

Our purpose is to document and publicize the values and conservation needs of horned lizards, to promote horned lizard conservation projects, and to assist with horned lizard management initiatives throughout their ranges.

The Latest Piece in the Endangered Species Act “Puzzle:” Did the U. S. Fish and Wildlife Adequately Take into Consideration the “Lost Historical Range” of the Flat-Tailed Horned Lizard in its 2011 Withdrawal of the Proposed Rule to List the Lizard as Threatened?

by Richard Campbell

Richard Campbell is an Adjunct Professor of Law, Golden Gate University School of Law, San Francisco and Attorney for the U.S. Environmental Protection Agency, Region 9. The opinion expressed in this article are the author's only and do not represent those of the U.S. Environmental Protection Agency or the Golden Gate University School of Law.

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*Flat-Tailed Horned Lizard (Phrynosoma mcallii) in hand.
Photo provided by Dale Turner.*

The latest chapter in the long-running dispute about the listing of the Flat-Tailed Horned Lizard (*Phrynosoma mcallii*) as a threatened species under the Endangered Species Act (ESA) occurred on 15 March 2011, when the U.S. Fish and Wildlife Service (Service) withdrew its original Clinton-era proposal to list the lizard as a threatened species under the Act. See 58 Federal Register 62624 (29 November 1993); 76 Fed. Reg. 14257 (15 March 2011). The decision by the Service to withdraw its proposed listing was made in response to the Ninth Circuit's decision in *Tucson Herpetological Society v. Salazar*,

566 F.3d 870 (9th Cir. 2009). In that case, the Court agreed with the Society that when the Service determines whether a species is endangered or threatened throughout a significant portion of its range, the Service must take into consideration whether the “lost historical range” of the species (as opposed to its current range) constitutes a significant portion of the range of that species. The Service's consideration of the lizard's lost historical range in its 2011 decision not to list it as threatened under the Act is discussed below.

BACKGROUND

Flat-Tailed Horned Lizard

The Flat-Tailed Horned Lizard is on average three inches long and has managed to adapt to the Sonoran Desert in Arizona (including the Gila and Tinajas Atlas Mountains in Yuma County), the Coachella Valley of California, and in the northernmost Sonoran Desert of Mexico (62 Fed. Reg. 37852, July 15, 1997). Forty-two percent of lizard habitat occurs on private land (58 Fed. Reg. 62625). The balance of lizard habitat on public land is managed by the Bureau of Land

Continued on page 3

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Management (BLM) (58 Fed. Reg. 62628).

Proposed Listing Decision

On 29 November 1993, the Service proposed to list the lizard as a threatened species (58 Fed. Reg. 62624). Habitat loss caused by urban development, conversion of desert lands for agriculture, offhighway vehicle usage, and military activities (e.g., Goldwater Bombing Range), coupled with inadequate regulatory mechanisms to stem this habitat loss on at least public lands managed by BLM, were cited as reasons for the proposed listing (58 Fed. Reg. 62626). The Service noted that fragmentation creates isolated subpopulations that, because of their reduced size, have an increased probability of extinction (58 Fed. Reg. 62626-27 (29 November 1993)).

In 1996, the Service estimated that man-made factors were responsible for the destruction of 1,103,201 acres of the lizard's estimated 4,875,624-acre historic range (71 Fed. Reg. 36745, 36749-51; 28 June 2006). In September 1996, a Service biologist maintained listing was the appropriate action to take:

*Nothing has really changed on the ground; and in some ways, the status of the lizard has continued to deteriorate. If forced to publish a final rule at this time, I do not believe we could make a case that threats have been alleviated to the point that listing is no longer warranted. (As quoted in the Society's Initial Brief to the Ninth Circuit on 3 July 2000; 2000 U.S. 9th Cir. Briefs LEXIS 40 *8).*

A few months later, however, on July 15, 1997, the Service decided it would not place the lizard on the Endangered Species list (62 Fed. Reg. 37852). Three reasons were provided:

1. BLM and other federal and state agencies (including Arizona Game and Fish) had entered into a Conservation Agreement and agreed to implement a Management Strategy to protect lizard habitat;
2. A significant portion of lizard habitat was no longer threatened by geothermal and oil and gas development and pesticide spraying as it had been in 1993; and

3. Lizard survey methodology was too uncertain to conclusively demonstrate a downward trend in populations (62 Fed. Reg. 37859).

In essence, the Service found that the lizard's current range on public land was sufficient to prevent listing even though it was extirpated from a large percentage of its historical range and faced continuing threats on private land. Defenders of Wildlife (DOW) challenged the 1997 withdrawal in federal district court (in southern California), but the district court upheld the Service's decision.

2001 Ninth Circuit Decision

DOW appealed the district court decision to the Ninth Circuit (*Defenders of Wildlife v. Norton*, 258 F.3d 1136 [9th Cir. 2001]). In that case, the Ninth Circuit first found that due to the ambiguity of the phrase "significant portion of its range," the Service was entitled to deference in its interpretation of the term, so long as the Service articulated a reasoned basis for its decision and articulated a rational connection between the facts and the decision it made (*Defenders of Wildlife v. Norton*, 258 F.3d 1141 [9th Cir. 2001]). The Ninth Circuit also found that Congress added the "significant portion of its range" language to the ESA, at 16 U.S.C. § 1532(6), to allow the Service to take a flexible approach to wildlife management, i.e., one that would allow the Service to list a species that is threatened in a "significant portion" of its range even if that same species is thriving in other geographic areas (*Defenders of Wildlife v. Norton*, 258 F.3d 1141 [9th Cir. 2001]). The Ninth Circuit then noted that the Service's 1997 withdrawal of its listing decision presented the court with an opportunity to "puzzl[e] out the meaning" of what Congress meant when it told the Service to take into consideration "a significant portion" of a species' range when making listing decision (*Defenders of Wildlife v. Norton*, 258 F.3d 1141 [9th Cir. 2001]).

In puzzling out the meaning of "significant portion of its range," the Ninth Circuit first rejected the Service's argument that it could rely on only an examination of the lizard's current range on pub-

Continued on page 4

lic land (*Defenders of Wildlife v. Norton*, 258 F.3d 1138, 1140). The Ninth Circuit found that the Service’s distinction between public and private land explained much of the dispute between the Service and DOW, and was responsible, in large part, for the shift between the Service’s initial findings that accompanied the proposed rule and its subsequent decision to withdraw the rule. (*Defenders of Wildlife v. Norton*, 258 F.3d 1140-1141). The Ninth Circuit concluded that the Service needed to take a more “flexible” approach and look at both private and public lands when considering historical range (*Defenders of Wildlife v. Norton*, 258 F.3d 1145).

The Court next rejected DOW’s assertion that a species should be listed merely because it no longer inhabits a high percentage of its historical range. The Court explained, *[I]t simply does not make sense to assume that the loss of a predetermined percentage of habitat or range would necessarily qualify a species for listing. A species with an exceptionally large historical range may continue to enjoy healthy population levels despite the loss of a substantial amount of suitable habitat. Similarly, a species with an exceptionally small historical range may quickly become endangered after the loss of even a very small percentage of suitable habitat* (*Defenders of Wildlife v. Norton*, 258 F.3d 1143).

The Ninth Circuit then conclud-

ed that “a significant portion of its range” should be interpreted as follows:

[A] species can be extinct “throughout ... a significant portion of its range” if there are major geographical areas in which it is no longer viable but once was. Those areas need not coincide with national or state political boundaries, although they can. The Secretary necessarily has a wide degree of discretion in delineating “a significant portion of its range, since the term is not defined in the statute (*Defenders of Wildlife v. Norton*, 258 F.3d 1143).

The Court granted, however, that if a species has lost a large portion of its historical range, the agency “must at least explain [the] conclusion that the area in which the species can no longer live is not a ‘significant portion of its range’” (*Defenders of Wildlife v. Norton*, 258 F.3d 1145). The Ninth Circuit directed the Service to take this into consideration in its next decision on whether to list the lizard under the Act (*Defenders of Wildlife v. Norton*, 258 F.3d 1145).

2003 Listing Decision

In the course of making its next listing decision, the Service solicited the opinion of four lizard experts:

Of the four, two recommended listing the species as threatened, one did not express a firm opinion, and one concluded that listing was not warranted. ... Kevin Young, the biologist that did not favor listing, stated that a ‘significant portion

of the [lizard’s] range’ has indeed been lost, but concluded that listing would likely direct resources away from efforts to protect the species on public lands, and toward unproductive efforts to protect lizard habitat on private lands (566 F.3d at 875, n. 7, citing 68 Fed. Reg. at 340-41).

Based on this and other evidence, the Service again decided against listing the lizard in 2003. This decision was subsequently challenged in federal district court (this time in Arizona) by the Tucson Herpetological Society (and others, including DOW, Sierra Club, and the Center for Biological Diversity) arguing that the withdrawal did not comply with the Ninth Circuit’s 2001 decision in *Defenders*.

The district court agreed with the Tucson Herpetological Society in a 2005 decision where it found that the Service “assumed without explanation that large swaths of lost habitat were of no significance at all” and ordered the Service to try again (though the district court found the Service’s assessment of threats to the lizard’s current range was adequate). The Service withdrew its 2003 decision and restored the lizard to proposed listing status while it reconsidered its decision (70 Fed. Reg. 72776; Dec. 7, 2005).

2006 Delisting Decision

After another public notice and comment period, the Service again decided to withdraw the

proposed listing in 2006 (71 Fed. Reg. 36,745; June 28, 2006). The Service noted that the “sole purpose” of the 2006 decision was to address the lost historical habitat issue that was the subject of the district court’s 2005 decision (71 Fed. Reg. 36749). Again, the Society challenged this decision in district court (*Tucson Herpetological Soc’y v. Kempthorne*, 2006 U.S. Dist. LEXIS 70736; N.D. Ariz.

In 2007, after hearing the challenge, the district court upheld the Service’s 2006 lost habitat analysis and listing decision: *After setting a temporal baseline and defining the subject area, the Secretary proceeded to evaluate the significance of the lost historical habitat. He concluded that the Coachella Valley area [in California], including its lost associated habitat, was insignificant because of its small size relative to the overall range of the species, the high level of fragmentation due to human development, the lack of genetic, behavioral, or ecological differentiation, and the small size and importance of the population in general.... The remaining parcels of lost historical habitat areas near Mexicali and Yuma were also deemed insignificant.*

Not only has the species persisted for nearly a century in the face of the steady habitat destruction, but the size of existing lizard populations has not declined and is not likely to decline in the foreseeable future because of the loss of 1,103,201 acres of historic range, the Secretary found.... After surveying the ‘available data con-

*cerning population abundance, trends, and threats,’ the Secretary concluded that yesterday’s conversion of suitable habitat to agriculture in the Mexicali and Yuma areas is not significant to the survival of today’s lizards (Tucson Herpetological Soc’y v. Kempthorne, 2007 U.S. Dist. LEXIS 50740 *27-28; N.D. Ariz. 2007).*

The Society appealed this decision to the Ninth Circuit, first arguing the Service’s reasoning was inconsistent with the Ninth Circuit’s 2001 decision in *Defenders* because it merely relied on pointing to some areas where lizard populations persisted to support a finding that threats to the species elsewhere were not significant. The Society argued the ESA requires a more thorough explanation.

Ninth Circuit 2009 Decision

In its 2009 *Tucson Herpetological Society* decision, the Ninth Circuit found, in part, that the Service had relied on limited and inconclusive studies in its determination that the lizard was persisting in its current range (particularly in Mexico for which there were no studies provided), and that this reliance had adversely impacted the Service’s lost range analysis:

The absence of conclusive evidence of persistence, standing alone, without persuasive evidence of widespread decline, may not be enough to establish that the [Service] must list the lizard as threatened or endangered ... But this is a different case. The [Service] affirmatively relies on ambiguous studies as evidence of persistence

*(i.e., stable and viable populations), and in turn argues that this ‘evidence’ of persistence satisfies Defenders’ mandate and proves that the lizard’s lost range is insignificant for purposes of the ESA. This conclusion is unreasonable. The studies do not lead to the conclusion that the lizard persists in a substantial portion of its range, and therefore cannot support the [Service]’s conclusion (Tucson Herpetological Soc’y v. Kempthorne, 2007 U.S. Dist. LEXIS 50740 *879; N.D. Ariz. 2007).*

The Ninth Circuit again remanded the decision whether to list the lizard back to the Service for further reconsideration based on better studies. In a dissent, