# SPECIES STATUS ASSESSMENT

**FOR THE**

# TEMBLOR LEGLESS LIZARD

## (*Anniella alexanderae*)

Photo by Jonathan Hakim

**U.S. Fish and Wildlife Service**
**Pacific Southwest Region**
**Sacramento Fish and Wildlife Office**
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**VERSION HISTORY**

**Version 1.0**: We began the original version of this Species Status Assessment in January 2025 and completed a draft SSA report in July 2025.

**Version 1.1:** The draft Species Status Assessment Report underwent peer and technical review, and edits were incorporated into this version in September 2025.

## EXECUTIVE SUMMARY

We, the U.S. Fish and Wildlife Service (Service), received a petition from the Center for Biological Diversity on October 20, 2020 (CBD 2020, entire) to list the Temblor legless lizard (lizard) (*Anniella alexanderae*) as threatened or endangered and to designate critical habitat, under the authority of the Endangered Species Act of 1973 as amended (16 U.S.C. 1531-1543) (Act). On June 17, 2021, we issued a 90-day finding that the petition presented substantial information to indicate that listing may be warranted (86 FR 32241).

The Temblor legless lizard burrows through loose California substrate (soil or vegetation duff) in a range running along the eastern foothills of the Temblor and Diablo mountains and extending into the San Joaquin Valley floor west of Interstate 5 (Rose et al. 2022, p. 16). They essentially swim through the substrate (Evelyn and Sweet 2018, p. 6), probably at depths of 1 to 24 inches (2.5 to 61 centimeters (cm)) based on studies of a closely related species (Miller 1944, pp. 279, 281, 289; Kuhnz 2000, pp. 2, 18) and thus require loose well-drained soil or vegetation duff for all life stages (Miller 1944, p. 284; Parham and Papenfuss 2009, p. 169). Its range includes western portions of Kern, Kings, and Fresno Counties, as well as a small section of eastern San Luis Obispo County. It was first recognized as a separate species in 2013 based on genetic and morphological distinctions (Papenfuss and Parham 2013, pp. 6–9).

Although the number of separately interbreeding Temblor legless lizard populations is unknown, we are not aware of any clear barriers that would prevent genetic interchange throughout the range. The existence of numerous intermittent and ephemeral streams, and adjacent habitat, with sandy soils provides a potential means for dispersal to different areas. No portions of the range are known in which the lizards have genetic, morphological, or behavioral distinctions from lizards in other areas. Genetic variation across the range is low (Parham et al. 2019, pp. 17–18). We therefore treat the species as a single population for purposes of this report. The resiliency of that population depends on the availability of resources meeting the needs of individual lizards, as well as on several population-level factors such as population size (N), growth rate (λ), and effective population size ($N_e$, an indication of ability to avoid inbreeding depression and to adapt to future changes). All of these population-level factors are unknown for this species.

The Temblor legless lizard is currently a candidate species under the California Endangered Species Act. In addition, the Service and Bureau of Land Management (BLM) are working with the California Department of Fish and Wildlife (CDFW) to fund ongoing research on the lizard.

Threats to the species include impacts from oil production (including loss and fragmentation of habitat, spills, noise impacts, or wastewater seepage); catastrophic events such as floods and droughts; and climate change.

Based on a geographic information system (GIS) landcover analysis of the range, potentially-suitable habitat (shrublands and grasslands) has fallen from 75.9% of the range in 1986 to 71.3% in 2023. Meanwhile development (primarily related to oil-extraction) has increased from 6.1% to 10.2% of the range. Temperatures have increased, but rather than converting grasslands to shrublands, the percentage of shrublands across the range has increased by over 5%. This is likely beneficial to the lizard, which needs overhanging vegetation to provide shade and support prey populations. Sightings of lizards relatively close to oil wells and to a landfill indicate the lizards can coexist to some extent with such activities nearby. Oil and wastewater spills have occurred but tend to be channeled and confined by topographic features rather than spreading across the landscape. Current resiliency therefore appears sufficient to allow recovery from normal environmental fluctuations.

Current redundancy also appears sufficient to survive catastrophic events. Although the known range is small, available habitat appears well-distributed, making the lizard more likely to spread out across the range rather than clustering in small areas that would be more vulnerable to local catastrophic events such as oil spills. From 2018 to 2023 about 70 small spills and one major spill occurred in oil-producing areas of the range. Oil fields constitute about 37% of the range, but the spills only totaled about 7 acres because the oil and wastewater spilled was contained by the topography of the landscape rather than being widely transported by water. A major drought would affect the entire range, and so is likely the most challenging catastrophic event reasonably likely to occur, but the lizard has survived such major droughts in the past and remains distributed across its entire range. Current representation is naturally low due to the lack of morphological, behavioral, or genetic variation across the range. Habitat characteristics do vary somewhat, both from the foothills to the valley floor and from north to south, but no habitat type is currently in danger of being lost, and the lizard relies more on microhabitat features of loose soil and overhanging vegetation. Such areas are scattered relatively evenly across the range.

To characterize the future condition of the species, we established two plausible future scenarios, one optimistic and the other pessimistic, in order to capture the range of reasonably likely future conditions. We expect actual future events to fall somewhere between these scenarios. We considered most impacts to the species out to 2075 because we had data to support those analyses. Because better data is available regarding future weather-related changes, we considered impacts from those out to 2100 in both our scenarios.

Under Scenario 1, the declining construction rate of new oil wells levels off at roughly current rates, resulting in a total of 10,000 new wells (50% more than are currently active) by 2075. Emissions of heat-trapping gasses follow the more optimistic RCP 4.5 trajectory, and non-oil related development is limited to about 1% or less of the range (in keeping with current trends), mostly in areas not constituting potential habitat. This scenario results in the decrease of potentially-suitable habitat from 487 sq mi rangewide to 456 sq mi (a 6.4% decrease). All such development-related habitat losses would occur in the oil fields. Precipitation levels remain at current or higher levels under this scenario, thereby helping to alleviate droughts and preventing conversion of shrubland to grassland by wildfires. Redundancy (susceptibility to catastrophes) would thus be lowered somewhat in the oil field areas due to oil development, but would not be strongly affected elsewhere. Representation remains inherently low due to lack of differences across the range.

Under Scenario 2, the production of new wells increases to twice that of the other scenario, heat-trapping gas emissions follow the more pessimistic RCP 8.5 trajectory, and net non-oil related development affects 5% of the range (1% of which occurs in non-habitat areas). This results in potentially-suitable habitat decreasing from 487 sq mi rangewide to 398 sq mi due to development (an 18.3% decrease). Two thirds of these losses occur in the oil field areas, leaving about half of those areas undeveloped by oil extraction. Temperature increases also lower the quality of some additional marginal habitat and leave the lizard more dependent on overhanging vegetation for shade and precipitation for moisture (and to maintain the vegetation). This dependency in turn leaves the lizard susceptible to fires and droughts, but fires are projected to decrease under the scenario and precipitation is projected to increase. Overall resiliency thus decreases under the scenario, but less so outside the oil fields which is a major portion of the range. Redundancy is affected by increased flooding, and by increased susceptibility to major drought (which would affect the entire range). Representation would again remain unaffected because it starts from such a low baseline, with no known differences across the range.

# CHAPTER 1 – INTRODUCTION

## 1.1 SPECIES OVERVIEW

The Temblor legless lizard (lizard) (*Anniella alexanderae*) burrows through loose substrate (soil or vegetation duff) in a range that includes the eastern foothills of the Temblor and Diablo ranges of California, along with adjacent portions of the San Joaquin Valley floor west of Interstate 5 (Rose et al. 2022, p. 16). Its long narrow range runs through western portions of Kern, Kings, and Fresno Counties, as well as a small section of eastern San Luis Obispo County. Like snakes, the Temblor legless lizard has no legs, but like other lizards it can close its eyelids and may self-amputate part of its tail if startled (Ast 2003, p. 1; Thompson et al. 2016, p. 188). It was first recognized as a separate species in 2013 based on genetic and morphological distinctions (Papenfuss and Parham 2013, pp. 6–9).

## 1.2 PETITION HISTORY AND PREVIOUS FEDERAL ACTIONS

We, the U.S. Fish and Wildlife Service (Service), received a petition from the Center for Biological Diversity on October 20, 2020 (CBD 2020, entire) to list the lizard as threatened or endangered and to designate critical habitat, under the authority of the Endangered Species Act of 1973 as amended (16 U.S.C. 1531-1543) (Act). On June 17, 2021, we issued a 90-day finding that the petition presented substantial information to indicate that listing may be warranted (86 FR 32241). We subsequently assessed the lizard's current and future viability, as summarized in this species status assessment (SSA) report, in order to inform our upcoming 12-month finding on whether listing is warranted. If we find that listing is warranted, we will propose to list the lizard as either threatened or endangered, provide at least 60 days for public comment, and then make a final determination. If we determine in our 12-month finding that listing is not warranted, that will conclude our response to the petition.

## 1.3 STATE LISTING STATUS

The Center for Biological Diversity also petitioned the California Department of Fish and Wildlife (CDFW) to list the lizard under the California Endangered Species Act (CESA) (CBD 2021, entire). CDFW issued a 90-day evaluation report on March 25, 2022 (CDFW 2022, entire), recommending that listing under CESA may be warranted. The California Fish and Game Commission voted unanimously to accept the recommendation on June 15, 2022, thereby establishing the lizard as a candidate species under CESA while further review takes place (CBD 2022, p. 1; CDFW 2025c, p. 2).

## 1.4 SSA FRAMEWORK

The Service uses the SSA framework (Service 2016, entire) to provide an integrated analytical approach to assess a species' current biological condition and its projected capability of sustaining populations in the wild into the future (Smith et al. 2018, entire). Building on the best of our current analytical processes and the latest scientific information in conservation biology, this framework integrates analyses that are common to all functions under the Act, eliminates duplicative and costly processes, and allows the Service to strategically focus on our core mission of preventing extinction and achieving recovery. The purpose of this SSA Report is to provide a summary of a species' risk assessment and assist in informing decisions and activities under the Act .

Using the SSA framework, we consider what a species needs to maintain its viability by characterizing the biological status of the species in terms of its resiliency, redundancy, and representation (3 Rs) (adapted from Shaffer and Stein 2000, pp. 308–311). For this assessment, we define viability as the ability of the species to sustain populations in the wild within a biologically meaningful timeframe, in this case, at least 50 years. We chose 50 years because the available data allow us to reasonably predict the potential effects of certain stressors, such as oil and gas extraction, within the range of the Temblor legless lizard through this timeframe and because 50 years represents a period of time that captures a range of variation in environmental conditions which the species will need to withstand in order to sustain populations into the future. For stressors that are predictable over longer timeframes, such as warming average temperatures, we extended our review of likely impacts to the year 2100.

The 3 Rs are defined as follows (Smith et al. 2018, pp. 306–307):

- Resiliency is the ability of a species to withstand environmental stochasticity (normal, year-to-year variations in environmental conditions such as temperature, rainfall), periodic disturbances within the normal range of variation (fire, floods, storms), and demographic stochasticity (normal variation in demographic rates such as mortality and fecundity) (Redford et al. 2011, p. 40). Simply stated, resiliency is the ability of a species to bounce back and sustain populations through the natural range of favorable and unfavorable conditions.

- Redundancy is the ability of a species to withstand catastrophes. Catastrophes are stochastic events that are expected to lead to population collapse regardless of population health and for which adaptation is unlikely (Mangel and Tier 1993, p. 1083).

- Representation is the ability of a species to adapt to both near-term and long-term changes in its physical (climate conditions, habitat conditions, habitat structure, etc.) and biological (pathogens, competitors, predators, etc.) environments. This ability to adapt to new environments-- referred to as adaptive capacity--is essential for viability, as species need to continually adapt to their continuously changing environments (Nicotra et al. 2015, p. 1269). Species adapt to novel changes in their environment by either [1] moving to new, suitable environments or [2] by altering their physical or behavioral traits (phenotypes) to match the new environmental conditions through either plasticity or genetic change (Nicotra et al. 2015, p. 1270; Beever et al. 2016, p. 132). The latter (evolution) occurs via the evolutionary processes of natural selection, gene flow, mutations, and genetic drift (Zackay 2007, p. 1; Crandall et al. 2000, pp. 290–291; Sgro et al. 2011, p. 327).

## CHAPTER 2 – SPECIES BIOLOGY

In this chapter, we summarize basic information about the Temblor legless lizard, including its taxonomy, physical description, genetics, historical range and distribution, and general life history traits.

## 2.1 TAXONOMY

The Temblor legless lizard is one of four legless lizard species in California first identified in 2013 by Papenfuss and Parham (2013, pp. 6–9). The four new species had all previously been considered populations of the California legless lizard (*Anniella pulchra*) (Papenfuss and Parham 2013, pp 1–2). Identification of the four new species left the remaining California legless lizards restricted primarily to the northern portion of their former range. Accordingly, we now refer to these as "Northern California legless lizards," as suggested by Papenfuss and Parham (2013, p. 13). The *Anniella* genus contains one additional species in northwest Baja California: the Baja California legless lizard (*Anniella geronimensis*) (Papenfuss and Parham 2013, p. 2; ITIS 2021, p. 1).

A 2018 draft species account for the U.S. Forest Service's Southwest Region management plan (Evelyn and Sweet 2018, pp. 2–3) disagrees with Papenfuss and Parham's (2013, p. 23) determination that the Temblor legless lizard is a valid species. However, to our knowledge that draft document has not been finalized, and all subsequent reviewers have accepted the species status of Temblor legless lizard as valid (ITIS 2021, p. 1; de Queiroz et al. 2017, p. 38; CDFW 2022, p. 5; de Queiroz and Chan 2025, p. 23).

