RED DIAMOND RATTLESNAKE

Crotalus ruber Cope 1892

Status Summary

Crotalus ruber is a Priority 3 Species of Special Concern, receiving a Total Score/Total Possible of 44% (48/110). During the previous evaluation, it was also considered a Species of Special Concern (Jennings and Hayes 1994a).

Identification

Crotalus ruber is a large (165 cm TL), heavy-bodied, tan, brick-red, reddish- or pinkish-brown rattlesnake (Stebbins 2003). As is typical of pit vipers, *C. ruber* has a large triangular head, a thin neck, and a heat-sensing pit on each side of the head between the eyes and nostrils. An average of 35 light-edged or indistinct diamonds run down the back (Ernst and Ernst 2003). The tail is ringed with alternating bands of black and white or gray, ending in a rattle. Two light stripes occur on the sides of the head, and the venter is light colored and unmarked (Ernst and Ernst 2003). The dorsal body scales are keeled.

Neonates of *C. ruber* are similar in appearance to the western diamond-backed rattlesnake (*C. atrox*). Adults can be distinguished by coloration and behavior, with *C. ruber* much redder and less aggressive than *C. atrox*. In California, the ranges of these two species barely meet (Stebbins 2003).

Red Diamond Rattlesnake: Risk Factors

Ranking Criteria (Maximum Score)	Score
i. Range size (10)	10
ii. Distribution trend (25)	15
iii. Population concentration/ migration (10)	0
iv. Endemism (10)	0
v. Ecological tolerance (10)	3
vi. Population trend (25)	10
vii. Vulnerability to climate change (10)	3
viii. Projected impacts (10)	7
Total Score	48
Total Possible	110
Total Score/Total Possible	0.44

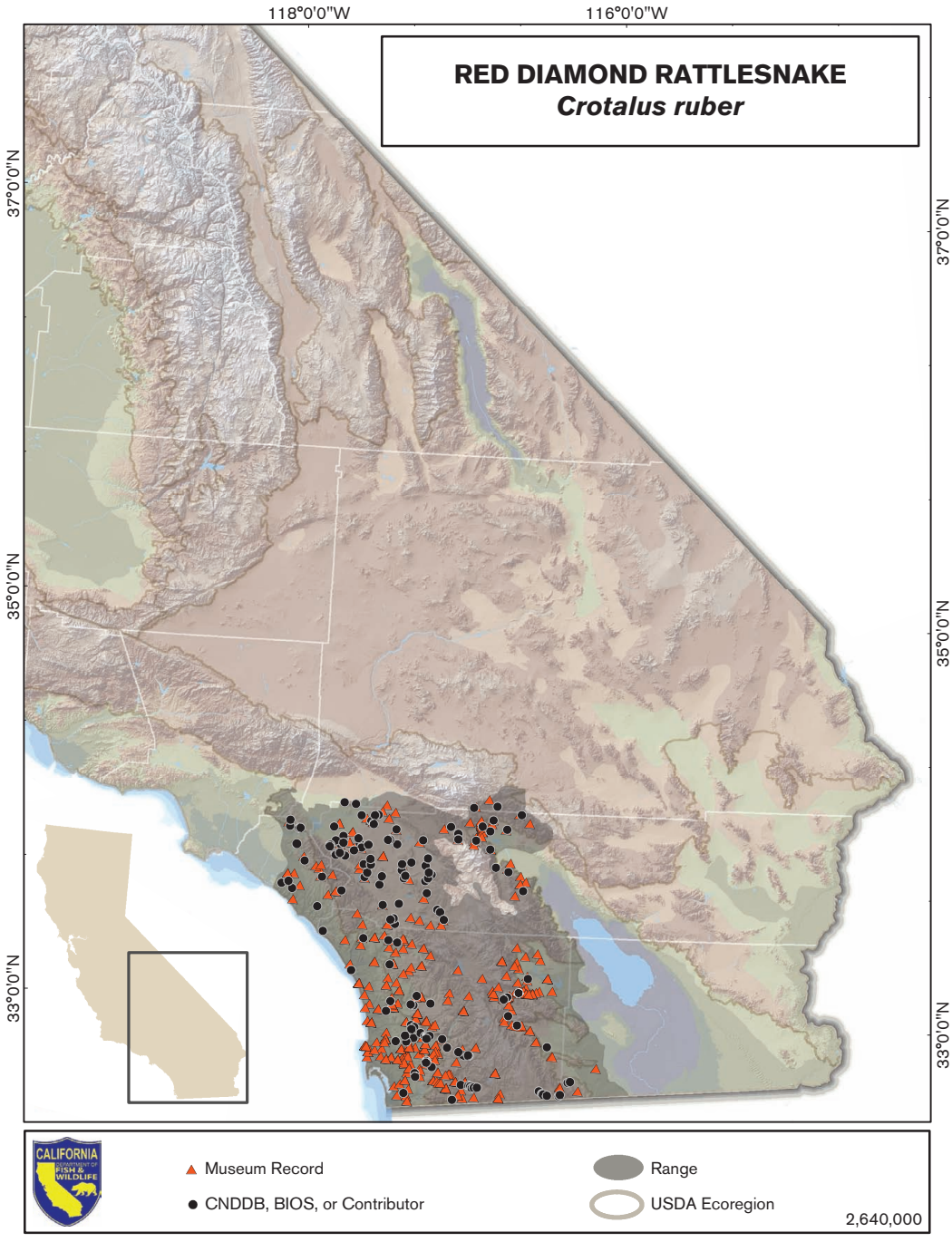

PHOTO ON PREVIOUS PAGE: Red diamond rattlesnake, San Diego County, California. Courtesy of Jeff Lemm.

Taxonomic Relationships

Based on analyses of morphology and mitochondrial DNA, Murphy et al. (1995) proposed synonymizing *Crotalus ruber* with an island species, the Cedros Island diamond rattlesnake (*C. exsul* Garman 1884). Because *C. exsul* was named first, Murphy et al. (1995) suggested changing the name of *C. ruber*. However, this has been opposed in favor of stability of the nomenclature (Smith et al. 1998, ICZN 2000). Here, we use *C. ruber* to refer to all California animals.

Life History

Crotalus ruber is generally most active between March and June (Ernst and Ernst 2003). In one study from San Diego County, snakes typically emerged from overwintering locations in late February, but some individuals were inactive until mid-April (Brown et al. 2008). Most movement occurred in late spring and summer, dens were populated in November, and no movement was recorded in December or January (Brown et al. 2008). In Riverside County, desert animals were active from early March to late November (Greenberg 2002).

During the cold winter months, *C. ruber* spends most of its time underground in dens located in rock crevices, animal burrows, or under shrubs or cacti. Several individuals may aggregate in these dens, but denning behavior is variable across sites (Klauber 1956, Ernst and Ernst 2003). In one study in San Diego County, 7 out of 11 radio-tracked snakes overwintered in communal dens located in rock crevices of granite boulders with up to 7 other individuals (Brown et al. 2008). Most snakes reused den sites over multiple years and moved ~300 m away from den sites during the active period the following year (Brown et al. 2008). In contrast, in sites where large rocks were rare, animals were observed to overwinter singly under prickly pears (*Opuntia* sp.), did not show consistent site fidelity to overwintering sites, and moved farther from overwintering sites after emergence (Greenberg 2002, Dugan et al. 2008).

Home range area is also variable in this species, and male home ranges are larger than those of females (Tracey 2000, Greenberg 2002, Brown et al. 2008). The few available radiotelemetry studies suggest that home ranges may be larger in the desert than in coastal habitats. In a reserve in San Diego County, average home range sizes were 2.8 ha for males ($n = 5$) and 0.9 ha for females ($n = 6$; Brown et al. 2008). At another relatively coastal site in Chino Hills State Park in southwestern San Bernardino County, Dugan et al. (2008) found that male home range size varied from 0.3 to 4.5 ha ($n = 7$). In contrast, average home range sizes for desert animals from Riverside County were 25.7 ha for males ($n = 5$) and 5.9 ha for females ($n = 4$; Greenberg and McClintock 2008).

Courtship and mating have been observed in the field in California from February to May (Brown et al. 2008, Dugan et al. 2008). In San Diego County, Brown et al. (2008) witnessed females mating from April to May (sometimes with den mates), and births occurred in September. Goldberg (1999) examined the reproductive condition of 43 specimens, 41 of which were from desert habitat in Riverside County and 2 from coastal Orange County. Reproductively active males were observed in August (Goldberg 1999). Although specimens were unavailable from later in the year, Goldberg (1999) speculated that sperm production continued through the early fall. Sperm was found in the vas deferens for all animals (collected February through August), suggesting the use of sperm stored overwinter for spring mating (Goldberg 1999). Females contained enlarged ovarian follicles (>10 mm) from March through September. Females may reproduce every other year, given that only 7 of 15 females showed evidence of reproductive activity (Goldberg 1999).

An average of eight young (range 3–20, $n = 40$; Klauber 1956) are live-born after a gestation period of 141–173 days ($n = 3$, data from captive animals; Klauber 1956). Goldberg (1999) estimated similar average litter sizes from counts of enlarged ovarian follicles (range 4–8, mean

6.3, $n = 7$). Klauber (1956) examined 249 specimens from San Diego County to estimate growth curves and found that young are 30 cm TL at birth on average and roughly double in length during their first year. Estimates for size at reproductive maturity range from 60 to 75 cm TL (Klauber 1956, Wright and Wright 1957, Goldberg 1999).

Crotalus ruber mostly feeds on small mammals but will also eat lizards, birds, and other snakes (Tevis 1943, Klauber 1956, Cunningham 1959b, Patten and Banta 1980). Dugan and Hayes (2012) compiled range-wide dietary data from museum specimens, live animals, road kills, existing literature, and other observations. Roughly 92% of all prey items were mammals, with lizards (8%) and birds (1%) taken less frequently. Prey items were found in snakes collected year-round, suggesting that *C. ruber* occasionally feeds during the winter (Dugan and Hayes 2012).

Habitat Requirements

Crotalus ruber occurs in several habitat types, including coastal sage scrub, chamise chaparral, redshank, desert slope scrub, desert washes, grassy fields, orchards, cactus patches, and rocky areas (Klauber 1956, Jennings and Hayes 1994a, Tracey 2000, Dugan et al. 2008). Klauber (1956) noted that 44% (30/68) of animals were found near heavy shrub and chaparral, and 21% (14/68) were found near rocks and boulders in road surveys. On a reserve in San Diego County, snakes were found in association with rock outcrops 57% of the time and in shrubby vegetated habitats without rocks 28% of the time (Brown et al. 2008). There are several accounts of *C. ruber* climbing in bushes and trees up to 2 m off the ground (Klauber 1956 and pers. comm. therein) and *C. ruber* has also been observed swimming in reservoirs (Klauber 1956).

In one radio-tracking study from San Diego County, habitat use was nonrandom with respect to available vegetation. Snakes preferred scrub vegetation less than 1.5 m tall and avoided human development (Tracey 2000). For animals that were radio-tracked in fragmented habitats, none were observed to cross a developed edge or road over a 2-year period. For example, one adult male in a naturally vegetated fragment actively avoided a road edge, and turning movements away from this edge were detectable up to 50 m from the road (Tracey et al. 2005).

Dugan et al. (2008) radio-tracked adult males at a site that lacked large rocks but had cactus, coastal sage scrub, nonnative grassland, riparian areas, and oak woodland habitats. The preferred habitat was cactus patches of prickly pear (*Opuntia* sp.) followed by chaparral, and none of the tracked snakes used oak woodland. Several individuals spent most of their time within a single cactus patch during the year (Dugan et al. 2008).

Distribution (Past and Present)

Crotalus ruber has a small range in California, occupying the southwestern corner of the state. It occurs in southeastern Los Angeles and Orange Counties, the Morongo area of southwestern San Bernardino County, western Riverside County, San Diego County, and extreme southwestern Imperial County (Klauber 1956). *Crotalus ruber* occurs in areas with rainfall ranging from 8 to 80 cm/year, usually in areas below 1200 m in elevation (Klauber 1956). The geographic range of *C. ruber* extends out onto the desert floor from the eastern slope of the Peninsular Ranges (Klauber 1956). Outside of California its range extends south through Baja California and several nearshore islands (Klauber 1956).

