CEC California Ecology and Conservation Research

Natural Reserve System UNIVERSITY OF CALIFORNIA

Desert night lizards (*Xantusia vigilis*) favor shelter under partially decomposed Mojave yucca (*Yucca schidigera*) logs

Francisco Basso[1], Athena Lynch[2], Alia Warden[1]

[1]University of California, Davis; [2]University of California, Los Angeles

Thermal regulation and management are vital for many species, including the desert night lizard (*Xantusia vigilis*). This lizard is incredibly sensitive to temperature change, which is often a factor in their choice of shelter. Desert night lizards are most commonly found under the debris of Joshua tree (*Yucca brevifolia*) which they favor, though they may shelter under other yucca species if necessary. In recent years, due to climate change and fires, Joshua tree populations have declined and studies predict this trend will continue. In our study, we examined the microhabitat preferences of desert night lizards in an ecosystem deprived of Joshua trees. We surveyed fallen Mojave yucca (*Yucca schidigera*) logs, which are shorter and more leaf covered than that of Joshua trees. We recorded the size, temperature, percent leaf cover, and decomposition state of the logs as well as evidence of lizard presence (a live lizard or molted skin). Here, we show that most of the desert night lizards were found under logs with an intermediate state of decomposition, which also showed the least temperature variation. The insulation provided by a log decomposed enough to remain tightly bound to the ground, but not so decomposed that holes and breaks allow for excessive heat transfer, may create an ideal habitat for the desert night lizard and keep them safe from temperature extremes.

Keywords: *Xantusia vigilis*, *Yucca brevifolia*, *Yucca schidigera*, habitat preferences, thermal regulation, Mojave Desert

INTRODUCTION

Most lizards have specific temperature ranges that they have adapted to and make choices to try to stay within. Desert night lizards (*Xantusia vigilis*) are viviparous insectivores native to the arid locales of California, the desert regions of other southwest states, and Baja California in Mexico. Of the night lizard family, *Xantusia vigilis* are characterized by their particular vulnerability to temperature changes (Davis et al. 2010, Kour and Hutchinson 1970; Marlow 2000, Zweifel and Lowe 1966). Their preferred body temperature is 30°C (Cowles and Burleson 1944); one study found that males experienced sterilization when exposed to 36.5°C for seven days (Cowles and Burleson 1945), and they are severely slowed in colder temperatures (Kaufmann 1989). Night lizards are known to change the color of their skin as a means of temperature regulation, a notable adaptation that helps them manage temperature extremes (Caswell 1950). While the lizards can be found under many plants, or even nonnatural objects discarded by humans (Clark 2010), they are most commonly found under Joshua tree (*Yucca brevifolia*) debris, something that may cause trouble for them in the near future (Stebbins 1948, Zweifel 1966).

Joshua trees have been under threat in recent years from the effects of climate change and fire alike, and it is likely these trees will become increasingly rare as climatic factors continue to cut down their numbers (Harrower 2018, Shafer et al. 2001, Sweet 2019). The range of Joshua trees is predicted to be heavily impacted by climate change (Harrower 2018, Shafer 2001, Sweet 2019), and their overall population may be reduced by 90% by the end of the 21st century (Cole et al. 2011). Recent fires have had severe effects on Joshua tree abundance as well. In 2020, the Dome Fire wiped out a dense population of Joshua trees in the Cima Dome area of the Mojave national preserve (NPS 2020). With Joshua tree numbers set to decline heavily, it is worth investigating the desert night lizards' preferences in a habitat without their favorite yucca, as that may soon be the case for much of their population.