There has also been a long-running disagreement among taxonomists (Ast 2003, p. 1; Hunt 2008, pp. 848.3–848.4) regarding whether the Temblor legless lizard's genus (*Anniella*) should be placed in its own family (Anniellidae) or should instead be grouped in the Anguidae family alongside glass lizards (Anguinae) and alligator lizards (Gerrhonotinae) (Hunt 2008, p. 848.4). Although genetic studies conducted in 1987 and 1999 placed *Anniella* in its own family, numerous studies based on morphological characteristics, conducted from 1957 to 2005, failed to reach a consensus (Hunt 2008, pp. 848.3–848.4). However, two additional genetic studies have since published, both of which support placement of *Anniella* in its own family (Pyron et al. 2013, pp. 4, 18; Burbrink et al. 2020, pp. 508, 509, 515). Burbrink et al. (2020, p. 508) provided a cladogram based on their genetic data indicating that the split between Anniellidae and Anguidae dates to the late Cretaceous period. Currently, with the exceptions of the Integrated Taxonomic Information System (ITIS 2021, p. 1) and the Reptile Database (Reptile Database undated, p. 1), most taxonomic summaries now appear to be following these more recent, genetically-based interpretations and assigning *Anniella* to Anniellidae (California Herps undated, p. 5; Hammerson 2019, p. 2; NatureServe 2021, p. 2; Center for North American Herpetology undated, p. 1). The question of the family status of *Anniella* lizards is largely subjective, however, depending on the importance assigned to differences with *Anniella*'s sister clade of glass and alligator lizards (Parham in litt. 2025, p. 6).

## 2.2 PHYSICAL DESCRIPTION

Temblor legless lizards are thin, snake-like reptiles, with pale olive-colored backs, light gray ventral scales, and a single black stripe on their backs and each side (Papenfuss and Parham 2013, p. 8; Thompson et al. 2016, p. 186; Parham and Papenfuss 2009, p. 169). Adults grow to about nine and a half inches (in) long (23.9 cm), including the tail (Papenfuss and Parham 2013, p. 8). They burrow in loose, well-drained soil and leaf litter (Ast 2003, p. 1), and several characteristics support their burrowing lifestyle, including smooth scales, a shovel-shaped snout, and the absence of external ear openings (Thompson 2016, p. 186). Their light gray ventral surface distinguishes them from other *Anniella* species, as do their high number of scales (more than 250) along the back (Papenfuss and Parham 2013, pp. 5, 7).

## 2.3 HISTORICAL RANGE AND DISTRIBUTION

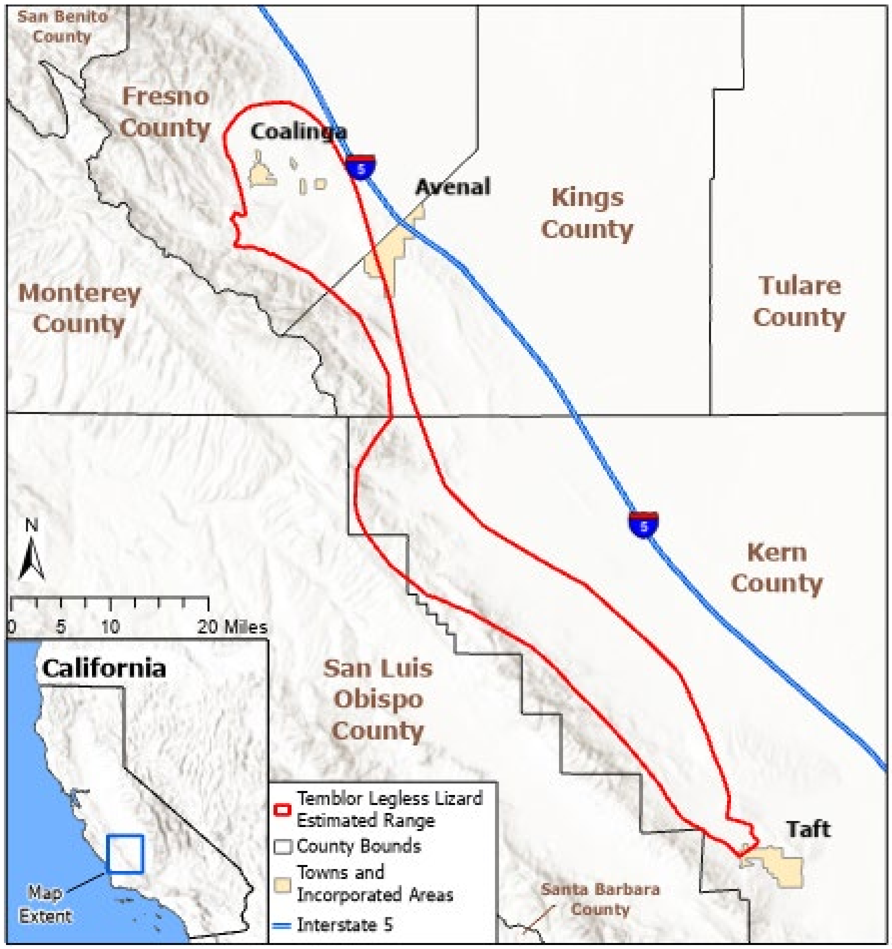



**Figure 1. Temblor legless lizard estimated range.**

The newly identified species was originally known from two sites in Kern County, west of Highway 33, between McKittrick and Taft (Papenfuss and Parham 2013, pp. 2, 8). Additional surveys led to a published range running along the base of the Diablo and Temblor Ranges from just north of Coalinga to just northwest of Taft (Parham et al. 2019, p. 11; Rose et al. 2022, p. 16). Two sightings have since occurred slightly outside that range, leading us to make slight adjustments along watershed and ecoregion boundaries to allow the range to encompass them. Subsequent genetic information has come to light indicating the southernmost of those sightings was not a Temblor legless lizard after all (Rose in litt. 2025a, p. 9). Another Temblor legless lizard has recently been found about 1,100 ft (335 m) outside the range boundary, in the southeast portion of the range between the current boundary and the California Aqueduct (Rose et al. 2025, p. 6). We have chosen to leave these slight adjustments in the species range as they stand rather than redrawing the range and redoing all our GIS landcover analyses (below) because the changes are so minor in scale. A legless lizard has also recently been sighted considerably outside the northwestern portion of the range, but its species has not been determined genetically (Rose in litt. 2025a, p. 9). We expect that future surveys may show the range needs to be expanded to the aqueduct itself, which would act as a barrier to lizards attempting to disperse further.

Overall size of the apparent range is roughly 90 by 8 miles (145 by 13 kilometers (km)). Although further adjustments may be necessary, such as possibly extending the southwest boundaries to the California Aqueduct, the range we currently recognize, is shown in Figure 1.

About 25 occurrences are currently known (Diversity Database 2024a, entire; Rose et al. 2025, p 5–7), (counting multiple sightings at roughly the same location as a single occurrence).

Most, but not all, sightings of the lizard have occurred in the southern and northern portions of the range (Rose et al. 2024, pp. 4–7). The central area includes private property, where surveys have been difficult to conduct due to lack of access (Rose et al. 2022, p. 3; Rose et al. 2024, pp. 1, 8–11). Access is improving, however, potentially leading to additional sightings in the future (Papenfuss in litt. 2025, pp. 1, 2).

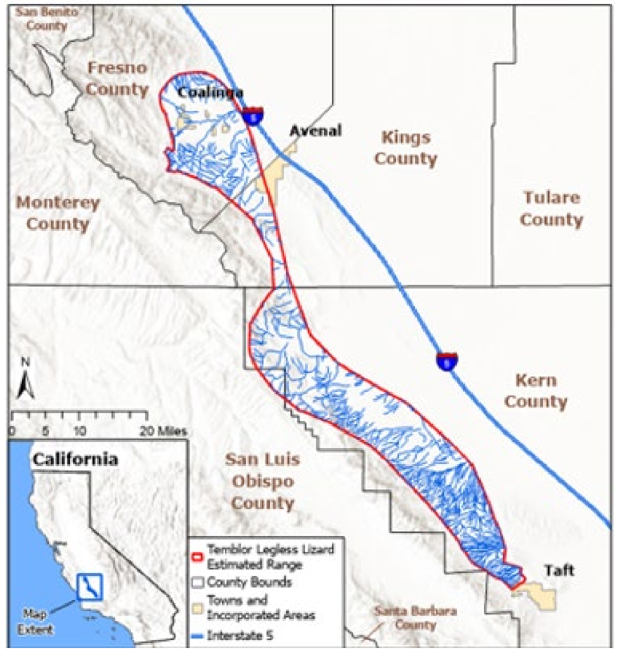



**Figure 2. Larger streams in the range.**

Habitat for the lizards appears to be well distributed across the range. For instance, occupied areas are often close to intermittent or ephemeral streams (Rose et al. 2022, p. 8), and larger such streams are present throughout the range (though somewhat more common in the south, see Figure 2). Overhanging vegetation and loose soils are likely to be found at numerous locations along such streams (as well as near smaller streams that remain unmapped), because the streambeds channel water to support bushes, and because sand is washed down them and deposited by storms (Rose et al. 2022, p. 8). Habitat in the actual stream channel is problematic for the lizard, however, because they could drown if a rainstorm fills the channel (Parham in litt. 2025, p. 1).

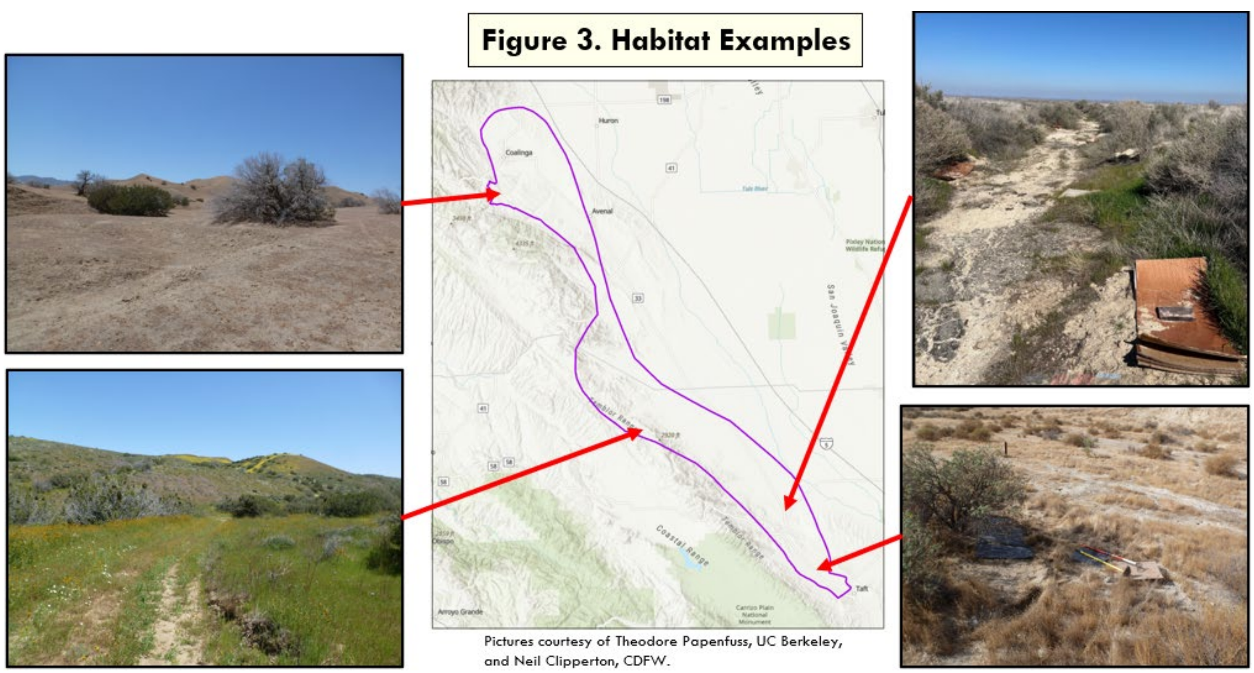



**Figure 3. Habitat Examples**

## 2.4 LIFE CYCLE

All life cycle information we are aware of is based on observations of "California legless lizards" (*Anniella pulchra* prior to the recognition of the Temblor legless lizard (and others) by Papenfuss and Parham (2013, pp. 1, 5–9)). *Anniella* lizards in general have been described as "ovoviviparous," meaning that the young are born freely moving after developing within eggs that stay in the mother's reproductive tract (Miller 1944, pp. 276, 277, 288). However, the term "ovoviviparous" has since come to be considered archaic due to lack of clear distinctions from viviparity ("live birth") (Packard et al. 1977, p. 75; Blackburn 1999, p. 994). For instance, *Anniella* lizards lack calcareous-shelled eggs, but still have egg membranes, whereas other animals may have reduced or no membranes but still provide yolks, or provide various combinations of yolk and additional nourishment (Packard et al. 1977, p. 74–75). *Anniella* lizards are thus simply "viviparous" and give birth to one to four young (usually two) (Jennings and Hayes 1994, p. 110).

The birthing season for California legless lizards in general has been described as September to November (Jennings and Hayes 1994, p. 110). But Miller (1944, pp. 276–277) noted that gravid specimens from San Diego and Los Angeles Counties (now considered Southern California legless lizards (*Anniella stebbinsi*)) (Papenfuss and Parham 2013, p. 2; de Queiroz et al. 2017, p. 38), had embryos that were well developed or somewhat well-developed in November, whereas gravid specimens from Kern County (Temblor legless lizards) had well-developed or somewhat well-developed embryos in September and late August. Miller (1944, p. 277) concluded that the lizards in San Diego, Los Angeles, and Kern Counties had different breeding seasons, with Temblor legless lizards (Kern County) tending to give birth in September. This was based off only one or two specimens from each area, however.

In contrast, Goldberg and Miller (1985, p. 618) found that 10 out of 10 gravid females from Los Angeles County (Southern California legless lizards) gave birth in mid to late October (the 14th through the 29th). Together, these studies indicate that Southern California legless lizards give birth from October through November. If we infer a similarly large birthing season for Temblor legless lizards, that would mean they give birth from September through October.

Goldberg and Miller (1985, p. 618) also found gravid Southern California legless lizard females from July through early October, indicating a roughly 4-month gestation period. Assuming the length of gestation is the same in Temblor legless lizards, that would indicate the Temblor legless lizard mating season is in May and June (allowing four months gestation until births in September and October).

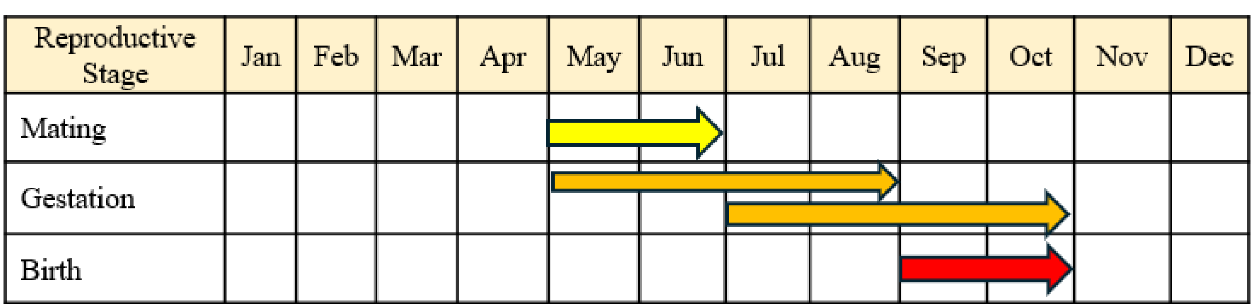


**Figure 4. Reproductive stages inferred for Temblor legless lizards.**

Goldberg and Miller (1985, p. 618) also noted that (depending on the month) only 40 to 75 percent of the females large enough to give birth and sampled during the gestation period were pregnant. They concluded that females of breeding age might not breed every year, thus lowering the reproductive potential of the population. They also noted that this is the case for island night lizards (*Xantusia riversiana*). Like Temblor legless lizards, island night lizards are viviparous and have high site fidelity (Goldberg and Bezy 1974, p. 350; Jennings and Hayes 1994, pp. 110; Holmes et al. 2016, p. 2).

Miller (1945, pp. 273, 276, 288) recognized four age groups in what is now the Northern California legless lizard (*Anniella pulchra*, collected at Antioch, CA). Those groups are: Young of the Year, Immature, Subadult (two years old; sexually mature but probably non-breeding), and Breeding Adult (probably at least 3 years old). He noted that Immature lizards were "probably female" if 2 years old. This implies 2-year-old lizards that are not immature (and are thus Subadults) are probably male. Lacking evidence to the contrary, we assume these categories apply to Temblor legless lizards as well. The typical lifespan of *Anniella* lizards remains unknown, but captive individuals have lived almost six years after capture as sexually mature adults (Jennings and Hayes 1994, p. 110).

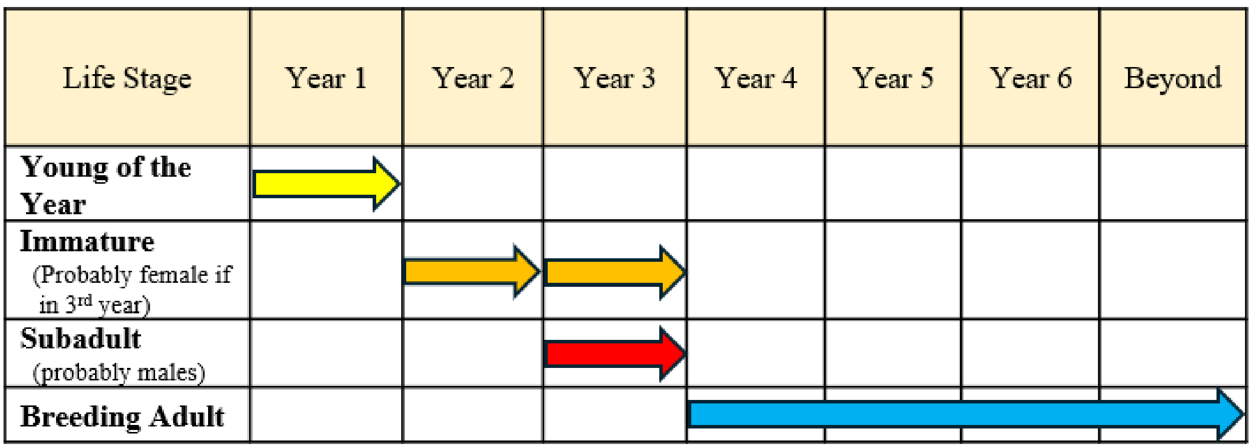



**Figure 5. Life history stages after birth.**

## 2.5 ANALYTICAL UNITS

We considered whether it was appropriate to separate the range of the Temblor legless lizard into different analytical units to account for local habitat differences, local adaptations, or separately interbreeding populations.

The range is small (roughly 90 miles long by about 8 miles wide) (145 by 16.1 km), and areas with loose substrate and overhanging, well-rooted vegetation (see INDIVIDUAL NEEDS, below) occur throughout. No areas in the range are known to support lizards with locally unusual markings, behaviors, or genetics. Mitochondrial DNA variation across the range is low (Parham et al. 2019, pp. 17–18), suggesting recent interbreeding. Lizards appear to be well distributed throughout the range. Likely impediments to dispersal, such as roads, may potentially be crossed by following the sandy soils in and near intermittent or ephemeral streams, and either crawling through or being washed through culverts or under bridges. While there have been fewer sightings in the central portion of the range, this is to be expected given that there is more private land in that area, and thus greater difficulty in gaining access to conduct surveys. While there is the potential for there to be multiple populations across the range that are separated by barriers or unsuitable habitat (Halstead in litt. 2025, p. 1), we do not have information on population structure at this time.

Accordingly, after a review of the best available information, for purposes of this assessment we are treating the entire range as a single analytical unit.

# CHAPTER 3 – SPECIES NEEDS

To remain viable, species need one or more resilient populations. Resilient populations, in turn, need a sufficient number of reproducing individuals to allow the population to recover from normal environmental fluctuations. In this chapter we discuss what is needed by Temblor legless lizard individuals in order to survive and reproduce, what additional things are needed by the population to make it resilient, and what beyond that is needed by the species as a whole to maintain redundancy and representation, and thereby maintain viability.

## 3.1 INDIVIDUAL NEEDS

Based on observations of the closely related Northern California legless lizard, Temblor legless lizards burrow through loose substrate by pushing it to the side with their heads while undulating their bodies to push themselves forward (Miller 1944, p. 279). They can essentially swim through particularly loose soil or vegetation duff (Evelyn and Sweet 2018, p. 6), but they also create and use persistent burrow systems (Kuhnz 2000, p. 36). They have been observed at depths of 1 to 24 inches (2.5 to 61 centimeters (cm)) (Miller 1944, pp. 279, 281, 289; Kuhnz 2000, pp. 2, 18). One of their habitat requirements is thus relatively loose well-drained substrate (Miller 1944, p. 284; Parham and Papenfuss 2009, p. 169). Soils with more than about 10% clay content are avoided, as are particularly rocky, gravelly, or disturbed soils (Jennings and Hayes 1994, p. 111; Thompson et al. 2016, pp. 188–189). The extent of rock or gravel content they can coexist with in the soil remains unclear, however, as they typically occupy gravelly sandy loam in the southern portion of their range (Rose in litt. 2025a, p. 13).

Northern California legless lizards (and presumably Temblor legless lizards) also avoid areas that are too dry, because without sufficient moisture in at least some accessible layer of substrate, they are unable to shed their skin effectively (Miller 1944, pp. 277, 285). Unshed pieces of old dry skin left on the head can interfere with feeding, and in some cases lead to starvation (Miller 1944, p. 277). In laboratory experiments, Northern California legless lizards avoided wet soil (15% moisture) but moved freely through both dry (0.3% moisture) and damp soils (1.3% to 1.8% moisture) situated in layers above the wet soil (Miller 1944, p. 285). They were also collected from the wild where they occupied soils with 2.7% to 9.5% moisture contents (Miller 1944, p. 284). Reasons for avoiding wet soil were not discussed in the available literature but presumably it is more difficult to push aside, has fewer interstitial spaces for air, and is often cold. Areas near intermittent and ephemeral streams often provide particularly good habitat, because such areas are more likely to have loose soils and necessary moisture levels (Rose et al. 2022, p. 8).

Habitat differences in occupied across the range include changes from flatter areas, wider streambeds, and somewhat lower precipitation in the San Joaquin Valley floor to hillier areas with more precipitation in the foothills of the Temblor and Diablo ranges (PRISM Climate Group 2022, p. 1). Occupied areas in the southern portion of the range tend to consist of somewhat more gravelly soils with sagebrush (*Atriplex spp.*) as the overhanging vegetation (Rose et al. 2022, p. 8; Rose in litt. 2025a, p. iii). In the northeastern portion, soils tends to be sandier and shrubs include more mesquite (*Prosopis pubescens*) and salt cedar (*Tamarix ramosissima*). In the northwest, occupied sites tend to be in grazed areas under California juniper (*Juniperus californica*) (Rose in litt. 2025a, p. iii, Papenfuss in litt. 2025, p. 2). The extent of habitat connectivity is unknown, because it depends on the extent of connecting surface areas with loose substrate. Intermittent and ephemeral streambeds are relatively common throughout the range, however, and may provide dispersing lizards with a means of reaching areas of habitat that would otherwise be cut off by roads or development.

Dispersal abilities and distances are not well known, particularly for young lizards. One study of PIT (passive integrated transponder) tagged adult Northern California legless lizards of indeterminate sex, released into different local habitat types, found that "lizards seek and settle into quality habitat," sometimes moving 10 to 25 meters (m) (33 to 82 feet (ft)) to get there, at which point they often established home ranges averaging about 71 $m^2$ (764 $ft^2$) (Kuhnz 2000, pp. 32, 34, 38). The study was unable to follow lizards that left the 6.2-acre (2.4 hectare (ha)) study area, however, and the PIT tags were only detectable to a depth of 4.5 inches (11.5 cm) (Kuhnz 2000, pp. 34, 58). Since legless lizards immediately burrow when placed at the surface (Miller 1944, pp. 278–279), they presumably disperse by burrowing, and therefore require loose substrate connecting areas of good habitat that are relatively close (possibly within about 82 ft (25 m), based on the study).

Northern California legless lizards (and presumably Temblor legless lizards) hunt by ambushing small invertebrates such as insect larvae and spiders (Miller 1944, pp. 274, 280; Jennings and Hayes 1994, p. 110). They lurk at or just below the surface of the soil or leaf litter, apparently listening for movements of their prey. They can apparently hear such movements even with their ear areas below the soil surface (Miller 1944, p. 280), suggesting they localize the prey's location using subsurface vibrations. Having determined a prey animal's location and direction of travel, they emerge from the substrate in front of it and catch it (Miller 1944, p. 280). They thus need arthropod prey populations, and the microhabitat structures that attract such populations. Those microhabitat structures include leaf litter and overhanging vegetation to provide shade, hiding places, and food of various types for small invertebrates, as well as systems of larger (shrub or tree type) roots used by many larval insects as a food source (Miller 1944, p. 282; Johnson and Rasmann 2015, pp. 518, 52–521). Overhanging vegetation and leaf litter also help maintain soil moisture, and moderate soil temperatures, while larger roots also help to increase pore size in coarse sandy soils and prevent erosion (Miller 1944, p. 282; Lu et al. 2013, pp. 1, 6–7; Rose in litt. 2025b, p. 1).

Northern California legless lizards (and presumably Temblor legless lizards) become inactive in soil temperatures below 55°F (13 °C), while soil temperatures above 104°F (40°C) can kill them (Miller 1944, p. 284). When given the choice in a laboratory study, Northern California legless lizards usually avoided soils below 68°F (20°C) or above 82.4°F (28°C) (Bury and Balgooyen 1976, p. 154). However, Temblor legless lizards have been found in soils above 82.4°F (28°C) on several occasions (Rose in litt. 2025a, p. 36), and a study of Northern California legless lizards specifically noted that in the wild the lizards "do not avoid temperatures below 20 C°" (Kuhnz 2000, p. 36). The different findings may be due in part to the fact that Bury and Balgooyen (1976, p. 153) used lizards from the coast of Santa Cruz County, where temperatures are typically lower than in the southern San Joaquin Valley and nearby foothills. Kuhnz (2000, p. 36) also noted that the lizards used temperature differences in the soil to thermoregulate, so it may be that the lizards she found in soils below 68°F (20°C) were simply cooling off after having recently occupied warmer substrate. Miller (1944, p. 283) provided examples of such soil temperature differences, noting that when the air temperature two inches above the soil was 83.3°F (28.5°C), the temperature of the unshaded surface could be 104°F (40°C), while only 4 inches (10 cm) down it would fall to 73°F (23°C). On ground shaded by a large bush, the surface soil would be 77°F (24.8°C), and would fall to 69°F (20.8°C) just two inches down. Similarly, he noted that in sand, temperatures about 10 inches below the surface typically stayed at about 68°F (20°C) throughout the day, regardless of whether the surface sands were 104°F (40°C) or 50°F (10°C).

Likely predators of Temblor legless lizards include likely predators of Northern California legless lizards that are in the Temblor legless lizard range. These include king and ringneck snakes (*Lampropeltis getulus, Diadophis punctatus*), birds such as shrikes, thrashers, and robins (*Lanius ludovicianus, Toxostoma redivivum, Turdus migratorius*), deer mice (*Peromyscus maniculatus*), long-tailed weasels (*Mustela frenata*), and domestic cats (*Felis sylvestris*) (Jennings and Hayes 1994, p. 110; Kuhnz 2000, p. 33). They may also be preyed on opportunistically by other birds and mammals such as hawks, owls, crows and foxes (*Corvus spp., Vulpes spp.*) (Kuhnz 2000, p. 33; Evelyn and Sweet, 2018, p. 6).

### 3.2 POPULATION NEEDS

**Resiliency**: Since the Temblor legless lizard has only a single population (so far as is known), the viability of the species depends on the resiliency of that one population. Population resiliency, in turn, depends on the availability of resources meeting the needs of individual lizards, discussed above, as well as on several population-level factors. For instance, large population size (N) allows recovery from the typical range of random (stochastic) environmental fluctuations such as a minor drought or flood. More serious environmental fluctuations are discussed under Species Needs, below. Populations that are particularly small (or smaller sections that become isolated from the rest of the population) may also be at risk due to demographic stochasticity (chance variations from optimal sex ratios or in reproductive output), or from Allee effects (inability of individuals to locate acceptable mates) (Lande 1998, pp. 353, 357; Stephens *et al*. 1999, p. 188; Møller and Legendre 2001, pp. 27, 31–33). These effects can cause a population to become smaller and smaller, thereby increasing the effects in each generation and leading ultimately to extirpation.

The intrinsic population growth rate (λ) must also be high enough to allow the population to fully recover between the impacts of environmental fluctuations or catastrophes. The growth rate is affected by average survivorship and fecundity, which in turn are influenced by predator population size, current availability of habitat, and the current state of environmental fluctuations.

