CALIFORNIA LEGLESS LIZARD

Anniella pulchra Gray 1852

Status Summary

Anniella pulchra is a Priority 2 Species of Special Concern, receiving a Total Score/Total Possible of 55% (61/110). During the previous evaluation, it was also considered a Species of Special Concern (Jennings and Hayes 1994a).

Identification

Anniella pulchra is a medium-sized (11.1–17.8 cm SVL), elongate, legless lizard that is snake-like in body form. This species possesses several characteristics that are related to an underground burrowing lifestyle such as smooth cycloid scales, a shovel-shaped snout, countersunk jaw, a short blunt tail, and the absence of external ear openings (Stebbins 2003). The dorsal coloration is generally metallic light silver or golden with a black middorsal line down the length of the body and black lateral stripes. *Anniella pulchra* typically have a lemon-yellow ventral coloration. Faintly striped variants sometimes occur, and dark-brown and black forms occur on the Monterey peninsula and around Monterey Bay, as well as from Morro Bay, Monterey County, south to Gaudalupe, Santa Barbara County (Stebbins 2003). This species is unlikely to be confused with other lizard species

California Legless Lizard: Risk Factors

Ranking Criteria (Maximum Score)	Score
i. Range size (10)	5
ii. Distribution trend (25)	15
iii. Population concentration/ migration (10)	0
iv. Endemism (10)	7
v. Ecological tolerance (10)	7
vi. Population trend (25)	10
vii. Vulnerability to climate change (10)	7
viii. Projected impacts (10)	10
Total Score	61
Total Possible	110
Total Score/Total Possible	0.55

