



REGAL RING-NECKED SNAKE

*Diadophis punctatus regalis* Baird and Girard 1853a

*Status Summary*

*Diadophis punctatus regalis* is a Species of Special Concern, although we refrain from assigning it a priority status at this time due to limited information. This taxon received a Total Score/ Total Possible of 68% (27/40) and was not previously considered a Species of Special Concern (Jennings and Hayes 1994a).

*Identification*

*Diadophis punctatus regalis* is the largest of the ring-necked snakes, reaching up to 85.7 cm TL, while most subspecies are less than 50 cm TL (Ernst and Ernst 2003). A slender snake with smooth scales, *D. p. regalis* is light gray, olive gray, or olive above with orange or red ventral coloration. The venter is speckled with irregular black spots. An orange or red neckband is generally present behind the head, though it can be faint or absent in some populations of this subspecies, particularly in New Mexico and Utah (Ernst and Ernst 2003, Stebbins 2003). Recent specimens from California and

Nevada have lacked neck rings (Emmerich and Cunningham 2003, Wood and Richmond 2003).

*Regal Ring-Necked Snake: Risk Factors*

Ranking Criteria (Maximum Score)	Score
i. Range size (10)	10
ii. Distribution trend (25)	Data deficient
iii. Population concentration/ migration (10)	Data deficient
iv. Endemism (10)	0
v. Ecological tolerance (10)	10
vi. Population trend (25)	Data deficient
vii. Vulnerability to climate change (10)	7
viii. Projected impacts (10)	Data deficient
Total Score	27
Total Possible	40
Total Score/Total Possible	0.68

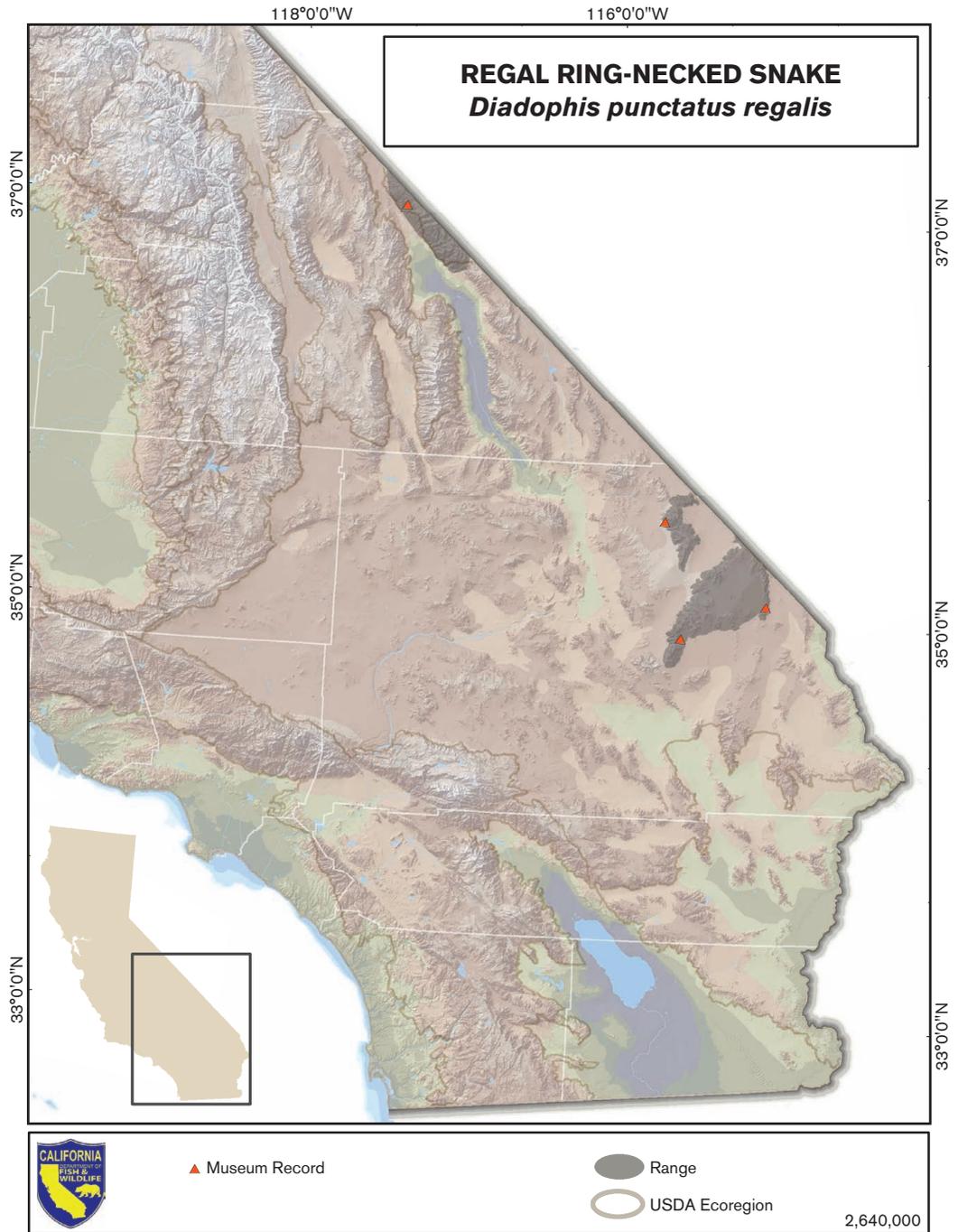


PHOTO ON PREVIOUS PAGE: Regal ring-necked snake, Santa Cruz County, Arizona. Courtesy of Jackson Shedd.

### Taxonomic Relationships

Twelve subspecies of *D. punctatus* have traditionally been recognized, largely on the basis of morphology (Ernst and Ernst 2003). *Diadophis punctatus regalis* is one of seven subspecies that occur in California (Ernst and Ernst 2003). Recent molecular work has called this traditional view of the subspecies into question (Feldman and Spicer 2006, Fontanella et al. 2008), and a taxonomic revision is likely in the near future. Feldman and Spicer (2006) sampled mitochondrial DNA from 39 animals throughout the range of *D. punctatus* in California. *Diadophis punctatus regalis* was recovered as sister to a clade containing all other California samples, although only two *D. p. regalis* individuals were included in the analysis (one from California and one from Arizona). Fontanella et al. (2008) conducted a more comprehensive phylogeographic analysis of *D. punctatus*, sampling across the known range of the species in the United States. The previously recognized seven subspecies in California were found to fall into four lineages, with *D. p. regalis* as a part of a Great Basin clade. Fontanella et al. (2008) concluded that species-level diversity is currently underestimated, warranting a full taxonomic review requiring further sampling (particularly throughout Mexico) and the addition of nuclear markers.

### Life History

Very little natural history information is available for *Diadophis punctatus regalis*, especially for California populations. Being such a widespread species, life history characteristics vary greatly across the species' range. It is reasonable to presume that *D. p. regalis* are ecologically distinct from other California *D. punctatus* populations based on their much larger size and unique restriction to desert spring habitats. Unless stated explicitly, life history information here is from other subspecies of *D. punctatus* and caution should be used in generalizing to *D. p. regalis*.

*Diadophis punctatus* is most active in the spring and early fall, and is primarily nocturnal (Ernst and Ernst 2003). Males aggregate for

mating in the spring and fall (Noble and Clausen 1936, Dundee and Miller 1968). Females are thought to reproduce annually and may produce more than one clutch per year (Ernst and Ernst 2003). Oviposition occurs from May to September but is concentrated in June and July, and hatching occurs from July to September (Ernst and Ernst 2003). Clutches from multiple females may be laid together in communal nest sites (Blanchard 1942, Gilhen 1970). *Diadophis punctatus* eggs are 16–44 mm long (mean 25 mm,  $n = 108$ ) and hatchlings are 7.6–18.8 cm TL (mean 12.4 cm,  $n = 120$ ; Ernst and Ernst 2003). *Diadophis punctatus regalis* eggs and hatchlings are likely at the larger end of the spectrum. A field-collected 60 cm SVL female *D. p. regalis* from Arizona contained three large eggs (mean length 44 mm, mean width 11.3 mm) that hatched after 52 days of incubation (Vitt 1975). The neonates were 16.9–18.8 cm long (mean 18 cm). Gehlbach (1965) reported one female *D. p. regalis* carrying 18 eggs. Estimates for size at maturity for *D. punctatus* range from 17.8 to 18 cm (Wright and Wright 1957, Myers 1965), but given that hatchling *D. p. regalis* can be this large, they likely mature at a larger size. Development times to maturity in *D. punctatus* can take 1–3 years depending on locality (Fitch 1975, Degenhardt et al. 1996).

*Diadophis punctatus* can often be found in aggregations under cover objects (Ernst and Ernst 2003), and some populations make spring and fall migrations to and from hibernacula. *Diadophis punctatus regalis* from the Rocky Mountains in Utah at 1580 m elevation showed communal denning and repeated use of the same hibernacula in multiple years (Parker and Brown 1974). It is unknown whether California populations of *D. p. regalis* also show this behavior. Field-active body temperatures across several populations of *D. punctatus* range from 2.0°C to 34.4°C (Clarke 1958, Brattstrom 1965, Fitch 1975, Mitchell 1994).

