

ECOLOGY OF THE WESTERN SPADEFOOT IN EASTERN SAN LUIS OBISPO COUNTY

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Introduction

The western spadefoot (*Spea hammondi*) is in the American spadefoot toad family Scaphiopodidae, and is endemic to California and northern Baja California. It was historically distributed throughout the Great Valley and its foothills, and the coastal mountains of central and southern California. They occur in a variety of arid habitats that have open areas with sandy or gravelly soils, and breed in temporary pools including vernal pools, ephemeral ponds, and intermittent streams. They are named for a keratinous protrusion on their hind feet that they use to dig backwards into the ground. They remain buried in the soil for most of the year to avoid dry conditions, and are active above-ground for a couple months when breeding ponds have water. In some cases, it may take several years for appropriate breeding conditions, in which they remain dormant underground. Because of the limited period that the species is seasonally active, and the rarity of years with environmental conditions to support breeding (especially during droughts), this species is seldom observed. However, when conditions are favorable, they emerge and are very abundant in localized areas, exemplifying an explosive breeding pattern.

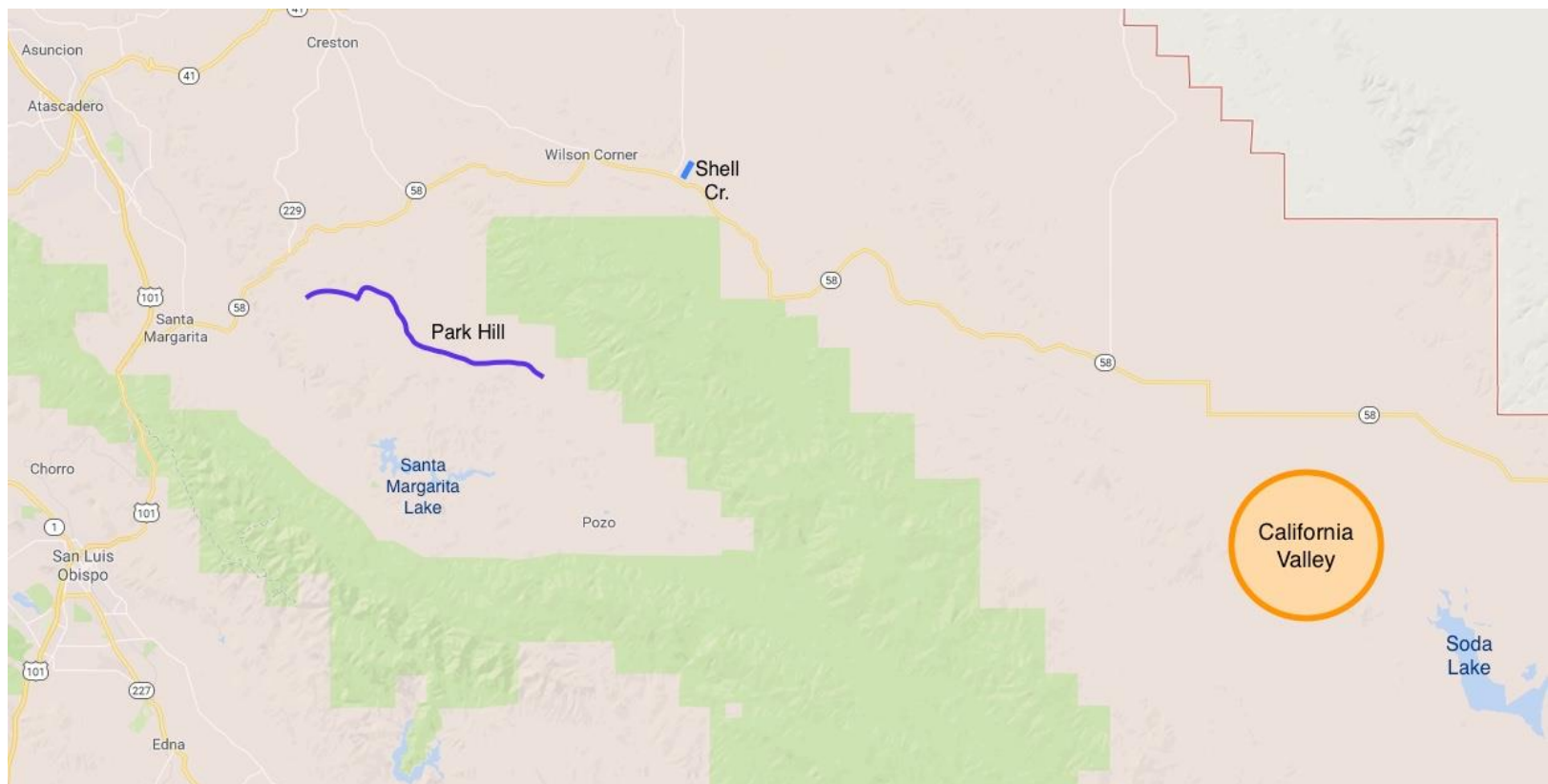
The western spadefoot is considered a Species of Special Concern by the California Department of Fish and Wildlife. A petition for its listing as threatened or endangered under the federal Endangered Species Act was submitted in 2012, and in 2015 the U.S. Fish and Wildlife Service issued a finding that the action may be warranted. They have been extirpated from at least 80% of previously occupied habitat in southern California and 30% in northern and central California, primarily due to habitat destruction. Climate change poses additional threats due to fewer years with sufficient rainfall and reduced breeding site hydroperiods. Because they cannot reliably be detected during presence/absence surveys conducted for project authorizations, and potential breeding sites are not easily identified during dry conditions, this species presents challenges to conservation efforts.