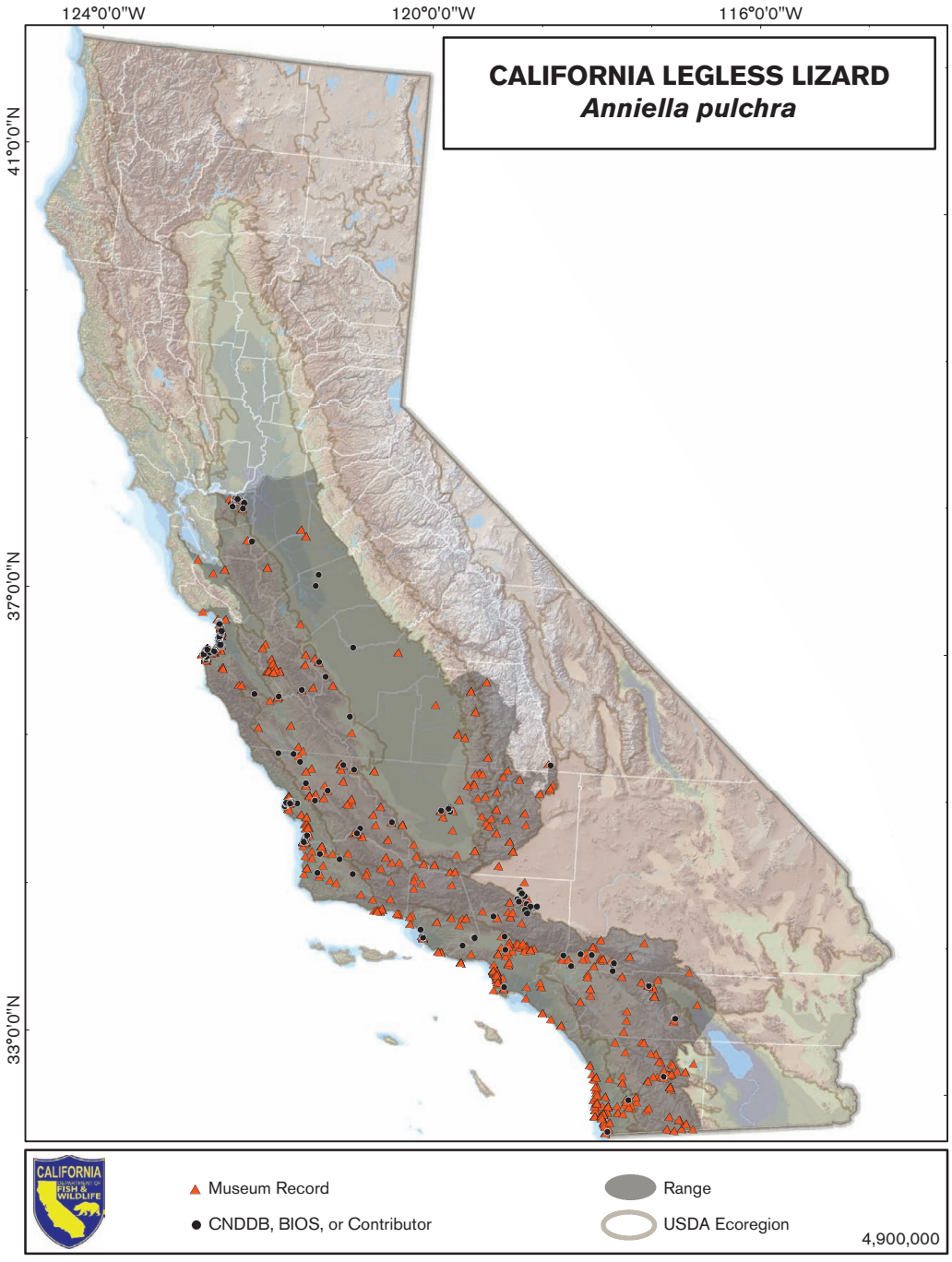

PHOTO ON PREVIOUS PAGE: California legless lizard, Kern County, California. Courtesy of Adam Clause.

in California because it is our only legless lizard. Though *A. pulchra* bears a superficial resemblance to some snake species, the presence of moveable eyelids effectively distinguishes it.

Taxonomic Relationships

Here we treat all California animals as a single species, *Anniella pulchra*. There is substantial evidence for population structure within this species in California from karyotype, allozyme, mitochondrial DNA, nuclear DNA, and morphological studies (e.g., Bezy and Wright 1971, Bezy et al. 1977, Rainey 1985, Pearse and Pogson 2000, Parham and Papenfuss 2009, Papenfuss and Parham 2013). A recent genetic study by Parham and Papenfuss (2009) identified five major lineages within California and documented more extensive genetic diversity within the species than previously reported. Papenfuss and Parham (2013) subsequently proposed that these clades be elevated to species status based on genetic information and some additional data on morphology. This revision occurred as we were finishing our evaluation of special concern status, and we retain the traditional arrangement here to allow the herpetological community time to evaluate this proposed change in taxonomy.

Life History

Breeding occurs between early spring and July in these live-bearing lizards. Oviductal eggs have been observed between July and October, and 1–4 young are born after a 4-month gestation period (Miller 1944, Goldberg and Miller 1985). Juveniles grow rapidly (2.5–4.4 mm SVL/month) and reach sexual maturity after about 2 years at ~9 cm SVL for males and after about 3 years at ~12 cm SVL for females (Miller 1944, Goldberg and Miller 1985). Life span in the field is unknown, but captive animals have survived for almost 6 years (L. Hunt, pers. comm., in Jennings and Hayes 1994a).

Anniella pulchra is rarely seen active on the surface, but they do use the soil/litter interface for feeding and mating (Miller 1944). Daily activity patterns peak in the morning and evening, though animals have been observed active at night (Miller 1944, Stebbins 1954, Gorman 1957, Bury and Balgooyen 1976, Kuhnz 2000). Coastal and southern populations are likely active year-round, while inland populations (e.g., Sierra Nevada foothills) may enter a period of dormancy during cold months (Banta and Morafka 1968, Zeiner et al. 1988).

Little is known about movement ecology. These fossorial lizards have been found at soil depths from a few to 50 cm below the surface (Miller 1944, Hunt 1984, Kuhnz 2000). Animals have been observed burrowing to a depth of 46 cm in the laboratory (Kuhnz 2000). In one short-term study (~2 months), 10 lizards were recaptured within 10 m of their original capture points (Miller 1944). A two-year PIT tagging study documented an average home range size of 71 m^2 (Kuhnz 2000).

Anniella pulchra prefers lower temperatures than most other California lizards (~21–28°C in lab trials, Bury and Balgooyen 1976; critical thermal maximum 34°C, Brattstrom 1965), which is consistent with a non-basking fossorial lifestyle. Surface activity by this species is likely limited by both ambient and substrate temperature (Miller 1944).

Little is known about the feeding ecology of this species. *Anniella pulchra* is a generalist sit-and-wait insectivore (Coe and Kunkel 1906, Miller 1944) that eats larval insects (e.g., microlepidopterans and beetles), adult beetles, termites, and spiders (L. Hunt, pers. comm. in Jennings and Hayes 1994a).

Habitat Requirements

At a regional scale, *Anniella pulchra* occurs in sparsely vegetated habitat types including coastal sand dunes, chaparral, pine–oak woodland, desert scrub, open grassland, and riparian areas (Stebbins 2003; S. Sweet, pers. comm.). At local scales, this lizard is a microhabitat specialist requiring sandy or loose loamy substrates conducive to burrowing (Miller 1944, Gorman 1957, Cunningham 1959a, Banta and Morafka 1968). Soils that are not used include gravel-sized substrates and those with greater than

approximately 10% clay content, resulting in absence of this species from serpentine and shale bedrock (S. Sweet, pers. comm.).

At a Monterey County coastal sand dune site, *A. pulchra* used non-compacted, organic-rich soil preferentially and were most abundant in undisturbed soil types, although they were also found in slightly cemented clay-/silt-rich sands (Kuhnz et al. 2005). Plant community structure also contributed to microhabitat suitability, with *A. pulchra* more common around native shrubs such as silver bush lupine, mock heather, and yellow lupine and less common around nonnative grasses, forbs, and iceplant (Kuhnz et al. 2005). In the Mojave Desert, *A. pulchra* can be found in leaf litter under juniper trees (*Juniperus*) (J. Parham and T. Papenfuss, pers. obs.). Soil moisture may also be a limiting factor for this species (Burt 1931, Miller 1944, Bury and Balgooyen 1976). Kuhnz et al. (2005) found more lizards in the low areas between dunes than in other areas, which may be due to water retention.

Distribution (Past and Present)

Most of the range of *Anniella pulchra* occurs in California, from Contra Costa County south through the Coast Ranges, in parts of the San Joaquin Valley, the western edge of the Sierra Nevada Mountains, the western edge of the Mojave Desert, and northern Baja California (Hunt 1983, Jennings and Hayes 1994a). Although most commonly found within 100 km of the coast, *A. pulchra* ranges in elevation from sea level to about 1800 m (Hunt 1983).

Based on the assumption that *A. pulchra* cannot persist in habitat where soil has been disturbed (e.g., plowing, bulldozing), Jennings and Hayes (1994a) estimated that ~20% of historical habitat is no longer suitable. Parham and Papenfuss (2009) noted that several localities they sampled around Bakersfield in the early 2000s no longer existed by the time their study was published. However, some populations have persisted in developed areas, particularly around fence lines, road verges, utility corridors, and gardens (S. Sweet, pers. comm.). For example, populations that were present in the 1970s were still extant in the 2000s in Fontana, San Bernardino County, in residential areas that were formerly the Delhi Dunes (S. Barry, pers. comm.). *Anniella pulchra* has also been observed in irrigated gardens in Contra Costa County where naturally sandy soils are available (E. Ervin, pers. obs.). The long-term viability of populations in such developed areas is an important research question.

Trends in Abundance

Very few population size estimates are available for this cryptic species. *Anniella pulchra* can be locally abundant, with the highest documented density of 1.67/m^2 occurring under a single yellow lupine bush in coastal dune habitat at Moss Landing, Monterey County (Kuhnz et al. 2005). Given the high degree of development within its coastal range, we suspect that some populations are declining. In particular, the black form on the Monterey Peninsula may be at great risk given the substantial development pressure in the region.

Nature and Degree of Threat

The greatest threats to *Anniella pulchra* are habitat loss and degradation, and climate change is also a potential emerging threat. Anthropogenic impacts that disturb soil moisture levels or result in soil compaction likely degrade habitat suitability for this species. While some disturbance may be tolerated, development that covers large areas (>8 ha) can potentially cause local extinctions of *A. pulchra* (S. Sweet, pers. comm.). Invasive plants may also have a negative impact on habitat suitability and abundance (Kuhnz et al. 2005). Over the next 100 years, mean annual temperature is expected to increase throughout the range of *A. pulchra* (reviewed in PRBO 2011). There is greater uncertainty in how precipitation will change, with some models predicting decreases in precipitation of up to 37% and other models predicting no change or only moderate declines (Bell et al. 2004, Snyder et al. 2004, Snyder and Sloan 2005, PRBO 2011). Warmer and

drier conditions might limit activity to deeper soil depths, although the population impacts of such a shift are unknown. Alterations in vegetation communities due to climate change may pose a larger threat to this species, as increases in grassland habitat are predicted through much of its range with concomitant decreases in preferred open habitat types such as coastal scrub, particularly in southern California (Lenihan et al. 2008, PRBO 2011). The frequency and size of fires in the Coast Ranges is expected to increase up to 50% by the end of the century (Fried et al. 2004, Lenihan et al. 2008, Westerling and Bryant 2008). Fire dynamics are more difficult to predict in southern California, partly due to the role of Santa Ana winds (reviewed in PRBO 2011, Franco et al. 2011). How fire affects *A. pulchra* is unknown. Direct mortality effects may be small due to its subterranean lifestyle, although indirect negative effects may occur through habitat shifts and changes in soil chemistry.

Status Determination

Anniella pulchra is a near-endemic, ecologically specialized lizard with much of its range occurring in heavily populated and impacted coastal areas. Little data is available on the abundance of this cryptic species, particularly in non-dune habitats, which limits our ability to quantify population trends or document extirpations.

Management Recommendations

Protection of dune areas both along the coast and in the Coast Range is critical. In occupied areas, disturbances such as development, agriculture, and off-highway vehicle use should be reduced or eliminated. Activities that compact soil, in particular, should be avoided. Given that *Anniella pulchra* appears to persist in some developed areas provided that sandy soils and native plant communities remain intact, incentivizing or requiring natural landscaping in low-density housing (as has been done in Monterey County for the federally and state endangered Santa Cruz long-toed salamander, *Ambystoma macrodactylum croceum*) may allow lizards to coexist with some development. The spread of nonnative plant species into remaining habitat should be minimized. Eradication of invasive plants and restoration of native vegetation may help increase *A. pulchra* density and should be explored.

Monitoring, Research, and Survey Needs

With a few exceptions (e.g., Miller 1944, Kuhnz et al. 2005), little is known about *Anniella pulchra* abundance across its range. Studies of basic ecology are needed in other parts of the range and in other habitat types. Minimally, surveys summarizing habitat use, soil characteristics, and population density in coastal southern California and the southern Sierra Nevada should be conducted to complement work in Monterey County. Understanding under what conditions this species can persist in human-disturbed habitats would be valuable, particularly with respect to soil characteristics and fragmentation that occurs as a consequence of urbanization and agricultural land use. *Anniella pulchra* co-occurs with Argentine ants (*Linepithema humile*) along the coast, but it is unknown whether this introduced species has any substantial impacts on *A. pulchra*.

Presence and abundance of this cryptic species are both difficult to assess, and more research into the best sampling methods for different habitats would be useful for the development of monitoring efforts. In a comparison of survey techniques in dune habitat in Monterey County, Kuhnz et al. (2005) concluded that time-constrained searches were the most reliable method for detecting *A. pulchra* presence across a range of population densities and dune vegetation types. In time-constrained searches, surveyors searched the surface, under dried vegetation or cover objects, and up to 15 cm below the surface. Kuhnz et al. (2005) noted that all survey methods were poor at detecting lizards at low densities of ~1/100 m^2, and even time-constrained searches greatly underestimated density compared to depletion raking (raking of substrate until one or fewer individuals were found per 40 hours of search

effort). However, these results may not apply in general across habitat types. For example, some investigators prefer to use cover objects at inland sites where *A. pulchra* is relatively rare (J. Parham, pers. comm.).

Additional genetic analyses at the population level may be the best way to efficiently determine the effective population size and genetic connectivity of apparently isolated populations. Particularly in conjunction with intensive time-constrained surveys, genetic data can be used to measure habitat-specific gene flow, current population size, and changes in population size. We recommend that appropriate genetic markers be developed and that tissues be collected and deposited in appropriate repositories for such analyses.