threats identified above are having on *Rana draytonii*. Surveys of private land in the Sierra Nevada are slowly revealing the presence of extant populations that were previously missed (S. Barry, pers. comm.), suggesting that this may be a fruitful strategy elsewhere in the range as well. Managers should partner with private landowners to gain access and survey for remaining populations of this species in areas where it has previously been thought to be extirpated, and these populations, which may be very small in size, should be monitored regularly.

Finally, the only range-wide genetic analysis of the species thus far conducted was based purely on mitochondrial DNA (Shaffer et al. 2004), and supporting data from a large set of nuclear DNA markers is badly needed. In particular, the potential genetic break between populations north and south of Santa Barbara County, and the genetic affinities of remnant populations from southern California and Baja California, Mexico, will form an important part of future management.

Additional monitoring, research, and survey needs are covered in depth in the USFWS recovery plan for this taxon. We refer the reader to this document for more information (USFWS 2002).