



# Determining the Susceptibility of Springs and their Associated Anuran Communities in the Mojave Desert to Climatic Change and Development

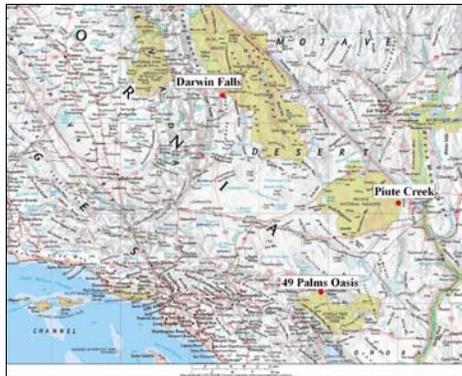
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## BACKGROUND & OBJECTIVES

From 2005-2006, the U. S. Geological Survey (USGS), Western Ecological Research Center (WERC)<sup>1</sup> and USGS, California Water Science Center (CWSC)<sup>2</sup> worked jointly to collect baseline aquatic and biotic data at selected springs at Death Valley National Park (DEVA), Mojave National Preserve (MOJA), and Joshua Tree National Park (JOTR). The project was initiated by the Inventory and Monitoring program of the National Park Service to assess the susceptibility of these springs and their associated anuran communities to water quality and quantity impacts resulting from anthropogenic and climatic changes. The anuran species studied were the western toad (*Bufo boreas*) at DEVA, the red-spotted toad (*Bufo punctatus*) at MOJA and JOTR, and the California treefrog (*Pseudacris cadaverina*) at JOTR.

The objectives were to identify the anuran species present, document species recruitment, determine distributions, estimate population sizes, and assess the general health of these communities within the study areas. Assessments were made from the aquatic and biological data collected as to which study sites and species might be more at risk from climatic fluctuations and anthropogenic alterations.

## STUDY SITES



Darwin Falls  
Death Valley National Park



Piute Creek  
Mojave National Preserve



49 Palms Oasis  
Joshua Tree National Park

This study took place in the Mojave Desert which encompasses 152,000 km<sup>2</sup> of land within California, Nevada, Arizona, and Utah. Our study sites were located within southern California at Darwin Falls in Death Valley National Park, Piute Spring in the Mojave National Preserve, and 49 Palms Oasis in Joshua Tree National Park.

## SPECIES OF INTEREST



Red-spotted toad  
(*Bufo punctatus*)



Western toad  
(*Bufo boreas*)



California treefrog  
(*Pseudacris cadaverina*)

- Historically, *B. punctatus* was found at all three sites. Currently, *B. punctatus* only occurs at MOJA and JOTR.
- B. boreas* is native to Darwin Falls, but thought to be introduced in all other areas of DEVA.
- P. cadaverina* is common throughout its range but has been declining within JOTR over the past 35 years.

## METHODS

Daytime visual encounter surveys (VES) were conducted in 2005 and 2006 at each site to document species recruitment. Estimates were recorded for the numbers of tadpoles present and the percent area occupied. Nocturnal VES were conducted to document distribution, demographics, population estimates, and general health of the post metamorphic community. Weight, length, sex, and location of species observed were recorded. Mark-recapture studies of adults were conducted over several nights in 2006. General health was assessed by swab testing for *Batrachochytrium dendrobatidis* (*Bd*), as well as visual inspection for external parasites and abnormalities. Specimens were also collected for pathological evaluation by the USGS National Wildlife Health Center.

## KEY FINDINGS

### Darwin Falls, Death Valley National Park

- B. punctatus* was not observed during our surveys and has not been detected since the early 1980s (Feder 1979).
- B. boreas* was observed throughout the wetted reach and the population was estimated to contain 381 adults (95% CI 314 – 482).
- The *B. boreas* population appeared healthy through visual and histological examinations. *Bd* was not detected at this site.



Photos of *B. boreas* tadpoles at Darwin Falls, Death Valley National Park.

### Piute Creek, Mojave National Preserve



Photos of *B. punctatus* with ectromelia of the left hindlimb. Photos courtesy of David E. Green, DVM, USGS National Wildlife Health Center.

- In 2006, we documented an elevated rate of abnormalities at 5.6% ( $n = 678$ ) in *B. punctatus* compared to baseline rates of 0-2%.
- Approximately 60 toads with abnormalities were classified, with a subset sent to David E. Green, DVM, Veterinary Pathologist at the USGS National Wildlife Health Center for histological analysis.
- B. punctatus* was found throughout the study site with an estimated 1153 adults (95% CI 935 – 1503) in 2006.
- Bd* was detected for the first time at this site in *B. punctatus*.

Abnormality Type	No.	Percentage
Craniofacial		
Anophthalmia	1	1.7
Microphthalmia	2	3.3
Paratoid development	1	1.7
Forelimb		
Ectromelia	2	3.3
Brachydactyly	3	5.0
Ectrodactyly	3	5.0
Polyphalangy	2	3.3
Phocomelia	1	1.7
Hindlimb		
Ectromelia	4	6.7
Brachydactyly	8	13.3
Ectrodactyly	23	38.3
Polyphalangy	5	8.3
Phocomelia	1	1.7
Hemimelia	1	1.7
Rotation of tibia-fibulare	3	5.0
<b>Total</b>	<b>60</b>	<b>100.0</b>

### 49 Palms Oasis, Joshua Tree National Park

- The *B. punctatus* adult population was estimated at 155 (95% CI 113 - 247) and *P. cadaverina* at 109 (95% CI 90 - 139) for 2006. Both species appear to have declined considerably over the last 35 years.
- The larval stage of trombiculid mites (chiggers), *Hannemania hylae* and *H. bufonis* were detected at this site. It was estimated that 57.7% of *P. cadaverina* examined had chiggers, and of those, a mean of 21.2 chiggers per individual were detected, whereas only 5.4% of *B. punctatus* examined had a mean of 8 chiggers. The numbers of chiggers on individual anurans were similar to those of Welbourn and Loomis (1975), but the percentages of anurans with chiggers has decreased.
- Bd* was detected for the first time at this site in *B. punctatus*.



*P. cadaverina* with the parasite *H. hylae*

## DISCUSSION

- The spring at Darwin Falls (DEVA) has ~10,000 year old water (preliminary estimates) and a large up-gradient recharge basin (~175 mi<sup>2</sup>). Due to the age of the water and size of the recharge basin, primary discharge of this spring is not considered to be dependent on climatic fluctuations. Diversion, however, from a private in-holding within the park boundary, may reduce the length of flow. Previous studies of *B. boreas* have found a significant correlation with the presence of *B. boreas* to surface water. Habitat for *B. boreas* at Darwin Falls could be reduced due to water diversion at this spring.
- At Piute Spring (MOJA) we observed an elevated rate of abnormalities and *Bd* in *B. punctatus*. Water quality testing did not reveal any deviations from normal systems and the age of water from Piute Spring and a seep was revealed to be old (preliminary estimates at ~8,000 years). The adjacent basin of Lanfair Valley is believed to be the infiltration source of the spring and encompasses a large area of about 273mi<sup>2</sup>. Due to the age of the water and size of the recharge basin, primary discharge of this spring is not considered dependent on climatic fluctuations; however, any future withdrawal of large quantities of ground water from Lanfair Valley may affect the discharge at Piute spring.
- The spring at 49 Palms Oasis (JOTR) consists of young water (less than 50 years), and the recharge area up gradient of the spring is small at 4.8 mi<sup>2</sup>. The capacity for longer term ground water storage and discharge rates are more dependent on climate trends. This is of concern given that both *P. cadaverina* and *B. punctatus* populations have declined by 62% and 48%, respectively since 1969 - 1971 (Welbourn and Loomis 1975). *P. cadaverina* is especially at risk given that it is currently only known to inhabit two springs within the park, as opposed to the seven it once occupied in the 1960s. *B. punctatus* was found to test positive for *Bd*, which is of concern to both species and has not been detected at this site prior.

## LITERATURE CITED

- Feder, J. H. 1979. Natural hybridization and genetic divergence between the toads *Bufo boreas* and *Bufo punctatus*. Evolution 33(4): 1089-1097.
- Welbourn, Jr. W. C. and R. B. Loomis. 1975. *Hannemania* (Acarina: Trombiculidae) and their anuran hosts at Fortynine Palms Oasis, Joshua Tree National Monument, California. Bull. So. California Acad. Sci., 74:15-19.