*Diadophis punctatus regalis* is a mildly venomous rear-fanged colubrid snake, using enlarged posterior teeth to deliver venom to

prey such as snakes and lizards (Gehlbach 1974, Anton 1994, Hill and Mackessy 2000, O'Donnell et al. 2007). In addition to subduing prey, copious salivation has been observed as a defensive response in *D. p. regalis* (Blanchard 1942). While *D. punctatus* is a generalized predator, southwestern populations, including *D. p. regalis*, have a diet composed of proportionately more reptiles (Gehlbach 1974) than other populations, which tend to consume a greater fraction of amphibians and earthworms (Ernst and Ernst 2003).

#### *Habitat Requirements*

In California, *Diadophis punctatus regalis* appears to be restricted to riparian areas surrounding desert springs. Snakes have been found in Death Valley in Inyo County in heavy riparian vegetation within 5 m of surface water (Emmerich and Cunningham 2003) and at Pachalka Spring, Clark Mountain, San Bernardino County, near the spring head (Wood and Richmond 2003). Outside of California, *D. p. regalis* have been found in evergreen woodland, deciduous woodland, desert grassland, oak-juniper, and succulent desert habitats such as sotol-agave and juniper-agave (Gehlbach 1974).

#### *Distribution (Past and Present)*

In California, the documented range of *Diadophis punctatus regalis* is extremely small. It is known from only a few isolated populations in the Clark, Grapevine, Mute, and Providence Mountains in the Mojave Desert. However, there is a strong possibility that undetected populations exist, particularly at additional springs in the mountain ranges where this taxon occurs. Outside of California, the subspecies occurs in parts of Idaho, Utah, Nevada, Arizona, New Mexico, Texas, and Mexico (Ernst and Ernst 2003). The Great Basin lineage defined by Fontanella et al. (2008) ranges from southern New Mexico north to southern Idaho and between roughly the Sierra Nevada Mountains in the west and the Guadalupe Mountains in the east. Much of the Great Basin clade is

restricted to patches of suitable mesic environments surrounded by less hospitable xeric habitats (Fontanella et al. 2008).

#### *Trends in Abundance*

No population estimates are available for California populations. Declines may have occurred near Fort Piute in the Mute Mountain Range (R. Fisher, pers. comm.).

#### *Nature and Degree of Threat*

The small and patchy distribution of *Diadophis punctatus regalis* in California makes it at risk of extirpation. Its dependence on rare desert spring habitats is an additional risk factor, particularly because these spring habitats are threatened by overexploitation of groundwater resources. Because of their reliance on mesic habitats in an arid matrix, *D. p. regalis* may also be sensitive to climate changes that affect the timing and amount of precipitation. While there is a large degree of uncertainty in how rainfall patterns will change within its range, most studies predict decreases in mean annual rainfall of up to 40% (reviewed in PRBO 2011). In addition to decreases in mean annual rainfall, the number of extremely hot days where temperatures exceed the long-term 95th percentile is expected to increase by roughly 30 days a year (Bell et al. 2004). If conditions become warmer and drier, this could negatively impact *D. p. regalis* habitat.

#### *Status Determination*

*Diadophis punctatus regalis* has an extremely small range in California and is dependent upon a rare habitat type that is sensitive to human use of groundwater in the desert. However, extirpations have not been well documented, and we have virtually no information about the number or status of populations occurring in California. Because of this, we choose not to define a priority at this time.

#### *Management Recommendations*

Protecting desert springs and associated mesic habitat patches is a key requirement for the

continued existence of this species. Minimizing use of water from desert spring sites will help maintain habitat for *Diadophis punctatus regalis*. It is difficult to make further management recommendations given the lack of information on this taxon's ecology in California or similar habitats.

*Monitoring, Research, and Survey Needs*

Given the inhospitable nature of habitat between occupied patches, long-distance dispersal events probably do not occur, and it is unlikely that populations in California are demographically connected. The extremely iso-

lated nature of most of their desert habitat and their relatively short surface activity period also make increased surveys an important priority for this taxon. Increased genetic sampling would help determine patterns of connectivity between fragmented southwestern populations, and we strongly encourage all field surveys to take nonlethal tissue samples of any specimens that are encountered. Given that no population study has been conducted within California and the unique habitat requirements of the taxon, additional work quantifying the basic ecology and life history of *Diadophis punctatus regalis* is badly needed.