Their distribution includes most of San Luis Obispo County, with almost all documented localities east of Highway 101. Although known to occur from Santa Margarita eastward throughout the Carrizo Plain, few records exist in the CNDDb. This study sought to expand the list of documented localities in this area by conducting focused surveys at three study sites: Park Hill Road (Santa Margarita), Shell Creek (along Highway 58), and California Valley. Surveys took place during spring 2017, when rainfall timing and amounts were highly favorable for spadefoot breeding.



Study Sites

Park Hill (PH) - ranch ponds consisting of artificial impoundments on drainages, swales or seeps, or impounded by the road.
Shell Creek (SC) - mainstem of the creek channel, with flowing water throughout all sections at the beginning of breeding, drying to intermittent pools in late spring.
California Valley (CV) - vernal pools, created wetlands, artificial basins, and Soda Creek isolated pools.



Study Sites Vicinity Map



Park Hill Ranch Pond

Shell Creek

California Valley Vernal Pool

California Valley Soda Creek

Methods

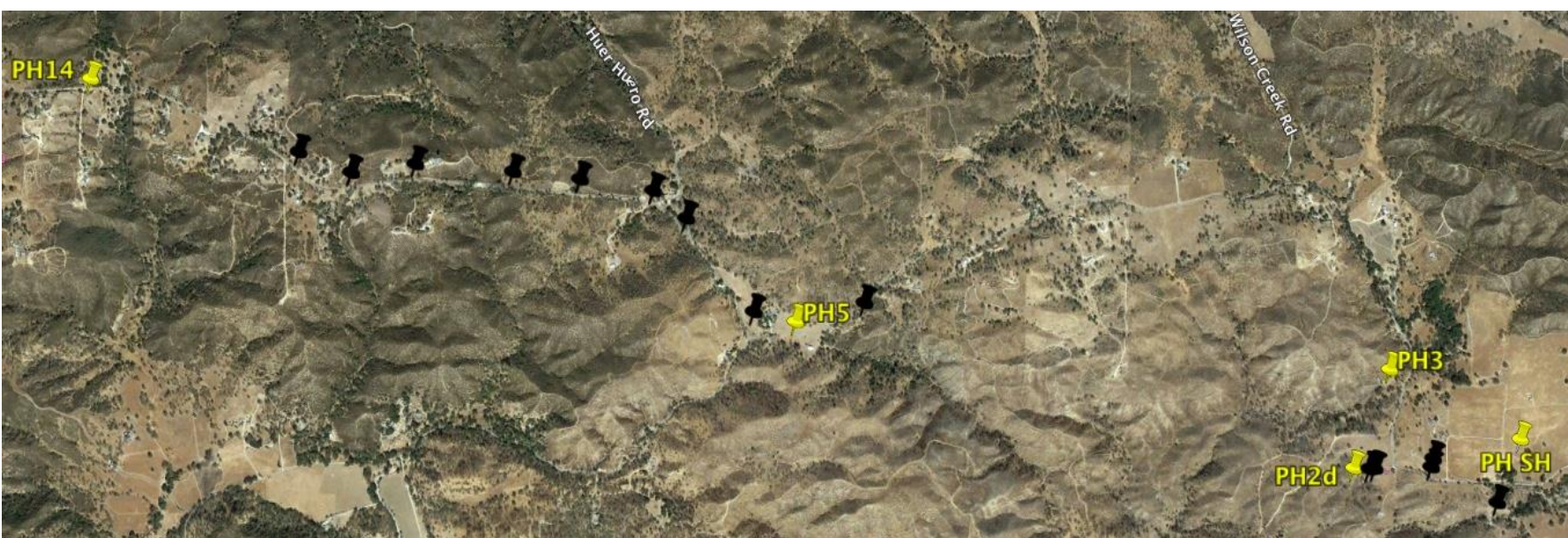
After breeding ponds filled, calling surveys were conducted from roadways to determine approximate breeding pond locations. Google Earth imagery was used to locate breeding habitats. When site access was possible, ponds were visually surveyed and dipnetted for tadpoles, 1 to 3 months after the peak calling period. Size at metamorphosis and other ecological observations were recorded.

Results

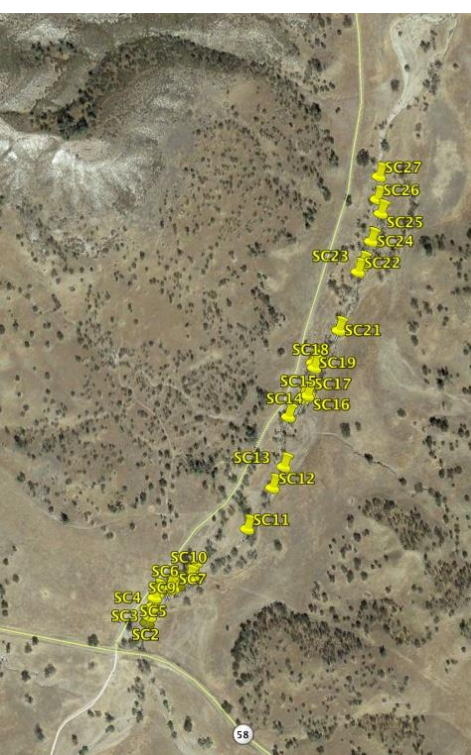
Calling surveys were an efficient method to locate aquatic breeding habitats, as they could be heard distinctly from 1 mile away under calm conditions. At the PH study site, spadefoot tadpoles were documented at 7 ponds, and calling was documented at an additional 5 sites that were not accessible. At SC, an estimated 1850 late-stage tadpoles and metamorphs were seen throughout the survey area on 1 May, and occurred in all reaches where water persisted, including areas with flowing water. In CV, several hundred spadefoots were heard calling during their peak, and adults were common on roadways, during an evening without rain. Breeding habitats in CV consisted of vernal pools within a vernal pool complex and essentially all pools within Soda Creek upstream from Seven Mile Road, but they were not found in any artificially created sites.



Park Hill West



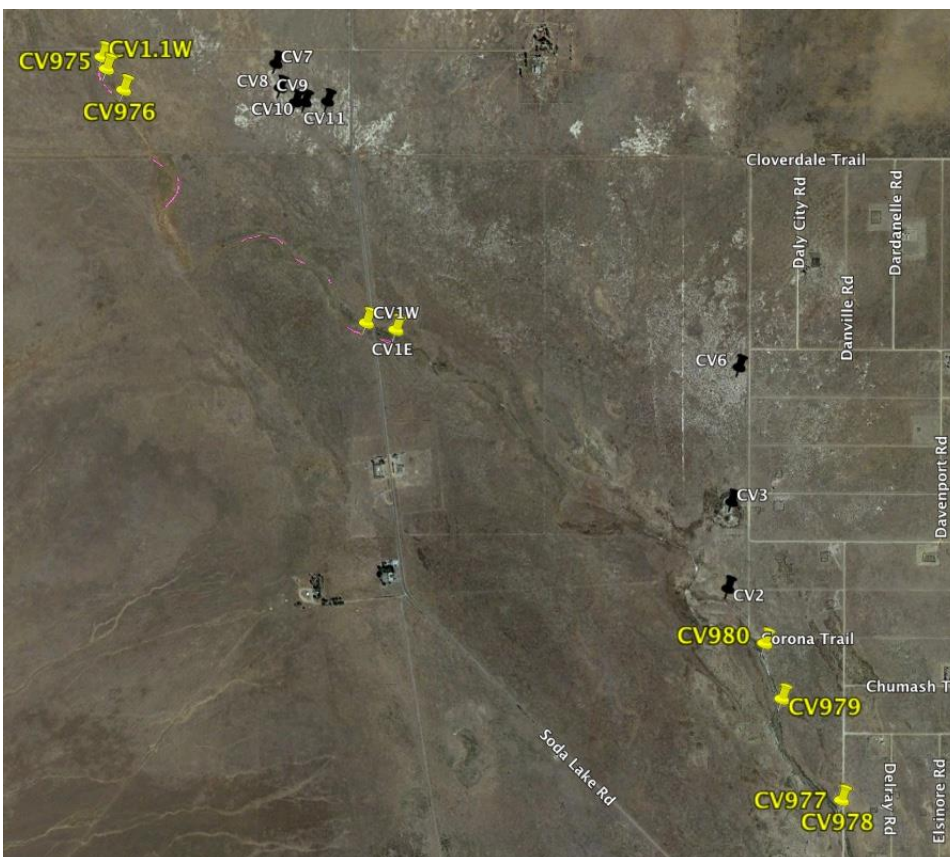
Park Hill East



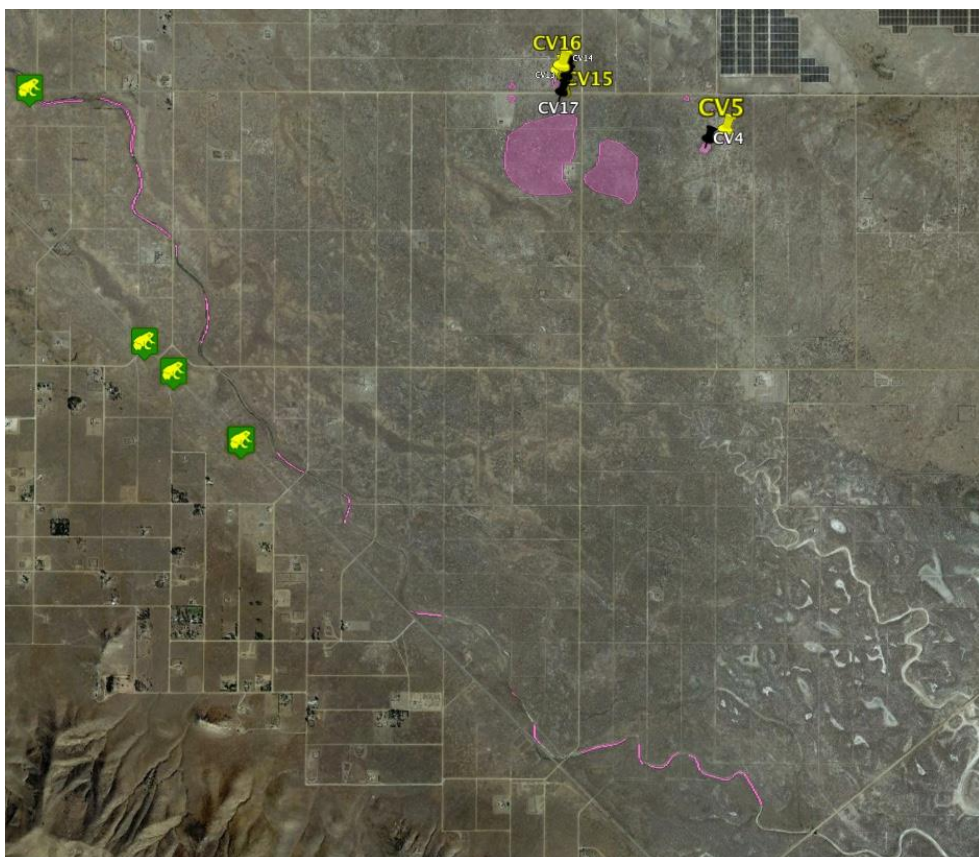
Shell Creek



Basemaps Google Earth Pro, Imagery 2016



California Valley West



California Valley East

Chronology

Calling started around 2 February, about 1 week after pools filled, and continued through last significant storms in late March. Soda Creek pools and PH ponds had >1 size classes of tadpoles indicating bouts of breeding activity. One CV vernal pool had a younger cohort than neighboring pools, from eggs laid in late March. CV vernal pools took 9.5 weeks from peak calling to metamorphosis, except the one that filled later took 6 weeks to metamorphosis. PH ponds took 16 weeks from peak calling to metamorphosis. All had metamorphosed and dispersed away by 1 June, even when water was still present.

Occurrence

Tadpoles were not found in all pools/ponds that males called from:

- In PH, larvae were not present in smaller ponds (even when they retained water long enough); larger ponds (even when lacking fish); and impoundments on drainages with moderate flow.
- In SC, tadpoles were found in pools with mosquitofish, but absent from pools with sunfish and rainbow trout.
- Within clusters of vernal pools in CV, no breeding occurred in some pools that had greater amounts of algae but otherwise appeared adequate.

Prey

- Mosquito larvae were absent from ponds with high densities of spadefoot larvae, but abundant in ponds without. Spadefoot tadpoles placed a stock tank containing mosquito larvae eliminated them in a few days.
- Spadefoot tadpoles were observed preying upon live California toad larvae and metamorphs. They were also seen eating dead spadefoot larvae and metamorphs (not known if they were killed or found dead), but they did not have cannibalistic morphology noted for this species.

Behavior

- At PH and SC, late-stage tadpoles formed very dense aggregations or clusters along shallow edges where water temperatures were greater than in the middle of the pool.
- In these clusters, transforming tadpoles appeared to be adjusting to air breathing, resting with their nostrils above water, and flipping over suddenly or jumping above the water to gulp air with their mouths.

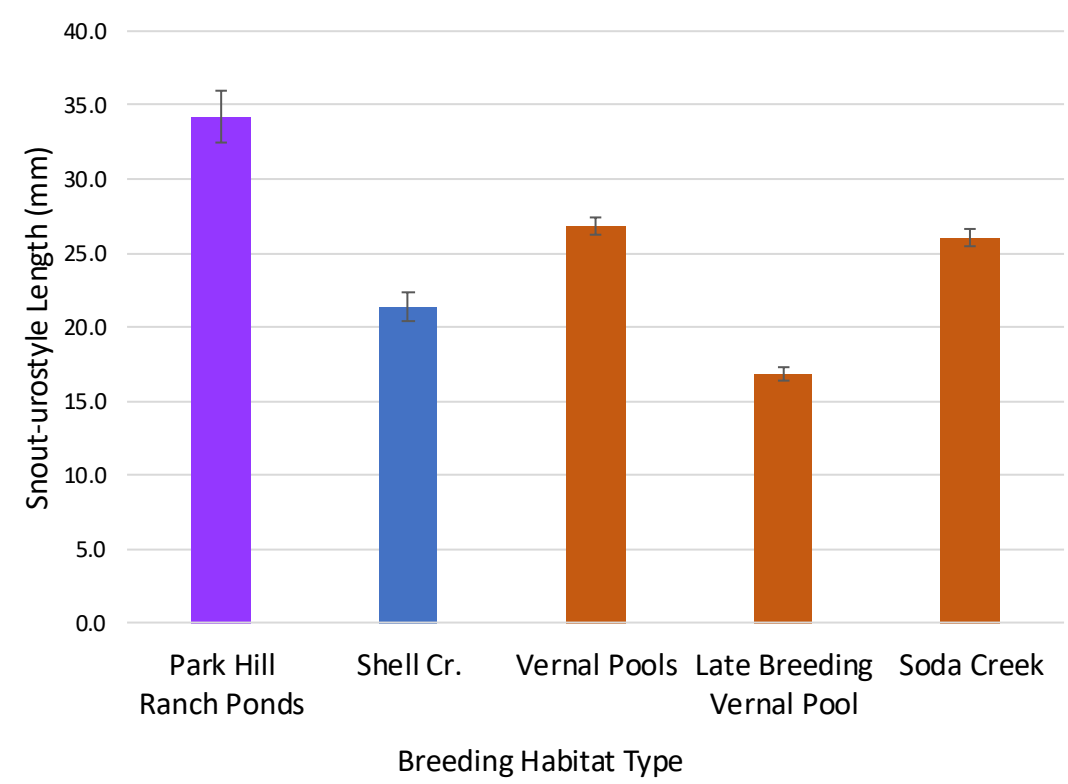


Metamorphosis

Groups of dead tadpoles were found at only three pools, while some individuals within those cohorts survived, due to adaptations to survive drying pools:

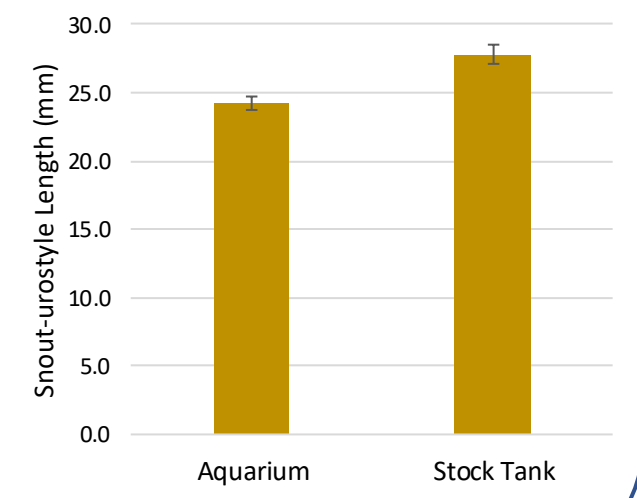
- In CV vernal pools, tadpoles continued to grow larger until the pools started shrinking - then were cued to metamorphose - fully formed legs and air breathing developed in 3 days.
- Once front legs emerged, they survived without standing water and still had tails <6mm long.
- After water disappeared, transforming tadpoles clustered in damp mud pockets, retaining moisture by pressing against each other, with "mud hats" to prevent desiccation and reflect the sun. Lacking mud, their dorsal surface was dry and leathery, but as long as the ventral surface was moist they survived.
- In CV, immediately upon pond drying they clustered in soil cracks and under vegetation mats on the pool edge, or individually in shallow pockets excavated in pool bottom/drying algae, remaining for several days before dispersing to upland habitats.
- In SC, when pools dried they clustered in hoof prints, depressions in damp sand, and under branches and rocks.
- In PH, recently-transformed spadefoots were not found under objects, in burrows, or in soil cracks apparently having promptly dispersed to upland habitats.
- Tadpoles in PH reached larger size (90 mm TL) than tadpoles in CV (48-56 mm TL) or SC (~50-65 mm TL), and took longer to metamorphose due to the longer hydroperiod of artificial ponds. Accordingly, size at metamorphosis was greater for PH (see below).

SIZE AT METAMORPHOSIS



Tadpoles collected from a drying pool, from the same cohort, were raised either at high density in a 10-gallon aquarium that was gradually dried down, or at low density in a 1.5-meter diameter stock tank that retained at least 30 centimeters of water. Tadpoles raised in aquaria reached metamorphosis an average of 7 days sooner, and were smaller than those raised in the stock tank.

SIZE AT METAMORPHOSIS



"Mud hat" prevents desiccation



Clustered in soil cracks



Clustered under vegetation



Excavated shallow pockets

Discussion and Conclusions

Qualities that provide adaptability for a pond-breeding amphibian in arid environments confer benefits to utilizing anthropogenic and atypical habitats. Plasticity in timing to metamorphosis not only allows larvae to respond to cues of pool drying by increasing the rate of development to increase survival, but also allows them to exploit aquatic food resources in longer lasting ponds by remaining as tadpoles longer and metamorphosing at a larger size, which is known to positively affect survivorship and fitness. In this study, spadefoots were found to breed in artificial ponds in an area where natural breeding sites are rare or absent, and they metamorphosed at a larger size than those from natural breeding sites in the vicinity.

When breeding in streams, they usually select those that dry to isolated pools, have low vegetative cover, fine substrate and high turbidity, such as Soda Creek in CV. Shell Creek, however, had clear flowing water, fish, cobble and gravel substrate, and riparian vegetation. Within the Shell Creek floodplain, I previously observed spadefoot larvae in off-channel pools, and there are CNDDb reports of larvae in vernal pools and roadside depressions. This is the first report of highly successful reproduction (~1850 individuals) in this atypical habitat. The observations gained from this study broaden our understanding of how this species opportunistically uses its environment.