To investigate this situation, we looked at the landscape of the Granite Mountains, a desert habitat which has no Joshua trees but features the Mojave yucca (*Yucca schidigera*) instead, a species which is far shorter and has longer leaves than the Joshua tree (NPS 2021). Night lizards in this habitat compared with those in Joshua tree ranges shelter under the Mojave yucca's generally shorter and more leafy logs, perhaps impacting the log's comparative insulation and available shelter area. We hypothesized that the lizards would occur under partially decomposed logs more because there might be more food for them there (Barclay 2000). We based this off of the assumption that there would be more invertebrates under partially decomposed yucca logs that have been there long enough to accumulate invertebrate visitors, but not so long that the invertebrates have run out of food and moved on from the log. We also expected the lizards to live under larger logs because we speculated that the larger logs would have better insulation and therefore smaller temperature swings, to protect the thermally sensitive desert night lizard (Kour and Hutchinson 1970). Lastly, we predicted that the lizards would favor logs with less leaf litter, reminiscent of the less leafy Joshua tree.

METHODS

We investigated our hypotheses at the Sweeney Granite Mountains Desert Research Center in San Bernardino County, California (34°48'35"N, 115°37'40"W). The study area was located in a creosote and succulent scrub plant community on the flats near mountain ridges in the Granite Mountains, an area in which the Mojave yucca thrives (Schoenherr 1995).

The study was performed from February 23–28, 2021. Each day, we scouted for fallen Mojave yucca logs. When we found a fallen log, we would mark its location (Fig. 1) and lift it up to assess and record desert night lizard presence under the log. Both desert night lizard molted skin and an actual desert night lizard were counted as lizard presence.

In order to study the lizards' habitat size preference, each yucca log was measured to the nearest centimeter (cm) as follows: height at the highest point of the log, width at widest point, and total length. We also recorded the estimated leaf cover percentage of the underside of the log. Then we scored level of decomposition of the log on the following scale (Fig. 2):

1: The log had recently fallen (had some green leaves), or was mostly intact

2: The log was partially decomposed (no green leaves), but did not crack or break when it was lifted

3: The log was severely decomposed (no green leaves), and crumbled or broke when it was lifted