Much of the range in California is in close proximity to areas of high human density. Jennings and Hayes (1994a) estimated that *C. ruber* was extirpated from roughly 20% of historical sites and attributed extirpations to habitat loss from urbanization and agriculture. Coastal populations are the most reduced, particularly in southern San Diego County (S. Barry, pers. comm.). Case and Fisher (2001) conducted pitfall trapping surveys in southern California and did not capture or observe

animals at several localities where Klauber (1939 and unpublished data) had previously noted them as common. Halama et al. (2008) noted that many native habitat localities where snakes were collected in the 1990s in western Riverside County have now been developed.

Trends in Abundance

While population estimates are not available, population declines are suspected due to habitat loss and fragmentation. Current declines of existing populations may be occurring particularly in the Morongo Valley in the northern end of the range due to development (S. Barry, pers. comm.). In one San Diego County site, minimum density was estimated as 0.63 *Crotalus ruber* per hectare, although the actual density was likely higher (41 individuals observed haphazardly in a 65 ha area over ~5 years; Brown et al. 2008).

Nature and Degree of Threat

Crotalus ruber is mainly threatened by development, which causes habitat loss and fragmentation. This species may also suffer from persecution and road mortality. Climate change may affect *C. ruber* through changes in fire regime and vegetation shifts. However, both increases and decreases in fire have been predicted, and there is little consensus because of the difficulty in modeling Santa Ana weather events in southern California (Westerling et al. 2004, Westerling and Bryant 2008). How *C. ruber* may respond to changes in fire regime is unknown. Climate change is predicted to decrease the availability of chaparral and shrubland by up to 44%, while grassland is predicted to increase by up to 390% in southern California (Lenihan et al. 2008, PRBO 2011). Though *C. ruber* has been documented in grassy areas, large losses in shrub habitat may negatively affect this species.

Status Determination

Crotalus ruber has a small range in California that includes areas of high human population density and development, resulting in a Priority 3 Species of Special Concern designation.

Management Recommendations

Remaining populations of *Crotalus ruber* in California often occur in habitats that are fragmented by roads and urban development. Existing large habitat fragments should be identified and protected. For example, a proposed Habitat Conservation Plan for western Riverside County represents a 3.5-fold increase in the amount of snake habitat protected (Halama et al. 2008). However, Halama et al. (2008) estimated from habitat suitability models that roughly 100,000 ha of predicted highly suitable habitat in the area would still be unprotected and at risk of development. It may be possible to reduce road mortality with wildlife tunnels and associated drift fences installed beneath high-traffic roads.

Monitoring, Research, and Survey Needs

Additional research into *Crotalus ruber* ecology and population dynamics in developed and fragmented landscapes would be useful for developing management strategies, particularly with regard to maintaining connectivity among populations. Creating habitat buffers around large remaining fragments and habitat corridors between fragments may help populations persist in these landscapes, but more research on habitat use and corridor placement is needed. Radiotelemetry data to date suggest high site fidelity among adults, at least in some coastal populations within years. Juveniles may show different dispersal behavior and benefit more from management strategies like habitat corridors (Tracey 2000). Current snake telemetry techniques that rely on surgically implanted transmitters have a lower size limit (e.g., animals needed to be >500 g in one study; Brown et al. 2008), making it difficult to study movement in small individuals. In these cases, landscape genetic data could provide important data to complement more detailed telemetry studies. The role of hibernacula in population viability

and movement patterns is also an important research need, particularly for juveniles.

Monitoring is needed to estimate abundances in addition to ongoing work on presence/absence to document local extirpations. Pitfall trapping has been used to successfully document presence and absence of this species in southern California (e.g., Case and Fisher 2001), and pitfall arrays that specifically compare habitats with different levels of human disturbance would provide valuable monitoring information.