

Observations of extreme dehydration and rehydration leading to recovery of a threatened California tiger salamander

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RESEARCH NOTE

Zachary A. Cava^{1*}, Kyla M. Garten¹, Sarah M. Foster², and Jeff A. Alvarez³

¹ The Biophilia Group, 2615 F Street, Apt 6, Sacramento, CA 95816 USA

² Foster Wildlife Surveys, 744 5th Avenue, Sacramento, CA 95818 USA

³ The Wildlife Project, P.O. Box 188888, Sacramento, CA 95818, USA

*Corresponding Author: cava.zachary@gmail.com

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The availability of soil moisture has been reported to be the most critical environmental factor leading to the distribution of urodels (Rosenthal 1957; Marangio and Anderson 1977; Stebbins and Cohen 1995). Salamanders use basic methods for hydroregulation including moving to and from wet and dry locations or changing body surface area exposed to air or to wet locations (Duellman and Trueb 1994; Stebbins and Cohen 1995). As a result, moisture availability can affect distribution, habitat use, and suitability for many salamander species (Rosenthal 1957; Anderson 1967, 1972). Species such as the California tiger

salamander (*Ambystoma californiense*) utilize underground refugia for the majority of the year to avoid water loss in their terrestrial habitat, which consist of grasslands and woodlands in relatively xeric portions of California (Storer 1925; McGinnis and Stebbins 2018). Increasingly, however, natural conditions are interrupted by natural, technogenic, and anthropogenic obstacles that can result in unsuitable conditions for migrating or foraging urodels (Twitty 1941; Wang et al. 2009; Alvarez et al. 2021). Herein, we report on the rehydration and recovery of an individual California tiger salamander after it became entrapped and desiccated in an open trench. California tiger salamanders are federally and state threatened in the Central Valley. This information can potentially reduce the loss of individuals and contribute to the protection and conservation of populations.

While conducting construction monitoring on 15 July 2020 at an undisclosed site within the Central California Distinct Population Segment of the California Tiger Salamander (USFWS 2004), we walked transects parallel to a 400-m long, 2-m wide, and 0.8-m deep earthen trench. The trench had been most recently checked approximately 12 hours prior; during the intervening 12-hour period, air temperature ranged between 14.5°C and 32.7°C, and humidity ranged between 36% and 90%. There had been no measurable precipitation since 13 June 2020. At 0630 hours a subadult California tiger salamander was observed at the bottom of the trench. We determined this individual was a subadult based on its size and lack of sexual characteristics typical of a reproductively mature animal. The body condition of the animal suggested that it had desiccated, and it appeared to be near death (**Fig. 1**). The salamander was carefully examined and although it moved very slightly, it had no righting reflex. This condition has been reported as the Critical Activity Point (CAP), with lethality “closely following” (Ray 1958). A container with a moist paper towel was used to transport the salamander for approximately 10 minutes.



Figure 1. A subadult California tiger salamander collected from an earthen trench. The specimen appeared severely emaciated, was not moving, and had no righting reflex, California, USA.

The salamander was re-examined and weighed on a digital scale (1 g accuracy) and appeared near death based on no movement and no righting response (**Fig. 2** and **Fig. 4A**). The weight of the salamander was 9 g. In an attempt to rehydrate the salamander through integumental water uptake, we placed it in a container with a layer of saturated paper towels both under and over the top of the salamander. We then placed the container in a dark area and assessed the salamander’s status periodically. Within approximately one hour the tiger salamander became noticeably more active and was able to support itself and lift its head. After two hours the salamander had increased in weight by 3 g (30% of the initial weight) and began to walk. After 3 hours the salamander was very active (i.e., walking, climbing, etc.) and had increased by an additional gram, bringing its total weight to 13 g (44% of the initial weight). At this time the salamander was deemed suitable for release (**Fig. 3** and **Fig. 4B**).



Figure 2. Subadult California tiger salamander weighed shortly after removal from an excavated trench, California, USA.



Figure 3. The same California tiger salamander three hours after rehydration in a water-moistened

container, California, USA.



Figure 4. Dorsal view of California tiger salamander, before (A) and after (B) rehydration, California, USA.

Cohen (1952) and Ray (1958) demonstrated dehydration-based weight loss in non-Ambystomid salamanders (*Aneides*, *Batrachoseps*, *Ensatina*, and *Taricha*) that are sympatric with California tiger salamanders. Stebbins (1945) also reported on the rehydration of a desiccated *Ensatina*. Although we do not know the original weight of our salamander prior to dehydration, its rehydration rate of 44% is greater than the rehydration rates reported in the aforementioned studies. Unlike the studies referenced above, our findings are unique in representing an opportunistic field observation rather than a controlled laboratory experiment. California tiger salamander distribution extends well into more xeric habitats than the three genera investigated by Cohen(1952), and California tiger salamanders have been known to survive substantial losses in body mass (Searcy et al. 2014). It is possible that California tiger salamanders have evolved adaptations to resist dehydration better than other species; however, because our measurements were obtained from a single animal, broad conclusions are limited.

In the case of technogenic obstacles in native habitats, trenches in particular have been reported to indiscriminately capture nearly 7,500 vertebrates over a two-year period (Doody et al. 2003). This entrapment can result in direct mortality on already declining species. Moreover, if desiccated amphibians are presumed dead when near their CAP, without attempts to rehydrate, this may result in preventable mortality.

Thorson (1955) showed that desiccation rates are not constant in the amphibians he tested. Although it appears that California tiger salamanders can survive a substantial loss of water, approaching half the body weight for our specimen, an individual's condition at the time it becomes entrapped may influence survival greatly. We suggest that exposure to open trenches may have a detrimental or lethal impact to California tiger salamanders due to the dry conditions of the disturbed soil at the bottom of the trench, as well as the lack of cover objects in the trench. Therefore, we suggest the following conservation actions to reduce amphibian mortality: When possible, areas with trenches that are likely to be excavated and remain open should be fenced with wildlife exclusion fencing that is maintained daily, and the trench should be checked every morning. Alternatively, if the trench is smaller in size, it should be covered with no accessible gaps available to amphibians. Additionally, cover boards that can lay flat on the trench floor should be placed every 20 m, and checked daily, and removed before filling of the trench. Rescued amphibians should be immediately placed in damp substrate (i.e., clean plastic bucket with moistened paper toweling or liberally wet sphagnum moss) and monitored for activity prior to release into a water-moistened, appropriate burrow.

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Literature Cited

- Alvarez, J. A., J. T. Marty, K. Christopherson, P. Craig, D. Weber, and C. D. Vang. 2021. An unanticipated ecological trap: Entrapment of the California tiger salamander in technogenic structures as a confounding stressor for a threatened species. *Herpetological Review* 52:274-278.
- Anderson, J. D. 1967. A comparison of the life histories of coastal and montane populations of *Ambystoma macrodactylum* in California. *American Midland Naturalist* 77:323-355.
- Anderson, J. D. 1972. Behavior of three subspecies of *Ambystoma macrodactylum* in a soil moisture gradient. *Journal of Herpetology* 6:191-194.
- Cohen, N. 1952. Comparative rates of dehydration and hydration in some California salamanders. *Ecology* 33:462-479.
- Doody, J. S., P. West, J. Stapley, M. Welsh, A. Tucker, E. Guarino, M. Pauza, N. Bishop, M. Head, S. Dennis, G. West, A. Pepper, and A. Jones. 2003. Fauna by-catch in pipeline trenches: Conservation animal ethics, and current practices in Australia. *Australian Journal of Zoology* 32:410-419.
- Duellman, W. E., and L. Trueb. 1994. *Biology of Amphibians*. Johns Hopkins University Press, Baltimore, MD, USA.
- McGinnis, S. M., and R. C. Stebbins. 2018. *Field Guide to Amphibians and Reptiles of California. A Field Guide to the Western Reptiles and Amphibians*. 4th edition. Houghton Mifflin Harcourt Company, New York, NY, USA.
- Marangio, M. S., and J. D. Anderson. 1977. Soil moisture preference and water relations of the marbled salamander, *Ambystoma opacum* (Amphibia, Urodela, Ambystomatidae). *Journal of Herpetology* 11:169-176.
- Ray, C. 1958. Vital limits and rates of desiccation in salamanders. *Ecology* 39:75-83.
- Rosenthal, G. M. 1957. The role of moisture and temperature in the local distribution of the plethodontid salamander *Aneides lugubris*. *University of California Publications in Zoology* 54:371-420.
- Thorson, T. 1955. The relationship of water economy to terrestriality in amphibians. *Ecology* 36:100-116.
- Searcy, C. A., L. N. Gray, P. C. Trenham, and H. B. Shaffer. 2014. Delayed life history effects, multilevel selection, and evolutionary trade-offs in the California tiger salamander. *Ecology* 95:68-77.
- Stebbins, R. C. 1945. Water absorption in a terrestrial salamander. *Copeia* 1945:.
- Stebbins, R. C., and N. W. Cohen. 1995. *Natural History of Amphibians*. Princeton University Press, Princeton, NJ, USA.
- Storer, T. I. 1925. A synopsis of the amphibia of California. *University of California Publications in Zoology* 27:1-342.
- Twitty, V. C. 1941. Data on the life history of *Ambystoma tigrinum californiense*. *Copeia* 1:1-4.
- United States Fish and Wildlife Service (USFWS). 2004. Listing of the Central California Distinct Population Segment of the California Tiger Salamander. *Federal Register* 68:47212-47248.
- Wang, I. J., W. K. Savage, and H. B. Shaffer. 2009. Landscape genetics and least-cost analysis reveal unexpected dispersal routes in the California tiger salamander (*Ambystoma californiense*). *Molecular Ecology* 18:1365-1374.