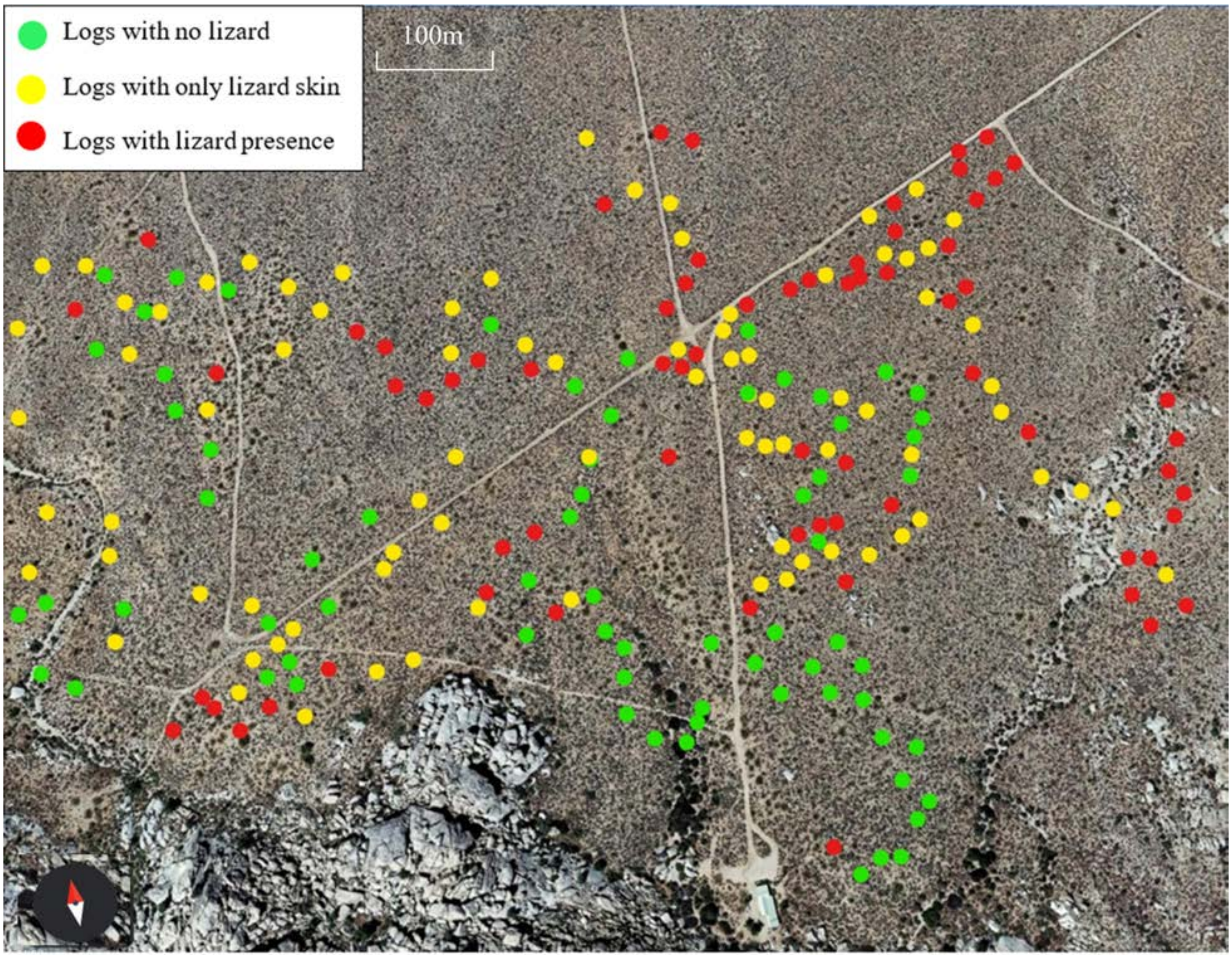

Figure 1. Log sites map. Map of the Granite Mountains Desert Research Center area, with points marking each measured log site. Colors specify evidence of desert night lizard presence, the type of presence (desert night lizard, molted skin, or both) or if there was no presence at all (Google n.d.).