Habitat heterogeneity (habitat differences across the landscape) can lessen the impacts of both normal and catastrophic environmental fluctuations. For instance, areas with cooler, wetter microclimates can ameliorate the effects of drought. There must also be sufficient habitat connectivity to allow dispersing individuals to help repopulate impacted areas, and to prevent the genetic isolation of subsets of the population (thereby lowering their "effective population size" ($N_e$)).

$N_e$ refers to the number of breeding individuals in an "ideal" population (with discrete, non-overlapping generations, equal contribution of all members to the next generation, and free mixing prior to mate choice), that experiences the same amount of genetic drift (random change in gene frequencies) as the actual population (Lande and Barrowclough 1987, pp. 88–89). Because most populations lack many of the characteristics of ideal populations, the actual (census) size of a population (N) is often much greater than its effective size ($N_e$).

Generally, $N_e$ should be at least 100 to prevent inbreeding depression, which can cause abnormal sperm, congenital defects, and lowered disease resistance (Soulé 1980, pp. 157–158; Gilpin 1987, p. 132; O'Brien 2003, pp. 62–63).

### 3.3 SPECIES NEEDS

Whereas resiliency applies to populations, redundancy and representation apply to the species as a whole and characterize the species' ability to recover from catastrophic events (redundancy) and to maintain the genetic diversity necessary to adapt to future changes (representation) (see section 1.4, above).

**Redundancy**: Redundancy is higher when there are more populations, because the chances of at least one population surviving a catastrophe (such as a major drought or disease outbreak) are increased. For similar reasons, redundancy increases with the size of the range.

As mentioned above regarding populations, high population size (N) also increases redundancy by increasing the likelihood of surviving a serious catastrophe. High population growth rate ($\lambda$) and good habitat connectivity both increase redundancy by decreasing the recovery time from such catastrophes. The population growth rate in turn depends on fecundity (number of young produced) and survivorship (likelihood of surviving to reproduce, or to reproduce again).

**Representation**: Representation is increased by genetic diversity, particularly locally adaptive genetic differences that might become more generally useful if the environment changes. Such locally adaptive differences in turn involve adaptations to a variety of local habitats (habitat heterogeneity). Habitat connectivity allows such differences to spread through the population via dispersal and interbreeding as needed if the general environment changes.

Temblor legless lizards have only a single known population in a small range. Genetically isolated subpopulations are possible, but we do not know where the boundaries to such subpopulations would be. As discussed above, population size (N), population growth rate ($\lambda$), and habitat connectivity are all unknown. Habitat heterogeneity is relatively low, although some differences exist (discussed above). There are no known indications of locally adaptive differences such as unusual markings or behaviors, and comparisons of mitochondrial DNA show little genetic variation across the range (Parham et al. 2019, pp. 17–18).

**Table 1. Needs of the Temblor legless lizard for viability.**

| Level | Requirement | Why it is needed | Associated 3Rs |
|---|---|---|---|
| **Individual** | Loose well-drained substrate. | Basic movement, hunting success, predator avoidance. | Resiliency |
| | Accessible areas of substrate moisture, ideally of about 1% to 2%. | Some moisture is necessary to properly shed skin. Overly wet substrate may interfere with movement, oxygen content, or temperature preferences. | Resiliency |
| | Arthropod prey populations. | Food. | Resiliency |
| | Overhanging vegetation and leaf litter | Habitat for prey populations. Helps prevent overheating and loss of moisture in soil. | Resiliency |
| | Systems of larger roots | Habitat for prey populations. Increases porosity of soil. Prevents erosion. | Resiliency |
| | Accessible substrate temperatures between about 20°C and 28°C (ideally). | Lower temps lead to torpor; higher lead to overheating. | Resiliency |
| | Avoidance of predators | Predators kill and eat Temblor legless lizards. | Resiliency |
| **Population** | Large population size (N). | Eases recovery from normal or localized environmental fluctuations, as well as from larger catastrophes. Also prevents impacts from demographic stochasticity and Allee effects. | Resiliency<br>Redundancy |
| | Large intrinsic growth rate (λ) in response to impacts. | Eases recovery from normal or localized environmental fluctuations, as well as from larger catastrophes. | Resiliency<br>Redundancy |
| | Habitat heterogeneity. | Lessens impact of normal and catastrophic environmental fluctuations | Resiliency<br>Redundancy |
| | Habitat connectivity. | Allows repopulation of impacted areas. Allows gene exchange to prevent inbreeding. Also allows useful local gene variants to spread across the species quicker if needed to address environmental change. | Resiliency<br>Redundancy<br>Representation |
| | $N_e$ 100 or greater. | Avoid inbreeding depression. | Resiliency |
| **Species** | One or more populations. | More populations increases chances of at least one surviving a catastrophe. | Redundancy |
| | Large range. | Increases likelihood that some part of the population will be less affected by a particular catastrophe. | Redundancy |
| | Locally adaptive genetic diversity. | Increases chance that some individuals will be pre-adapted to future environmental changes. | Representation |
| | Habitat heterogeneity. | Increases likelihood of locally adaptive genetic differences. | Representation |

# CHAPTER 4 – INFLUENCES ON VIABILITY

The following discussion provides a summary of the primary factors affecting the current and future condition of the Temblor legless lizard throughout its range, including both threats and conservation actions.

## 4.1 THREATS

We use the term "threat" to refer in general to actions or conditions that are either known to, or reasonably likely to negatively affect individuals of the species. In our 90-day finding, we identified several threats to Temblor legless lizards, including oil and gas development, urbanization, habitat fragmentation, industrial solar projects, wildfires, and increased temperatures and likelihood of drought (climate change) (86 FR 32241). In this analysis we also consider agricultural development (conversion of habitat to agriculture) as a possible threat (see Figure 5).

**Development**: Oil and gas development, urbanization, and agricultural development (conversion to orchards or row crops) all remove available habitat needed by the lizard and convert it to another use. Grazing is likely beneficial to Temblor legless lizards, as it controls the spread of nonnative grasses and thickness of thatch, thereby allowing shrubs to compete better and limiting areas of thick sod that would be difficult to burrow through (Papenfuss in litt. 2025, p. 2; Rose in litt. 2025a, p. iii). We do not consider grazing to be "agricultural development" for these purposes. Oil and gas development also threatens the lizard through the possibility of oil or wastewater spills from holding ponds. However, these holding ponds are often much deeper than 2–3 feet, and any leaking water would percolate directly downwards through several layers of soil that is already deeper than where the lizard occurs. It may also interfere with the lizard's hunting success, because drilling, pumping, and fluid injections produce powerful ground vibrations that could overwhelm the lizard's ability to locate its prey by listening for their movements from below the surface (see section 3.1, above).

Development of solar plants is also a potential issue in parts of the range. For instance, the proposed Kern Solar Ranch would take up 14,400 acres (5,827.5 ha) of the lower middle portion of the lizard's range if constructed (CEQAnet 2013, p. 1; CBD 2020, p. 23). Several smaller solar projects are currently in the permitting process (Fresno County Planning Dept 2025, pp 1, 3, 9, 11, 13, 17, 19).

Spills of oil, wastewater, or both can result in loss of habitat, and can also sicken or kill lizards directly. Cleanup of such spills may involve removing vegetation and moving or compacting large amounts of earth to provide access for heavy equipment and to contain and remove the oil (Gross 2022, video linked on p. 4 2:24–10:00). This can kill additional lizards and destroy additional habitat. Flooding from storms can potentially kill lizards directly, but can also exacerbate the effects of oil or wastewater spills by carrying the spilled petroleum products over a wider area.

Wastewater used in the oil extraction process in the region is commonly stored in unlined basins, allowing it to percolate into the ground (Gross 2021, pp. 1, 3). The petition raised concerns that chemicals in wastewater stored in such basins could affect Temblor legless lizards (CBD 2020, pp. 18–19).

**Habitat Fragmentation**: Loss of habitat due to development may fragment remaining habitat into isolated areas, thereby leaving any lizards in such areas in their own small, isolated populations. Small populations are more subject to impacts from environmental fluctuations, catastrophes, inbreeding depression, demographic stochasticity, and Allee effects (see section 3.2, above). If such isolated populations become extirpated, they can't be repopulated from outside.

**Increased Temperatures and Drought**: Increased temperature and drought could result in drier, hotter substrate and in loss of shrubs and associated shade, leaf litter, and invertebrate prey.

Hotter drier weather could also lead to increased, or more severe, wildfires, which could kill lizards directly and remove additional shrubbery and leaf litter.

**Increased Flooding**: Warmer temperatures can also result in changes to flooding patterns and magnitudes. There is a projected increase in flood risk in the Sacramento-San Joaquin Valley vicinity (Das et al. 2013, p. 108) into the future. Further, more severe floods would put pressure on levee systems used for agriculture, potentially resulting in the alteration of water systems widely used throughout California (Das et al. 2013, p. 109). Increases in the magnitude and frequency of river flooding generally have already occurred, impacting natural ecosystems (Caretta et al. 2022, p. 573). Because the species lives in sandy washes, increased flooding has the potential to impact the species by resulting in potential direct mortality of lizards and destruction of habitat.

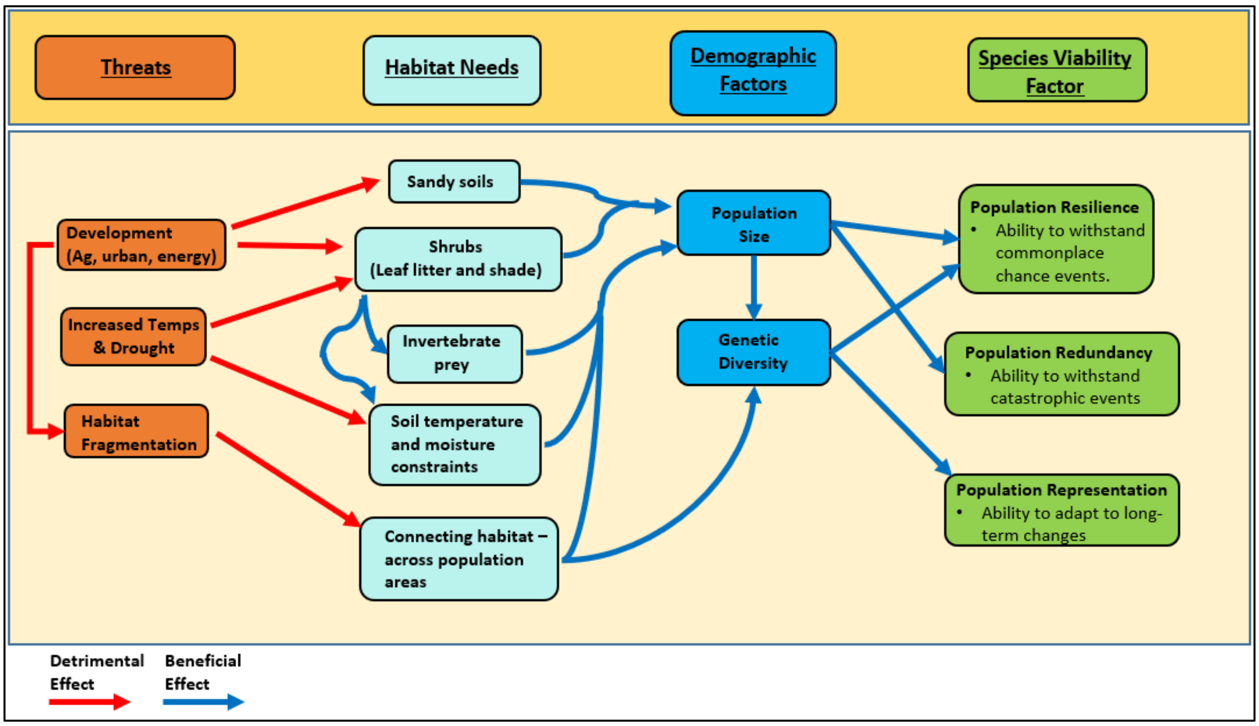



**Figure 6. Major factors and interactions affecting the viability of the Temblor legless lizard.**

## 4.2 CONSERVATION ACTIONS

The Temblor legless lizard is currently a candidate species (Diversity Database 2025, p. 17) under the California Endangered Species Act (CESA, California Fish and Game Code § 2050 *et seq*.). As such, until the Fish and Game Commission makes a final determination regarding its status, it receives the same protections against "take" that a state-listed threatened or endangered species would have (CDFW 2025a, p. 2). Projects on non-federal lands that incidentally (rather than purposefully) kill Temblor legless lizards must therefore have "incidental take permits" from the state allowing such deaths (CDFW 2025b, pp. 3, 8). The permits typically require minimization and mitigation measures to lessen the impact of such deaths on the species as a whole (CDFW 2021, pp. 26–37). Project proponents can, however, choose not to obtain such permits.

In addition, the Service and Bureau of Land Management (BLM) are working with CDFW to fund ongoing research on the lizard (Rose et al. 2024, unnumbered cover). This research has helped provide basic biological information on the species, including estimates of its range, the location of occupied sites, number of years a site is occupied, habitat preferences, etc. (Rose et al. 2024, pp. 1–11).

# CHAPTER 5 – CURRENT CONDITION

To analyze the current condition of the Temblor legless lizard, we consider to what extent its needs (identified in Table 1) are being met. We have very little information regarding the lizard's demographic needs. For instance, we do not have data to support estimates of basic population parameters such as size (N), population growth rate (λ), or effective population size ($N_e$). We also lack indications of locally adaptive genetic diversity. Genetic differences across the range appear to be small (Parham et al. 2019, pp. 17–18).

Given the lack of information regarding the demographic needs of the lizard, our discussion of the lizard's current condition focuses primarily on its environmental needs. In sections 5.1 and 5.2 below we discuss an environmental analysis we conducted using GIS software. In the following sections of the chapter, we go on to characterize the results of that analysis (as well as additional data) in terms of resiliency, redundancy, and representation.

## 5.1 LANDCOVER ANALYSIS OF HABITAT CONVERSION

To help us understand the extent to which development (of various sorts) may be affecting the lizard's environmental needs, we conducted a GIS analysis of how landcover within the range has changed from 1986 to 2023 (MRLCC 2024, NLCD[1] data). The dataset, compiled by the US Geological Survey (USGS) identifies each pixel in the mapped area as a particular type of landcover, thereby allowing the total extent of different landcover types to be compared for different years.

Since the extent of the range has been recently adjusted and might be further adjusted in the future (see section 2.3), we also compared landcover percentages within 0.1 mile (0.2 km) of any Temblor legless lizard sighting. Because the exact location of some such sightings is unknown, and indicated in the Diversity Database as taking place somewhere within a given polygon or circle (Diversity Database 2020, p. 16), we estimated the actual location of sightings in all such "non-specific" locations as taking place at the centroid of the polygon or center of the circle.

Based on the landcover data, all lizard sightings have been in either "Shrub/scrub" or "Grasslands/Herbaceous" habitat, so we refer to these habitat types as "potentially suitable." We use the term "potentially" because the lizard's requirements of loose substrate and overhanging vegetation will only be met within certain areas of those landcover types. For instance, the lizards that have been sighted in "grassland/herbaceous" habitat were presumably in smaller areas of shrubs and loose substrate within the larger grass-covered areas.

The data fails to distinguish between oil and gas development, and urban development. We therefore simply compared all "Developed" areas for our analysis without separating urban

[1] National Landcover Database from USGS

development from oil and gas. Generally, however, the "Developed, Open Space" areas are likely to represent oil and gas development, which typically involves dirt roads and graded areas around various types of equipment. The areas of agricultural development are identified separately by categories for "Cultivated Crops" and "Pasture/Hay" (see Figures 6 and 7).

We discuss the results of this analysis in section 5.3, below.

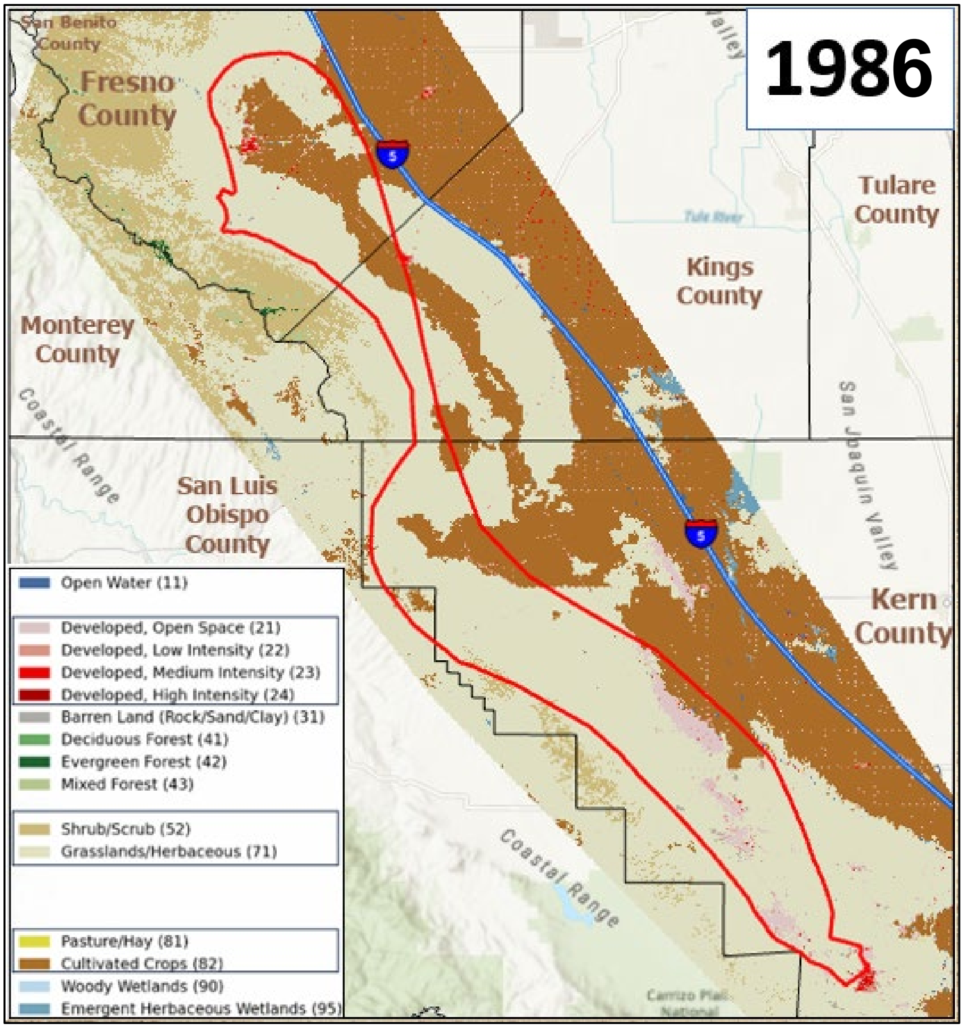



**Figure 7. Landcover types in and around the range – 1986. (MRLCC 2024, NLCD data).**

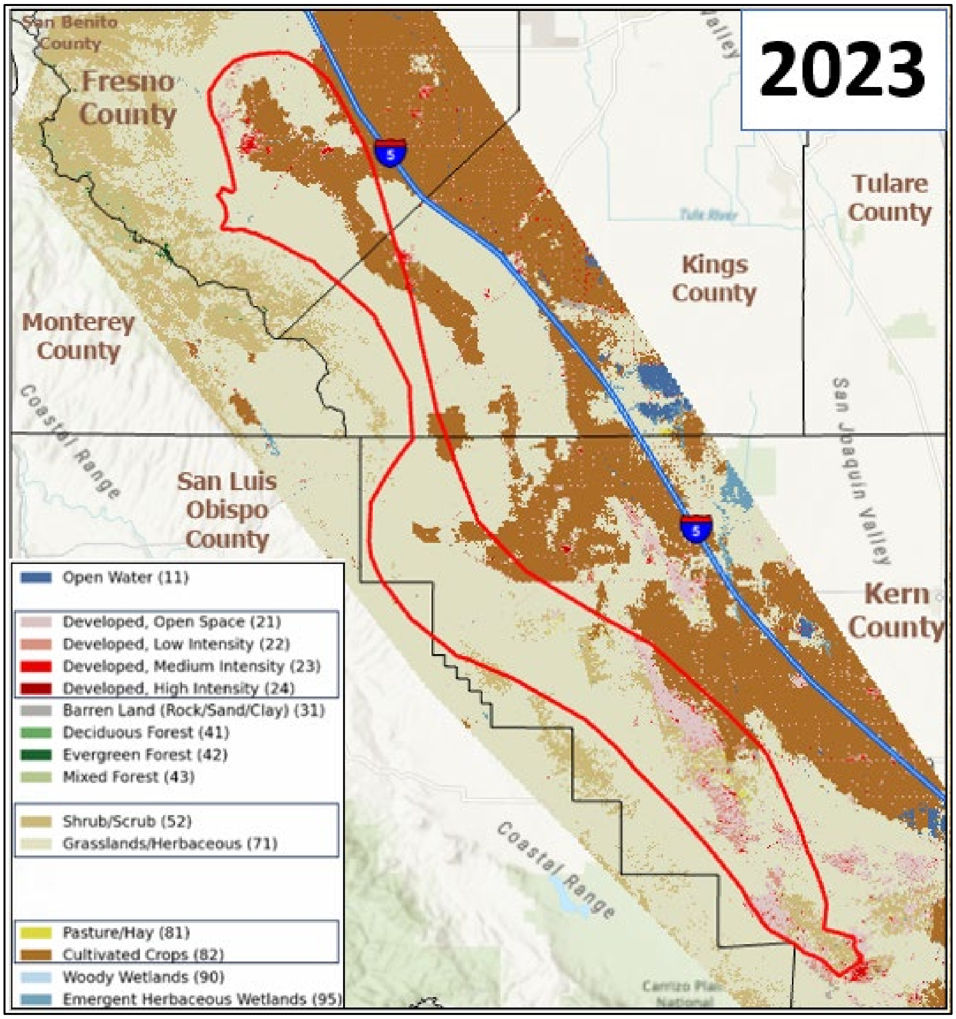



**Figure 8. Landcover types in and around the range – 2023. (NLCD data from MRLCC 2024).**

## 5.2 KEY UNCERTAINTIES AND ASSUMPTIONS

Rangewide Landcover Analysis

- The analysis only applies to lands within the estimated range, which may need to be adjusted as additional sightings are made.

- Lands characterized as agricultural in 1986, but as grassland or shrubland in 2023, did not thereby become potentially suitable habitat. Such lands comprised 3.5% of the range, and are subtracted from the percentage of potentially-suitable habitat that would otherwise be presented for 2023 in Table 2, below. This assumption is based on changes in soil composition due to tilling, the need for natural overhanging vegetation and root structures to regrow, and the experience of biologists surveying for the species (Rose in litt 2025a, p. 21; Parham in litt. 2025, p. 2; Halstead in litt. 2025, p. 2).

- The analysis groups shrublands and grasslands as “potentially-suitable habitat”, without accounting for the fact that shrublands are likely to be more suitable, since overhanging vegetation and root structures are more prevalent on them. However, changes in shrublands and grasslands are examined separately in Table 3, below, as part of our analysis of the impacts of increased temperatures.

- After conversion of various areas to development, much of the remaining potential habitat is in the central portion of the range. Only two sightings have occurred in this general area, assumedly because of low survey effort on these privately owned lands. If there actually are fewer lizards or less habitat in the central portions of the range, then the analysis would be underestimating the impacts of habitat loss and overestimating the extent of remaining habitat.

Landcover Analysis for Areas Within 0.1 Mile of Sightings

- The analysis only accounts for lizard sightings from 2024 and before.

- Diversity Database occurrences 2, 5, 8, and 9, are of relatively low accuracy, and we had no sources that were more accurate. Occurrence 2 is somewhere within an ellipse of about 55 acres (22.3 ha); occurrences 8 and 9 are accurate to one tenth of a mile, and occurrence 5 is only accurate to 0.6 mile (Diversity Database 2024a, pp. 3, 8, 11–12). Since we were examining landcover types within one tenth of a mile of each sighting, the landcover types around the actual sighting locations for those occurrences may have differed considerably from the landcover types around the presumed locations.

- Because the change in the percentage of agricultural land from 1986 to 2023 was so low (0.1%), we did not account for the amount of agricultural land from 1986 that may have been characterized as potentially-suitable habitat in 2023.

## 5.3 CURRENT RESILIENCY

The population size (N), growth rate (λ), and effective size ($N_e$) of Temblor legless lizards is unknown. Coverboard surveys (in which boards are placed on the ground and lifted later to check for lizards near the surface) have been conducted by the United States Geological Survey (USGS) and others to find occupied locations (Rose et al. 2025, pp. 4–7; Papenfuss in litt. 2025, p. 1), but such surveys are ineffective for estimating population size or density (Kuhnz 2000, pp. 1–2; Kuhnz et al. 2005, p. 401). For instance, prior to construction of new buildings for the Moss Landing Marine Laboratories, all the Northern California legless lizards in the 3.9 acre (1.57 ha) site were removed and transferred to a new site (Kuhnz et al. 2005, pp. 396). Based on previous population density estimates, workers expected to find about 170 legless lizards at the site, but they instead found 3,582 (Kuhnz et al. p. 399). Thus, although recent USGS surveys have only found Temblor legless lizards at 21 of 104 sites using coverboards (Rose et al. 2025, pp. 5–7), the population density at any of those sites (or at any other occupied sites across the range) could potentially be quite high.

**Habitat Conversion (Results of Landcover Analysis)**: Landcover percentages across the range in 1986 and 2023 are summarized in Table 2. "Development" refers to urban plus oil and gas, not to agriculturally developed land, which is a separate category, and includes both croplands and pasture, but not rangelands. "Potentially Suitable Habitat" includes grasslands and shrublands ("shrub/scrub").

| Table 2. | | Percent of Range | Ave. Percent Within 0.1 mi of Sighting |
|---|---|---|---|
| Development | 1986 | 6.1 | 6.6 |
| | 2023 | 10.2 | 10.4 |
| Agriculture | 1986 | 17.6 | 2.5 |
| | 2023 | 14.7 | 2.4 |
| Potentially Suitable Habitat | 1986 | 75.9 | 89.2 |
| | 2023 | 71.3 | 86.6 |

Landcover percentages across the range and within 0.1 mile of a sighting (1986 and 2023).

As the table shows, across the range, developed areas have increased by about 4 percentage points over a 38-year period, while agricultural areas have decreased by almost the same amount. Potentially-suitable habitat has decreased by about 4.5 percent. Potentially-suitable habitat remains the primary landcover type across the range, however, covering slightly more than 70% of the available area.

In the areas within 0.1 mi of a sighting, development has also increased by about 4 percentage points, but agriculture (with much less representation to begin with than across the range at large) only decreased by a tenth of a percentage point. This left potentially-suitable habitat with a slight decrease of 2.6 percentage points. Potentially-suitable habitat was still very highly represented near sighting locations, with average percentages remaining above 85%.

Accordingly, impacts from direct conversion of habitat for any of the three types of development considered here (urban, agricultural, or oil and gas) appear to be relatively low over the time period analyzed. This is in contrast to a statement in the petition claiming that 50 to 90 percent of the lizard's range is being destroyed and degraded by oil and gas development (CBD 2020, p. 15). The petition's assessment was based on a 2019 report by the IUCN (International Union for the Conservation of Nature, Hammerson 2019). That document was published about six months prior to the publication of the first mapped range estimate with detailed boundary lines we are aware of (Parham et al. 2019, p. 11). Hammerson's description of the range only included the area "between McKittrick and Taft" (Hammerson 2019, p. 1), which is about 14 miles long (22.5 km) and in an area heavily developed for oil and gas extraction. The full range described by Parham et al. (2019, p. 11) is about 90 miles long (145 km). As discussed in section 2.3 above, the estimated range we are using for the species is essentially the one provided by Parham et al. (2019, p. 11), but with two small extensions to account for additional occurrences found later that were slightly outside the original range estimate.

**Percolation Discharge of Wastewater from Unlined Holding Ponds**: In addition to possible wastewater spills, the petition expressed concern that wastewater percolating into the soil through the bottoms of unlined holding ponds could impact the lizard (CBD 2020, pp. 18–19). However, we did not find information indicating such percolating wastewater typically stays near the surface. Rather, it has been described as percolating downward through one or more soil layers (Figure 9). Closely-related Northern California legless lizards have been recorded at depths of 1 to 18 inches (2.5 to 46 cm) in captivity and up to about 2 feet (61 cm) in the field (Miller 1944, pp. 279, 281, 289; Kuhnz 2000, pp. 2, 18). Temblor legless lizards at depths of two or three feet (61 to 91 cm) or shallower should not be directly affected by such percolation discharges unless they happen to be burrowing along the edges of the holding ponds.

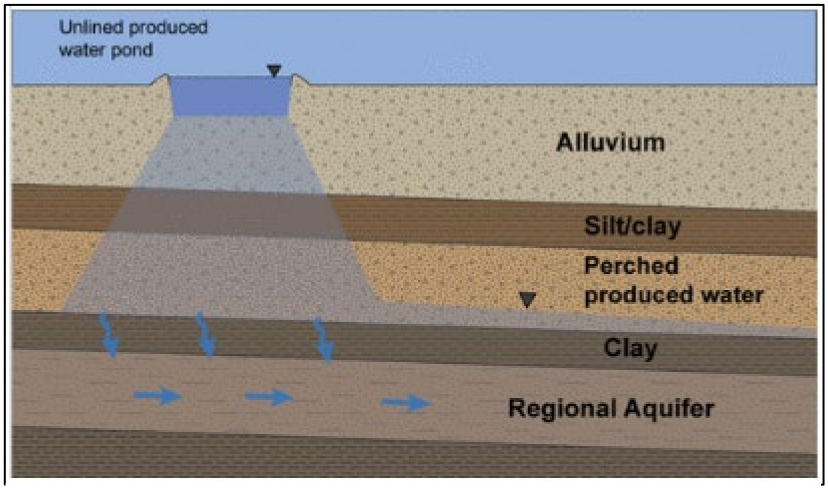



**Figure 9. Flow of percolating wastewater from holding pond (DiGiulio et al. 2021, p. 1).**

**Interference of Oil Development with Hunting Success or Dispersal**: We examined the specific circumstances of sightings close to developed areas to better understand the extent to which such areas might prevent nearby occupancy or dispersal. Occurrence 13 was first sighted in 2015 at the outskirts of a municipal landfill (Diversity Database 2024a, p. 16), which was subsequently expanded over the area of the original sighting. Additional lizards were subsequently sighted on the newly established outskirts of the expanded landfill in 2023 and 2024. Occurrence 5 (sighted in 2019 and 2023) is on the edge of an ephemeral creek, about 300 to 500 feet from an active well drilled in 2017 (with surrounding graded lands) (Diversity Database 2024b, GIS data; CalGEM 2025, GIS well data). Occurrence 8 was observed in 2022 within 600 ft of an active well drilled in 2010 (with surrounding graded lands) (Diversity Database 2024b, GIS data; CalGEM 2025, GIS well data). This data strongly suggests the lizards can successfully occupy and hunt in areas that are relatively close to ground-disturbing activities such as oil drilling and landfill maintenance.

Additionally, many such occupied areas are in or near intermittent or ephemeral creek beds, which were left undeveloped despite the construction of roads and machinery platforms nearby. The creek beds channel water during storms, and such flows would tend to undercut roads and machinery pads built across them. Creek beds generally contain loose soils, so they would presumably serve as dispersal corridors for the lizards, thereby lessening the extent of habitat fragmentation.

**Increased Temperatures**: Yearly temperatures in Kings County, averaged over a 5-year period, have increased 2.8°F (1.6°C) since the period of 1970 to 1974 (NCEI 2025, pp. 2–4 and attached worksheet). Kings County is likely the most representative county in the lizard's range, since it is the middle of the three counties through which the range runs, and since it does not extend into the Sierra Nevada Mountains.

| Table 3 | | Percent of Range |
|---|---|---|
| Shrub/Scrub | 1986 | 0.3 |
| | 2023 | 5.9 |
| Grasslands | 1986 | 75.6 |
| | 2023 | 65.4 |
| Barren | 1986 | 0.2 |
| | 2023 | 0.3 |

**Landcover types subject to change due to rising temperatures (1986 vs. 2023).**

Such an increase, along with associated increases in drought and wildfire, might tend to convert shrublands in the lizard's range to grasslands or barren areas, thereby making overhanging vegetation less available and lowering the quality of the habitat (CBD 2020, p. 31). However, a comparison of landcover data for the range from 1986 and 2023, from the same dataset used to conduct the analysis in Section 5.1, shows the opposite has actually occurred. The extent of shrublands has increased while grasslands have decreased. Barren areas have also increased, but only slightly (see Table 3).

**Summary:** Suitable habitat remains the primary landcover type across the range, covering roughly 70% of the available area, and the extent of shrublands (the most suitable habitat type) has increased since 1986. Further, lizards can successfully occupy and hunt in areas that are relatively close to ground-disturbing activities such as oil drilling and landfill maintenance. Therefore, current resiliency appears sufficient to allow the species to withstand normal environmental fluctuations.

### 5.4 CURRENT REDUNDANCY

**Distribution**: The 25 occurrences found so far are distributed across the entire range, although fewer have been found in the central area due to fewer surveys. Local areas with loose substrate and overhanging vegetation also appear relatively common in the range, suggesting that the lizard's population is well-distributed throughout. Accordingly, although the lizard's range is relatively small, and although we are assuming it has only a single population, the Temblor legless lizard currently appears reasonably capable of surviving and recovering from local catastrophic events.

**Localized catastrophes**: The lizard's widespread distribution across its range makes it more likely to survive and recover from localized catastrophes, such as oil or wastewater spills, floods, or most diseases. However, we have no information regarding any diseases that could threaten the population.

**Oil and Wastewater Spills**: In 2019, over 900,000 gallons (gal) (3 million liters (ltr)) of oil and wastewater spilled into a dry creek bed in the southern portion of the lizard's range (Sahagún 2019, p. 1). In terms of gallons spilled, this spill was roughly 6 times larger than the Refugio Spill of 2015 (Santa Barbara County, 140,000 gal), and 15 times larger than the Cosco Busan spill of 2007 (San Francisco Bay, 54,000 gal) (Thompson 2019, p. 2). Rather than spilling from a well, the oil and wastewater were actually pushed up out of the ground by pressure from steam injected down nearby wells to loosen the thick underground oil deposits (Thompson 2019, p. 1; CNRA 2024, p. 1). The oil and wastewater flowed intermittently for over two months before being completely stopped (Sahagún 2019, p. 7). More than 70 smaller spills also occurred between 2018 and 2023, involving a combined total of almost half a million gallons of oil and 1.5 million gallons of wastewater (Assoc Press 2024, p. 1). However, the 70 smaller spills only totaled about 6 acres (2.4 hectares (ha)) in area (Assoc Press 2024, p. 1), while the larger spill covered approximately one acre (0.4 ha) (Goldberg 2019, p. 2). Based on drone footage, cleanup of the spill might have affected another two acres (0.8 ha) including graded and bulldozed areas around the site to support heavy equipment and dam the spill (Gross 2022, p. 4 video at 2:24–10:00). Unlike a spill into the ocean or other large body of water, these spills were all onto dry ground where they were channeled by existing topography rather than distributed widely by water (Thompson 2019, p. 2). Accordingly, the potential impacts of such spills to Temblor legless lizards across the range is considerably more localized than might be expected based on the amounts of oil and wastewater involved. That said, Temblor legless lizards are often found in and around intermittent and ephemeral streams, which is where oil and wastewater spills are often channeled. Assuming contaminants are successfully removed from the soil, reseeded sagebrush may take 3 to 5 years to become large enough to provide necessary levels of leaf litter and shade (Jacobs et al 2011, p. 3). Topological changes necessary to dam the flow of spilled oil or wastewater may affect future runoff levels and sand deposition as well. Accordingly the impacts of spills of oil or wastewater, though relatively contained in extent, are still likely to remove any lizards in the local area, and prevent recolonization for about 5 years.

**Floods**: Although lizards on the edges of rising flood waters would tend to burrow away because they avoid wet substrate (Miller 1944, p. 285), flooding is still likely to kill numerous lizards, because they can't swim well and tend to live in and near intermittent or ephemeral streams (Miller 1944, p. 285; Parham in litt. 2025, pp. 1–2). However, even large, 100-year floods in the eastern, lower-elevation portions of the range tend to be channeled by those streams such that most portions of the natural landscape remain unflooded (Figure 10, left picture). The area around Coalinga, in the northeastern portion of the range, shows less channelization (Figure 10, right picture), but this is because the area has largely been converted to agriculture, which does not constitute habitat. One study found that, in sandy soils, lizards detected using coverboards were 469 ft (143 m) away from ephemeral or intermittent streams on average, while some lizards were almost half a mile (800 m) away (Rose et al. 2022, pp. 7, 20).

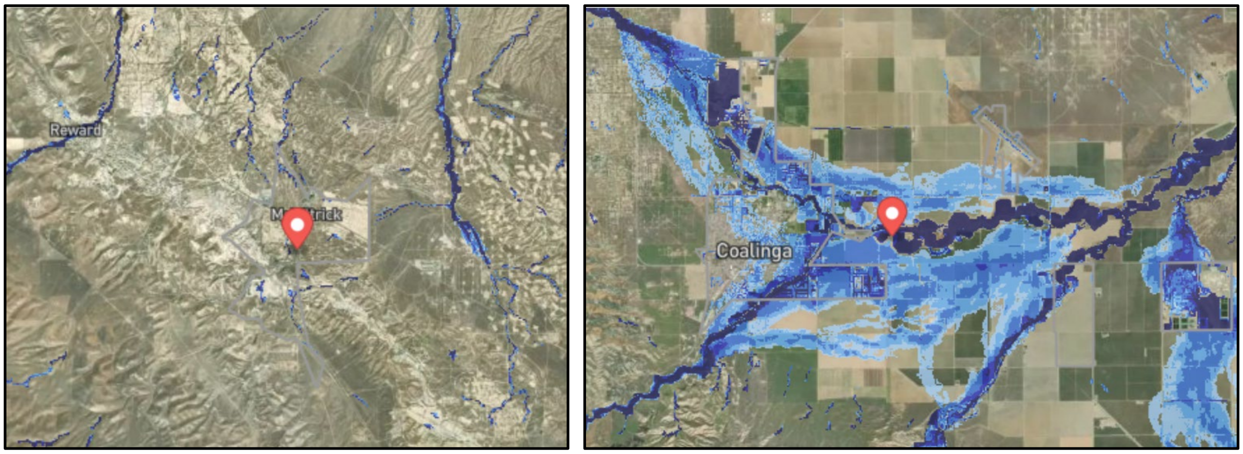
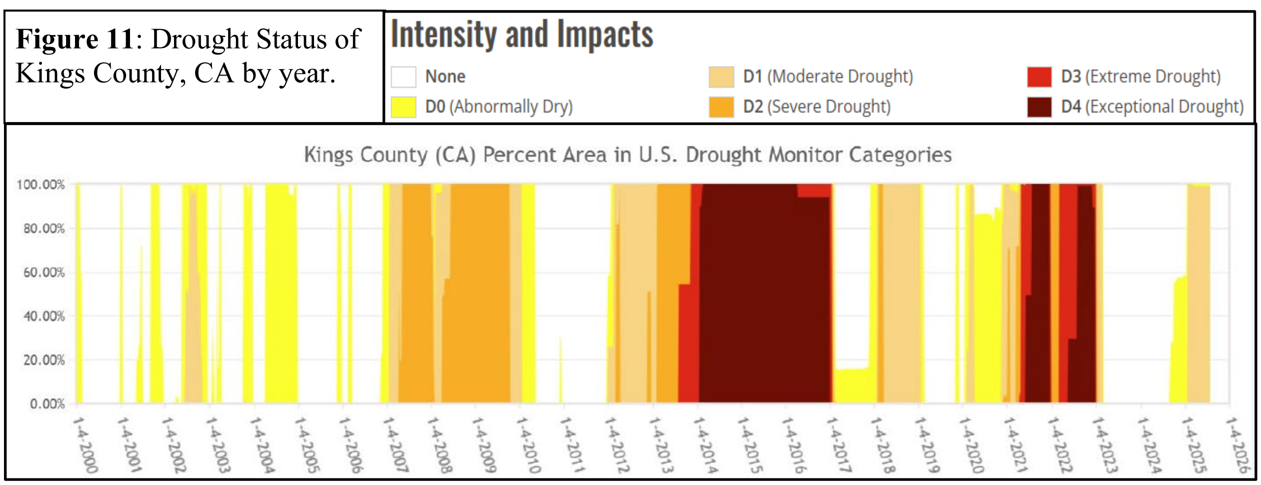



**Figure 10**: Projected 100-year flooding, McKittrick area, southeastern portion of range (**left**) and Coalinga area, northeastern portion of range (**right**) (First St Tech 2025a, p. 2; First St Tech 2025b, p. 2).

**Drought**: Drought is the most potentially serious plausible catastrophe because it would be likely to affect the entire range. Since 2000, Kings County has suffered several droughts, including an "exceptional" drought (the most severe of five categories) that lasted from 2014 to 2017, and another drought from 2021 to 2023 with two periods of exceptional drought during the second halves of both years (USDM 2025, p. 1) (see Figure 11). Surveys for Temblor legless lizards, conducted in the early months of 2022, 2023, and 2024, included 34 locations that were sampled in all three years (Rose et al. 2024, pp. 4–6). At those locations, a total of nine lizards were found in 2022, during a "severe" (third-level category) drought following six months of "exceptional" drought. In 2023, when the drought had just ended, 8 lizards were found; and the next year (after a full year with no drought), 12 lizards were found. This suggests (without actually demonstrating, since sample sizes are small) that Temblor legless lizards are impacted by droughts but are capable of surviving them and replenishing their numbers afterwards (Papenfuss in litt. 2025, p. 1). They must also have survived the larger, more severe drought of 2014 to 2017 as well.

**Figure 11**: Drought Status of Kings County, CA by year.



The species thus appears capable of surviving and recovering from plausibly likely catastrophic events.

## 5.5 CURRENT REPRESENTATION

The Temblor legless lizard has a relatively small range, with few obvious habitat differences that would tend to produce unique local adaptations. The species also has no known locally unusual markings, behaviors, or genetics. While locally adaptive genetic diversity across different portions of the range is possible, we have no evidence of it.

Representation is therefore likely to be inherently limited, though stable, with no particular areas standing out as unusually important for conservation.