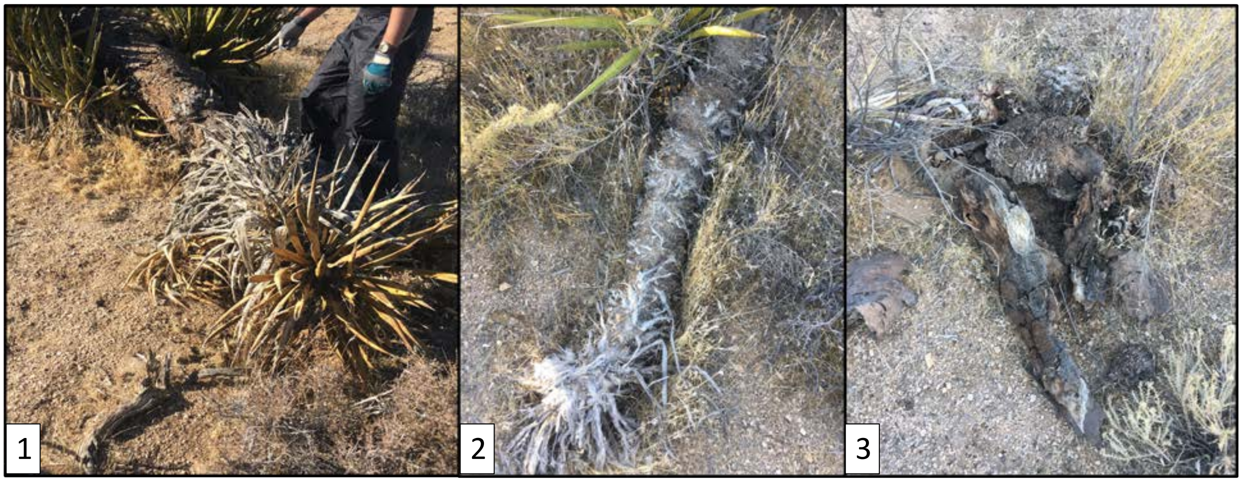

Figure 2. Log decomposition stages. To examine desert night lizard (*Xantusia vigilis*) shelter preference in the Granite Mountains, San Bernardino County, California, we looked at the level of decomposition of fallen Mojave yucca (*Yucca schidigera*) logs that the lizards take shelter under. The levels of decomposition are shown in this image from left to right: 1, the lowest decomposition level of yucca log; intact, recently fallen, still has colored leaves. 2, intermediate decomposition level of yucca log; mostly intact, no colored leaves left. 3, the most decomposed log category; broken or easily broken, no leaves.

In the sites where we found a desert night lizard, we first covered our hands with dirt close to the log, to avoid any adverse effects that extraneous substances on our skin might have had on the desert night lizard's skin. Then we captured the lizard and measured snout to vent length (cm) with a small ruler, and weight (g) with a Weigh Gram Scale Digital Pocket Scale.

In order to measure temperature variation of night lizard habitat, we surveyed nine *Yucca schidigera* logs outside the lizard survey area from February 25–28, 2021. We determined three different size categories: small (15–25 cm length), medium (35–50 cm length), and large (<60 cm length). We then selected three logs each size category, one for each decomposition level previously described: 1, 2, and 3. We recorded the temperature of the ground (°C) under the logs four times each day: early morning (~6:15am–6:45am PST), middle of the day (~11:30am–12:00pm PST), afternoon (~2:30pm–3:00pm PST), and evening (~5:30pm–6:00pm PST), to investigate the temperature variation throughout the day and across the different log characteristics.

2.1 Statistics

All tests were conducted with JMP Pro 15 (SAS Institute inc.). We used linear regression to test whether larger lizards were found under larger logs, and logistic regression to see if the likelihood of lizard presence depended on leaf cover. To see if the lizard presence was associated with a certain decomposition level, we used a chi-squared test.

Next, we had to determine if the size of the log, decomposition stage, or the interaction between those variables and time of day affected the temperature under the logs. We conducted a two-way ANOVA using the data from the temperature readings we took from our nine chosen logs at different times each day to do this. To see whether the size of the log affected the daily variation in temperature, we calculated the mean daily temperature difference under each log across the four days. An ANOVA was used to test whether the size of the log had an impact on the temperature variation.

RESULTS

Lizards in general were not found more under larger logs (N = 220; $\chi 2$ = 1.20; p = 0.2718), but longer lizards tended to be found under wider logs (N = 49; r2 = 0.096; p = 0.0301; Fig. 3). Habitat choice was not impacted by leaf cover (N = 220; $\chi 2$ = 3.61; p = 0.0575) but lizards in general were more likely to be found under the medium decomposition level logs (N = 220; $\chi 2$ = 16.1; p < 0.001; Fig. 4) The size of the log did not affect the temperature underneath it (N = 12, F = 4.14; p = 0.0742), and there was no interaction found between the time of day and the size of the log for the log temperature (N = 36, F = 1.21; p = 0.345). The size of the log also had no impact on the temperature variation throughout the day (N = 9; F = 0.484; p = 0.639), but decomposition did have an effect: the intermediate decomposition level had the least temperature change (N = 9; F = 6.144; p = 0.0353; Fig. 5).

DISCUSSION

Contrary to our predictions, neither the size of the log nor the percent of leaf cover had an effect on the tendency for lizards to be present. Since our results indicate that the size of logs has no effect on lizard presence, it is possible that other factors such as sun exposure or decomposition stage

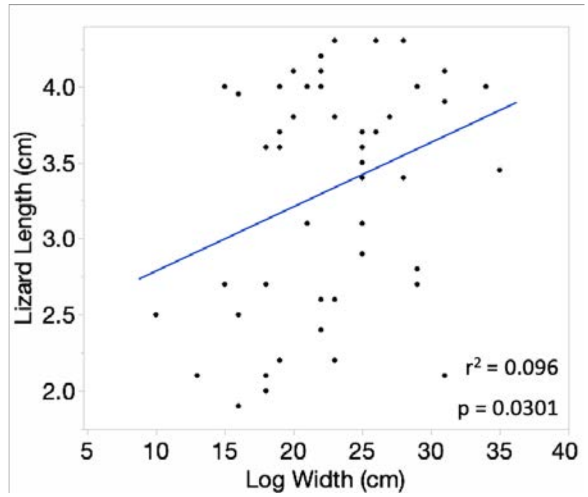

Figure 3. Effect of *Yucca schidigera* log width on *Xantusia vigilis* habitat choices. This graph shows the relationship between the width of *Yucca schidigera* logs and the length of *Xantusia vigilis* that are using the logs as cover in the Granite Mountains. Longer lizards tended to occur under wider yucca logs. The larger lizards may choose the logs with larger areas.

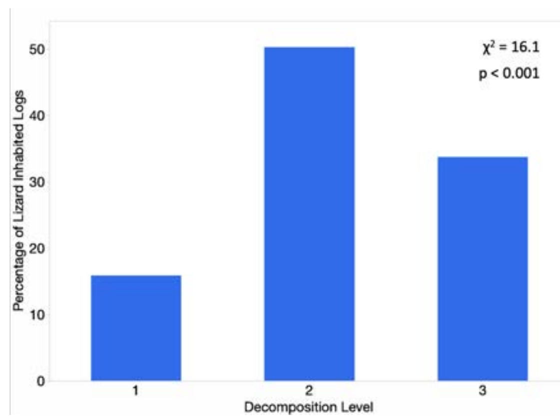

Figure 4. Effect of yucca decomposition level on lizard preference. To study the habitat preferences of *Xantusia vigilis* in the Granite Mountains, CA, we recorded the decomposition characteristics of fallen *Yucca schidigera* logs that had lizards or lizard skin underneath them. Every log measured was categorized into one of 3 decomposition levels: 1s were the least decomposed and mostly intact; 2s were partially decomposed; 3s were very breakable or already broken and crumbly. This graph shows the breakdown of decomposition levels of the logs that had either lizards or lizard skin. The majority of logs with lizard evidence were level 2.

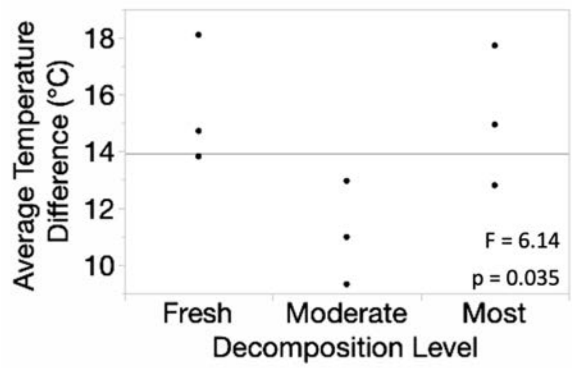

Figure 5. Temperature variation across decomposition stages of *Yucca schidigera*. This graph shows the daily variation in temperature during February 25–28, 2021 underneath the different decomposition classes of *Yucca schidigera* logs in the Granite Mountains, California. The temperature change was the smallest underneath the decomposition level 2 logs, which was also the decomposition level that we found the lizards preferred.

are more important for their microhabitat choices. As for leaf cover, we expected more insects to be present under logs where there was little leaf cover, and hypothesized that the lizards would follow their food source. However, we observed very little invertebrate activity during our study, and observationally there did not seem to be any difference in insect abundance under logs with leaves compared with logs without. If there is no difference in food availability across ranges of leaf cover, then our finding that desert night lizard presence has no relation to leaves is logical.

Though no relationship was found between lizard presence and size or leaf cover of the logs, there was a higher chance of finding a lizard or lizard skin underneath the intermediate decomposed logs. We also found that this middle decomposition stage had the lowest temperature variation throughout the day, which could be a reason we found more evidence of lizards under these logs. We thought that the medium decomposition level would have more insect activity (Barclay 2000), and therefore attract more lizards to a plentiful food source, which is a pattern previously observed in desert night lizards (Boylan et al. 2017). A study done in the Granite Mountains found that desert night lizards were 50% more likely to be found under *Yucca schidigera* logs that had invertebrates (Boylan et al. 2017). It is possible that this was part of the reason there were lizards under partially decomposed logs more frequently, but our findings suggest that temperature fluctuation is another reason for the lizards' habitat preferences. Western fence lizards (*Sceloporus occidentalis*) have been known to make microhabitat choices based on temperature, and it is very likely that other species such as the desert night lizard do the same (Sabo 2003). At the lowest decomposition level, the logs did not have a strong seal with the ground and may have not been very insulated. The highest decomposition level consisted of crumbling, barely intact logs with many holes and, again, little insulation. The insulation provided by a log decomposed enough to remain tightly bound to the ground, but not so decomposed that holes and breaks allow for excessive heat transfer, may create an ideal habitat for the desert night lizard, which is very sensitive to temperature change (Kour and Hutchinson 1970).

Our findings also raise questions about some specifics of night lizard social behavior. We saw larger lizards tended to live under larger logs, possibly because they needed more foraging area to obtain a sufficient amount of food. We know that night lizards tend to live in family units (Davis 2010, 2011), and future studies could investigate whether families have need for larger logs as well. If this is the case, habitat availability could affect the extent of family grouping among desert night lizards. Night lizards are also known to change the color of their skin as a means of temperature regulation (Caswell 1950). A future study examining whether the decomposition level of the log affects the controlled color variation of the lizard could tell us more about how adaptable they are to different habitats.

As previously mentioned, some of the desert night lizards' habitat may be in jeopardy in the coming years due to climate change. Luckily, despite being sedentary and very reliant on covered habitat, research has shown that these lizards do seem to be rather adaptable. One study found that in an area where Joshua trees had existed previously, but are now gone, desert night lizards were able to find other creative habitats. Not only were they found under other plant debris, but they also took shelter under discarded objects, such as plywood or clothing (Clark 2010). However, it is unknown whether they can survive as well under these substrates as compared to yucca logs. Further research should be done on the adaptability and resilience of these lizards in the face of habitat destruction. In the meantime, to maintain this lizard's shelter, there must be sustained protection of yucca plants at different life stages, including the old and dying logs that these lizards and many other organisms need for temperature regulation, food, and cover.

ACKNOWLEDGMENTS

This work was performed at the University of California's Sweeney Granite Mountains Desert Research Center, doi: 10.21973/N3S942

REFERENCES

Barclay, S., J. E. Ash and D. M. Rowell. 2000. Environmental factors influencing the presence and abundance of a log-dwelling invertebrate, *Euperipatoides rowelli* (Onychophora: Peripatopsidae). *J. Zool.* **250:**425–426.

Boylan, K., R. Degen, C. Sanchez, K. Schmidt, and C. Sengsourinho. 2017. Habitat selection of the desert night lizard (*Xantusia vigilis*) on Mojave yucca (*Yucca schidigera*) in the Mojave Desert, California. *CEC Research* **2**.

Caswell, H. 1950. Rhythmic color change in the lizard *Xantusia vigilis*. *Copeia* **2:**87.

Clark, H. 2010. A review of anthropogenic-sourced cover items used by the desert night lizard (*Xantusia vigilis*). *Sonoran Herpetologist* **23(2)**.

Cole, K. 2021. Joshua trees. National Park Service, U.S. Department of the Interior, www.nps.gov/jotr/learn/nature/jtrees.htm.

Cole, K., K. Ironside, J. Eischeid, G. Garfin, P. Duffy and C. Toney. 2011. Past and ongoing shifts in Joshua tree distribution support future modeled range contraction. *Ecological Applications* **21:**137–149.

Cowles, R. B., and C.M. Bogert. 1944. A preliminary study of the thermal requirements of desert reptiles. *Bulletin of the American Museum of Natural History* **83:**261–296.

Cowles, R.B., and G.L. Burleson. 1945. The sterilizing effect of high temperature on the male germ-plasm of the yucca night lizard, *Xantusia vigilis*. *American Naturalist* **79:**417–435.

Davis, A. R., A. Corl, Y. Surget-Groba and B. Sinervo. 2011. Kin presence drives philopatry and social aggregation in juvenile desert night lizards (*Xantusia vigilis*). *Behavioral Ecology* **23:**18–24.

Davis, A. R. 2010. Convergent evolution of kin-based sociality in a lizard. *Proceedings of the Royal Society B: Biological Sciences* **278(1711):**1507–1514.

"Dome Fire." 2021. National Parks Service, U.S. Department of the Interior, www.nps.gov/moja/learn/nature/dome-fire.htm.

Google. (n.d.). 2021. Sweeney Granite Mountains Desert Research Center. Retrieved from https://earth.google.com/web/@34.81024487,-115.62860821,1211.82927705a,712.92390432d,35y,11.16656229h,0t,0r.

Harrower, J., and G. S. Gilbert. 2018. Context-dependent mutualisms in the Joshua tree-yucca moth system shift along a climate gradient. *Ecosphere* **9(9)**.

Kaufmann, J. S., and A. F. Bennett. 1989. The effect of temperature and thermal acclimation on locomotor performance in *Xantusia vigilis*, the desert night lizard. *Physiological Zoology* **62(5):**1047–1058.

Kour, E. L., and V. H. Hutchison. 1970. Critical thermal tolerances and heating and cooling rates of lizards from diverse habitats. *Copeia* **2:**219.

Marlow, R. 2000. Life history account for desert night lizard. California Wildlife Habitat Relationships System. California Department of Fish and Wildlife California Interagency Wildlife Task Group.

Marr, D. L., and O. Pellmyr. 2003. Effect of pollinator-inflicted ovule damage on floral abscission in the yucca-yucca moth mutualism: the role of mechanical and chemical factors. *Oecologia* **136(2):**236–243.

Miller, M. R. 1951. Some aspects of the life history of the yucca night lizard, *Xantusia vigilis*. *Copeia* **2:**114.

Sabo, J. L. 2003. Hot rocks or no hot rocks: overnight retreat availability and selection by a diurnal lizard. *Oecologia* **136:**329–335.

SAS Institute Inc. 2019. JMP 15.2.1.

Schoenherr, A. A., 2017. *A Natural History of California*. University of California Press, Berkeley, California, USA, pp. 456.

Shafer, S., P. Bartlein and R. Thompson. 2001. Potential changes in the distributions of western North America tree and shrub taxa under future climate scenarios. *Ecosystems* **4:**200–215

Stebbins, R. C. 1948. New distributional records for *Xantusia vigilis* with observations on its habitat. *American Midland Naturalist* **39:**96.

Sweet, L. C., T. Green, J. G. C. Heintz, N. Frakes, N. Graver, J. S. Rangitsch, J. E. Rodgers, S. Heacox, and C. W. Barrows. 2019. Congruence between future distribution models and empirical data for an iconic species at Joshua Tree National Park. *Ecosphere* **10(6)**.

Zweifel, R., and C. Lowe. 1966. The ecology of a Population of *Xantusia vigilis*, the desert night lizard. *American Museum Novitiates* **2247**.