## 5.6 SUMMARY OF CURRENT CONDITIONS

We lack information regarding the lizard's population size or growth rate. We also have only a preliminary estimate of its range. Information on dispersal capabilities and genetic differences is also limited. We must therefore judge current conditions based on the seriousness of the threats that the lizard faces. Such threats include loss and fragmentation of habitat (primarily due to oil development), other impacts from oil development such as reduced hunting success or wastewater seepage from unlined storage ponds, loss of important habitat features such as overhanging vegetation due to increasing temperatures, and various potential stochastic impacts such as oil and wastewater spills and drought.

Since 1986, urban and energy development has increased, and agriculture has decreased, across the range. Potentially-suitable habitat has decreased slightly but remains extensive both across the range and within 0.1 mile of each known sighting. The largest areas of potentially-suitable habitat are in the more central portions of the range, which remain largely unsurveyed. Oil and wastewater spills have occurred but have been relatively contained by topography. Wastewater plumes likely run deeper than where lizards generally burrow. Occurrences near operating wells suggest those wells have limited impacts on hunting ability. Areas with high oil development may still allow some dispersal through or along the banks of intermittent or ephemeral streams. Although temperatures have been increasing in recent years, this has not caused shrublands to be replaced by grasslands, and so is unlikely to be limiting the overhanging vegetation and leaf litter that the lizards need.

Although the species' range is relatively small, the occurrences found, and the distribution of likely habitat, suggest the species is distributed across the entire range, and therefore, most local catastrophic events would be unlikely to impact the entire species. A potential exception is drought, but the species has weathered major droughts, apparently without becoming locally extirpated from any part of its range. The range is bordered to the north, west, and south by the ranges of other *Anniella* species, and to the east by the flat desert and agricultural areas of the San Joaquin Valley, so a contraction of the range in recent times is unlikely. Representation in the species is inherently low due to the lack of known genetic, morphological, or habitat differences that would help it adapt to environmental change. The low representation it inherently has does not appear to be declining, however.

# CHAPTER 6 – FUTURE CONDITION

In this chapter we consider what future conditions the lizard may face by examining the species' likely responses to two plausible future scenarios, one of which assumes a more optimistic course of events (Scenario 1), and the other of which is more pessimistic (Scenario 2). The true course of events will likely be somewhere between these two plausible bounds. The timeframe for both scenarios extends to 2100 (75 years) for climate-related projections, and to 2075 (50 years) for all other projections. This reflects the greater extent of available information regarding how climate may change in the future.

## 6.1 SCENARIO 1

**Summary of the Scenario:**

- Global atmospheric greenhouse gas emissions follow the Representative Concentration Pathway (RCP) 4.5 trajectory (to 2100).

  Explanation: The Intergovernmental Panel on Climate Change (IPCC) has projected likely effects out to 2100 under 4 primary trajectories (called RCPs) reflecting different levels of greenhouse gas emissions. These are RCP 2.6, RCP 4.5, RCP 6.0, and RCP 8.5 (IPCC 2014, p. 21). The number in each RCP trajectory (e.g. the 4.5 in "RCP 4.5") refers to the number of watts of radiative forcing (net downward minus upward radiative flux per square meter at the tropopause) expected to take place under that scenario in 2100 (IPCC 2013, pp. 1460–1461). The most optimistic of these trajectories (RCP 2.6) is a stringent mitigation scenario (IPCC 2014, p. 8) that we currently consider unrealistic. The RCP 4.5 trajectory is the next most optimistic (IPCC 2014, p. 21). It assumes greenhouse gas emissions will peak about mid-century and then decrease, stabilizing around 2080 at the equivalent (totaled for all greenhouse gasses) of about 27 gigatons of $CO_2$ per year (IPCC 2014, p. 21).

- About 200 new wells are constructed per year for oil and gas extraction (to 2075), all of which are within established oil fields.

  Explanation: Since 2011, the number of new wells known to have been constructed per 5-year period within the lizard's range (plus a 0.5-mile buffer to account for effects from wells just outside the boundary), has decreased from 7,963 to 3,614 to 733 wells (Service 2025 summary of CalGEM 2025 shapefile data, p. 1). However, only 41% of the wells listed by our source[2] (a state government GIS file of all the wells in the area going back to 1867), had known dates of first drilling. If we assume most of those undated wells were older, and that only about 20% of wells dug since 2011 were undated, the resulting numbers would be 9,556, 4,337, and 880 per 5-year period since 2011. New wells dug per year would thus average 1,911 per year for 2011–2015, 867 per year for 2016–2020, and 220 per year for 2021–2024. Scenario 1 assumes that the declining number of wells dug per year (averaged over a 5-year period) will level off at an average of about 200 per year through 2075 (10,000 new

[2] Excluding "cancelled" wells (permitted but not drilled).

wells total). Both active and new wells have clustered in established oil fields, so this scenario assumes that trend continues.

- Development other than oil extraction (e.g., urban or solar energy development) is limited to 1% of the range, most or all of which takes place in non-suitable habitat.

  Explanation: Agricultural lands have been decreasing since 1986 (see Table 2, above) so new agricultural lands are unlikely to be extensive. Population numbers for all towns in or overlapping the range have decreased since 2011 (Table 4). Plans to build a large (14,400 acre) solar plant in the range (the Kern Solar Ranch, mentioned in the petition) have been withdrawn (CBD 2020, p. 23; Interconnection.fyi 2025 pp. 1–2; Kern County Planning and NR Dept 2025, p. 44), and current plans for solar plants within the range involve only three plants and under 100 acres (Kern County Planning and NR Dept 2025, entire; CEQAnet 2025, entire; Fresno County Planning Dept 2025, pp. pp. 3, 9, 11, 13, 17, 19). Urban areas with the highest populations (Coalinga and Avenal), and thus most likely to expand further into the range, are abutted on most sides by agricultural lands and are thus most likely to expand into those if they expand at all (MRLC 2024, GIS data).

**Table 4**. Past and present populations of towns completely or partially in the range[3].

| Town | Previous Population | Current Population |
|---|---|---|
| Coalinga | 18,000 (2010) | 17,400 (2023) |
| Avenal | 15,300 (2010) | 14,075 (2023) |
| McKittrick, Fellows, & Derby Acres | 591 (2011) | 469 (2023) |
| Taft | 9,280 (2010) | 6,961 (2023) |

**<u>Future Conditions Under Scenario 1:</u>**

**Climate-Related Changes (Scenario 1)**: Table 5, below, summarizes projections for daily temperatures, precipitation, and wildfires in the lizard's range under the more optimistic RCP 4.5 trajectory (Cal-Adapt 2025a, p. 1; Cal-Adapt 2025b, p. 1; Cal-Adapt 2025c, p. 1; Cal-Adapt 2025d, p. 1; Cal-Adapt 2025e, p. 1). Maximum daily temperatures are projected to increase by about 4°F (2.2°C) by mid-century, and then start leveling off by the end of the century. Minimum daily temperatures show the same pattern, but with slightly smaller increases. Higher temperatures mid-century will be accompanied by a roughly 20% increase in area burned within the range by wildfires per year. However, the amount of precipitation will also increase by about 6%. By the end of the century, both these factors will have returned to roughly their baseline historical levels. Despite the mid-century increase in area burned annually, the probability of fire

[3] Data Commons 2025a, p. 10; Data Commons 2025b, p. 8; Data Commons 2025c, p. 8; Data Commons 2025d, p. 8; Data Commons 2025e, p. 9; Data Commons 2025f, p. 11

in any given grid cell (3.7 by 3.7 miles (6 km by 6 km)), will remain unchanged from the historical baseline throughout the century.

**Table 5. Temperature, Precipitation, and Wildfire Projections For the Range Under an Optimistic Emissions Trajectory**

| Time Period | Factors Influencing Viability - RCP 4.5 | | | | |
|---|---|---|---|---|---|
| | Maximum Daily Temp (Yearly average). | Minimum Daily Temp (Yearly average). | Annual Precipitation (30 yr average). | Area Burned in Range Annually (30 yr average). | Probability of fire within 10 yrs for a 13.7 sq mi (36 sq km) grid cell. |
| **Historical (1961-1990)** | 75.3 °F<br>24.1 °C | 46.6 °F<br>8.1 °C | 7.9 inches<br>20.1 cm | 3,912.9 acres<br>1,583.5 hectares | 0.2 |
| **Mid-Century (2035-2064)** | 79.1 °F<br>26.2 °C | 50.1 °F<br>10.1 °C | 8.4 inches<br>21.3 cm | 4,646.8 acres<br>1,880.5 hectares | 0.2 |
| **End-Century (2070-2099)** | 80.6 °F<br>27.0 °C | 51.3 °F<br>10.2 °C | 7.9 inches<br>20.1 cm | 3,803.9<br>1539.4 hectares | 0.2 |

**Changes due to Oil Extraction (Scenario 1)**: Additional well construction will result in loss of habitat, and increased chances of oil or wastewater spills. Out of 20,875 currently active or "new" wells within the lizard's range (including a 0.5-mile buffer), all but 32 are within established oil field boundaries (Figure 12), and even those are only slightly outside (Service 2025 summary of CalGEM 2025 shapefile data, p. 1). Under Scenario 1, we assume this trend continues, at a pace of about 200 new wells per year (or 10,000 additional wells within the oil field boundaries by 2075.

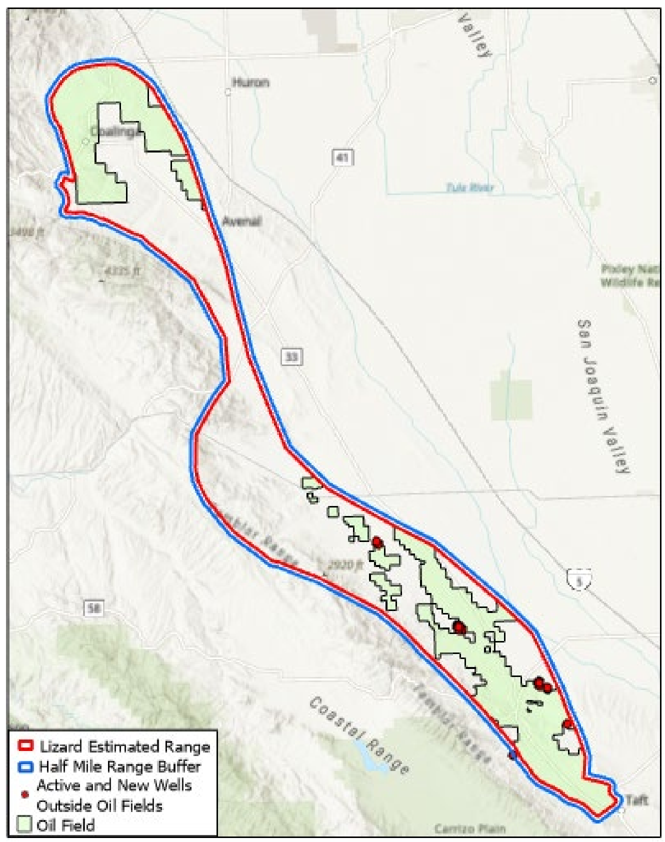



**Figure 12. The 32 New or Active Wells (out of 20,875) Outside the Oil Fields.**

Ten thousand additional wells will increase the current number of new and active wells by about half, thereby presumably increasing the area developed for oil by that amount as well. Current development across the range is 10.2% (see Table 2, above). Based on the map in Figure 8, we estimate about 9% of that development is for oil. Increasing oil development by half would bring it to 13.5%. Potentially-suitable habitat currently constitutes 71.3% of the range (Table 2), or 487 square miles (sq mi), (1,261 square kilometers (sq km)). If we assume all the new oil development occurs in potentially-suitable habitat (which likely overestimates impacts somewhat), then potentially-suitable habitat will decrease by 4.5% to 66.8% of the range (456 sq mi (1,181 sq km)). The decrease of potentially-suitable habitat from 487 to 456 sq mi represents a 6.4% loss of existing potential habitat, all of which would occur within the oil field areas.

**Changes Due to Other Types of Development (Scenario 1)**: Urban, agricultural, and industrial development (for industries other than oil extraction) are assumed to increase by one percent or less under this scenario. Such increases are also assumed to take place primarily in areas other than potentially-suitable habitat, and to thus leave the amount of potentially-suitable habitat unaffected. (See **Summary of the Scenario**, above, for an explanation of these assumptions).

**Future Resiliency –Scenario 1**

The mid-century increases in area burned and in precipitation (Table 5) could tend to favor an increase of grasses on the general landscape, since grasses would be able to grow back more quickly in most burned areas. This would tend to affect the availability of areas with overhanging vegetation and leaf litter. However, the projected fire and precipitation increases are both relatively small and temporary. Annual precipitation is projected to return to baseline under this trajectory towards the end of the century, and area burned actually drops slightly below historical levels at that time as well.

Losses of about 6.4% of existing potentially-suitable habitat in the oil field areas will lower resiliency somewhat. Remaining suitable habitat in those areas will also likely become somewhat more fragmented, although intermittent or ephemeral streams will continue to serve as connecting habitat to many areas otherwise isolated by new development.

In the 63.3% of the range outside the oil fields, oil extraction activities are not expected to affect species needs, except that any streams running out of the oil fields may still be affected by oil or wastewater spills originating within those boundaries.

Non-oil development is not expected to affect potentially-suitable habitat under this scenario.

Overall, some decline in resiliency is likely, due to changing environmental conditions and habitat lost to oil development, but such changes are relatively small and unlikely to prevent the species from withstanding stochastic events.

**Future Redundancy –Scenario 1**

Increased oil development will raise the likelihood of catastrophic spills within the oil fields. Increased fragmentation in those areas will also tend to increase the impacts of other catastrophic events such as floods or droughts in those areas. We would expect areas outside the oil fields to remain resistant to such events, however, and to potentially serve as sources for recolonization if needed.

Catastrophic events, such as floods and droughts, will tend to increase in frequency over time. However, the increase in average precipitation rates expected by mid-century (see Table 5), and the avoidance of any drops below current precipitation levels under RCP 4.5 will likely result in rain replenishing substrate moisture between droughts, potentially lessening their impact.

No effects on future redundancy appear likely under this scenario due to weather related changes or non-oil development. Overall, we expect redundancy under Scenario 1 to decrease slightly, but not to a degree that would make the lizard significantly more vulnerable to catastrophic events compared to the current redundancy.

**Future Representation –Scenario 1**

Individual lizards across the range will generally be able to adjust to somewhat-hotter temperatures by burrowing and seeking shaded areas. We have no indications of local adaptations in parts of the range that would help the species adjust to future changes.

Oil development will tend to degrade habitat in the northern and southern portions of the range, which have the most overlap with oil fields (Figure 12, above). We do not expect this to affect representation, however, because there does not appear to be anything unusual about the habitat or the Temblor legless lizards in those areas. Overall, representation is low because the species is narrowly distributed with no known local differences that could help it adapt to future changes. Future representation will likewise remain inherently limited.

## 6.2 SCENARIO 2

**Summary of the Scenario:**

- Atmospheric greenhouse gas emissions follow the RCP 8.5 trajectory (to 2100).

  Explanation: This scenario assumes that greenhouse gas emissions follow the least optimistic of the four trajectories established by the IPCC and discussed under **Summary of Scenario 1**, above.

- About 400 new wells are constructed per year for oil and gas extraction (to 2075).

  Explanation: This scenario assumes that the average number of new wells dug per year will increase until it levels off at 400 per year (twice the number assumed under Scenario 1). This will result in 20,000 new wells by 2075. As discussed under **Changes due to Oil Extraction (Scenario 1)**, there are currently 20,875 active or new wells within the lizard's range (including a half-mile buffer), all but 32 of which are inside the oil-field boundaries. An additional 20,000 wells will therefore roughly double the area developed for oil extraction, and all that new development will occur within the oil field bounds. As this is a pessimistic scenario, we assume that remaining oil reserves are sufficient to support that many new wells, possibly with the help of such new extraction technologies as may be developed.

- Non-oil development (agricultural, urban, and solar energy development combined) occurs in 5% of the range, but 1% of this occurs in non-potentially-suitable habitat (such as in currently agricultural lands).

  Explanation: Currently, agricultural development is negative, in the sense that agricultural lands are being lost (see Table 2, above). Urban development is also either negative or non-increasing, because population numbers at urban centers within or bordering the range have been decreasing (see **Changes Due to Other Types of Development (Scenario 1)**). This scenario assumes that the trends for at least one of these development types becomes positive enough such that, by 2075, the combined impacts to potential habitat total 5% of the range. An example of circumstances resulting in such a 5% loss might be that solar plant construction increases in the region, and urban development increases to provide housing for solar plant and oil-industry workers.

**Future Conditions Under Scenario 2**

**Climate-Related Changes (Scenario 2)**: Table 6, below, summarizes projections for daily temperatures, precipitation, and wildfires in the lizard's range under the higher emission RCP 8.5 trajectory (Cal-Adapt 2025f, p. 1; Cal-Adapt 2025g, p. 1; Cal-Adapt 2025h, p. 1; Cal-Adapt 2025i, p. 1; Cal-Adapt 2025j, p. 1). Maximum temperatures in this scenario increase about 5°F (2.8°C) by mid-century (only slightly more than in Scenario 1) but continue climbing another 3.2°F (1.8°C) by 2100. Minimum daily temperatures increase to the same extent as in Scenario 1 (3.4°F (2.4°C)) until mid-century, but then continue to increase by the same amount to 2100.

Annual precipitation also increases slightly to the mid-century mark, but then increases much more rapidly. This pattern represents one of the largest differences from the RCP 4.5 trajectory, where precipitation increase is higher up to mid-century, but then becomes negative, bringing precipitation back to historical levels again by the end of the century.

The Area Burned estimates, which show a downward trend across the entire century, are also noticeably different from the RCP 4.5 projections (where they increased to the mid-century mark before going down again). However, both projections indicate Area Burned will be somewhat less by century's end than it was historically. In contrast, the ten-year probability of fire within each grid cell shows no differences, regardless of RCP trajectory or time-period considered.

**Table 6. Temperature, Precipitation, and Wildfire Projections for the Range Under a Pessimistic Emissions Trajectory**

| Time Period | Factors Influencing Viability - RCP 8.5 | | | | |
|---|---|---|---|---|---|
| | Maximum Daily Temp (Yearly average). | Minimum Daily Temp (Yearly average). | Annual Precipitation (30 yr average). | Area Burned in Range Annually (30 yr average). | Probability of fire within 10 yrs for a 13.7 sq mi (36 sq km) grid cell. |
| Historical (1961-1990) | 75.3 °F<br>24.1 °C | 46.6 °F<br>8.1 °C | 7.9 inches<br>20.1 cm | 3,949.5 acres<br>1,598.3 hectares | 0.2 |
| Mid-Century (2035-2064) | 80.2 °F<br>26.8 °C | 51.0 °F<br>10.6 °C | 8.1 inches<br>21.6 cm) | 3,919.8 acres<br>1,586.3 hectares | 0.2 |
| End-Century (2070-2099) | 83.4 °F<br>28.6 °C | 54.4 °F<br>12.4 °C | 9.1 inches<br>23.1 cm | 3,583.7 acres<br>1,450.3 hectares | 0.2 |

**Changes due to Development (Scenario 2)**: Under this scenario, 20,000 new wells will be drilled by 2075, thereby roughly doubling the number of new and active wells currently operating. Since we're assuming 9% of the range is currently developed for oil production, a doubling of that would mean adding another 9%, all within the oil field areas. We make the conservative assumption here that the entire 9% will involve development of potentially-suitable habitat. We're also assuming a 5% increase in non-oil development under this scenario, 4% of which would occur by developing potentially-suitable habitat. Accordingly, total development of potentially-suitable habitat will increase by about 13% of the range under this scenario. Potentially suitable habitat will decrease from 71.3% of the range (487 sq mi, or 1,261 sq km) to 58.3% of the range (398 sq mi, or 1,031 sq km). This is an 18.3% decrease in total area of potential habitat, about two thirds of which will occur in the oil field areas. Oil fields constitute 36.7% of the range, so by 2075 about half that (9% + 9% = 18%) will be developed for oil extraction.

**Future Resiliency –Scenario 2**

Mid-century temperatures under this scenario will be very similar to those under Scenario 1, but as 2100 approaches both maximum and minimum daily temperatures will exceed Scenario 1 by about 3°F (1.7°C), as averaged across the entire year. Summer temperatures will tend to be even higher than the average, just as winter temperatures will be lower. These temperatures will make the shade provided by overhanging vegetation and leaf litter extremely important and may tend to reduce the carrying capacity of habitat in areas with less of these factors. Precipitation will also be much more important, to cool the substrate, maintain overhanging vegetation and prey populations, and to keep soil moisture levels high enough to allow the lizards to properly shed their skin (see section 3.1, above).

The projected increase in precipitation under this scenario at end-century is thus likely to provide important benefits to the lizards. The impact of droughts will become more serious, however, as will impacts from fires that remove overhanging vegetation. Accordingly, the continuing decrease projected for "area burned" under this scenario will be beneficial to the lizards as well.

Increased development under Scenario 2, both for oil extraction and other purposes, will decrease total potentially suitable habitat by about 18.3%. This will still leave the range with almost 400 sq mi (1,031 sq km) of potentially suitable habitat, however, as compared to 487 sq mi (1,261 sq km) currently. The oil fields will be most affected, with about half their area developed for oil, and remaining potentially suitable habitat likely fragmented. But even in those areas fragmentation will continue to be reduced by connecting intermittent or ephemeral streams.

Overall resiliency will thus decline due to these changes, but should remain sufficient to allow the species to continue to withstand stochastic events.

**Future Redundancy –Scenario 2**

With increased oil-extraction will come increased likelihood of oil and wastewater spills in the oil field areas (roughly 37% of the range). This will be exacerbated by fragmentation of remaining potentially-suitable habitat in those areas. Higher temperatures will also tend to increase the impacts of drought across the range. And increased likelihood of unusual weather events will mean an increase in both droughts and flooding. However, increased annual precipitation will tend to limit the droughts' duration and allow soil moisture to replenish.

Overall, we expect redundancy under Scenario 2 to decrease more than under Scenario 1, but to still leave the lizard capable of recovering from catastrophic events.

**Future Representation –Scenario 2**

Habitat in the oil fields (primarily in the northern and southern portions of the range) will be degraded under this scenario. Additional habitat lost to non-oil development will also tend to be near urban and agricultural areas in the north and south. However, we have no information to indicate those areas are unusual or support subpopulations that are unusual.

Representation (which is currently low due to lack of such differences) would thus remain unchanged under this scenario.

## 6.3 SUMMARY OF FUTURE CONDITIONS

**Under Scenario 1**: Potentially-suitable habitat will decrease by about 6.4% due to oil-related development, with losses restricted to the oil field areas (36.7% of the range). Those areas will also likely experience increased oil and wastewater spills. Resiliency will thus decrease somewhat, particularly in those areas. Remaining potentially-suitable habitat in the oil fields will also tend to become more fragmented, although intermittent and ephemeral streams will maintain most connections.

In the rest of the range, resiliency should remain relatively high except in places already converted by agricultural or urban development. Temperature increases will start leveling off later in the century, and the likelihood of fire will decrease. Long-term conversion of shrublands to grasslands is unlikely, due to relatively stable precipitation and eventual decreases in fires.

Overall, resiliency will decrease somewhat but the lizard will likely remain able to recover from common environmental fluctuations through 2075 based on all the factors considered, and through 2100 based on consideration of weather-related changes alone.

Redundancy will also decrease somewhat due to habitat loss and fragmentation in the oil-field portions of the range and an increase in likely catastrophic events such as drought and flooding. The lizard should still be able to recover from such events, however.

Representation will remain low but unchanged, since no subpopulations or areas of the range appear to be unusual compared to the others.

**Under Scenario 2**: Development will increase by 13% of the range, and increased heat will lower the ability of marginal areas to support lizards. Most loss of potentially suitable habitat will occur in the oil fields (36.7% of the range), leaving about half their area developed for oil extraction. Fragmentation in the oil fields will be worse than under Scenario 1, but intermittent and ephemeral streams should still maintain some connectivity. Shrublands are unlikely to be converted to grasslands because precipitation will increase and fire risk will go down. Because 58.3% of the range (398 sq mi (1,031 sq km)) will remain potentially suitable habitat, the lizard should remain able to recover from common environmental fluctuations under this scenario.

Redundancy will decline for the lizard under this scenario, since increased oil development may lead to more spills, and since increasing temperatures will tend to increase the impacts of fire and drought. Increased precipitation will also bring increased flooding risk. However, none of these events are likely to depopulate large areas. Flooding and spills will remain channeled and relatively localized, and increased precipitation should mean that extended multi-year droughts will become less likely, and that soil moisture and vegetation will be able to return to normal levels. The lizards should thus remain capable of weathering catastrophic events under this scenario.

Representation under this scenario will remain low and unchanged, since the species already lacks important genetic or habitat differences across the range.

# CHAPTER 7 – OVERALL ASSESSMENT OF SPECIES VIABILITY

Our goal in this report has been to characterize the viability of the Temblor legless lizard using the best scientific and commercial information available to us. We do not have data regarding population size, whether it is increasing or decreasing, genetic connectivity, or dispersal ability, and our data regarding range and distribution is limited. Consequently, this report focuses primarily on known threats, and the extent to which they may impact species viability, now and in the future.

We conducted a GIS analysis of landcover and found that development has increased since 1986 and potentially suitable habitat has decreased, but both by less than 5% of the range. Agriculture has also decreased (by less than 5%), but ex-agricultural lands are assumed not to constitute potentially suitable habitat due to relatively permanent hydrography and soil-composition changes. Temperatures have also increased, but this has not caused a decrease in shrublands, and so presumably has not affected the availability of overhanging vegetation, leaf litter, or systems of larger roots generally. Repeated sightings of lizards relatively close to oil wells and to a landfill indicate the lizards can coexist to some extent with such activities nearby. Oil and wastewater spills have occurred but tend to be channeled by topographic features rather than spreading across the landscape. Current resiliency therefore appears sufficient to allow recovery from normal environmental fluctuations.

Current redundancy also appears sufficient to survive catastrophic events. Although the known range is small, available habitat appears well-distributed such that the lizard likely avoids clustering in small areas that would be more vulnerable to catastrophes. A major drought would affect the entire range, and so is likely the most challenging catastrophic event reasonably likely to occur, but the lizard has survived such major droughts in the past and remains distributed across its entire range. Oil spills have occurred, but are relatively localized. Flooding tends to fill ephemeral and intermittent streambeds, but not higher areas (except in lands already converted to agriculture).

Current representation is naturally low due to the lack of habitat differences or inherent biological differences across the range. We have not found that any threats are likely to lower representation further, however.

To characterize the future condition of the species, we established two plausible future scenarios, one optimistic and the other pessimistic, to attempt to capture the range of possible futures. We expect actual future events to fall somewhere between these scenarios. Because better data is available regarding future weather-related changes, we considered impacts from those out to 2100 in both our scenarios. We considered other impacts to 2075.

Under Scenario 1, the declining production of new oil wells levels off slightly below current rates, emissions of heat-trapping gasses follow the optimistic RCP 4.5 trajectory, and non-oil related development is restricted to 1% of the range, primarily in agricultural or other non-habitat areas. This results in a 6.4% decrease in potentially-suitable habitat, somewhat increased fragmentation and chances of spills in the oil field areas, and increased temperatures whose effects are somewhat ameliorated by precipitation that increases mid-century and then drops back to current levels. Resiliency and redundancy both decrease somewhat, but the lizard remains capable of withstanding normal environmental fluctuations and catastrophic events. Resiliency remains unchanged, but started low to begin with

Under Scenario 2, the production of new wells increases to twice that of the other scenario, heat-trapping gas emissions follow the pessimistic RCP 8.5 trajectory, and non-oil related development totals 5% of the range, 1% of which occurs in non-habitat areas. This results in an 18.3% decrease in potentially suitable habitat, but still leaves such habitat in 58.3% of the range. About two thirds of the habitat loss is in the oil field areas, leading to increased fragmentation as well as increased spill chances. Intermittent and ephemeral streams still limit fragmentation, however. Temperatures increase considerably lowering the carrying capacity of some areas with marginal vegetation or water. Precipitation increases as well, ameliorating the higher temperatures and lowering chances of long droughts. Shrublands remain unlikely to be converted to grasslands. Resiliency and Redundancy thus both decrease more than in Scenario 1, but the lizard should still retain the ability to withstand normal environmental fluctuations and catastrophic events. Resiliency would remain low and largely unchanged.

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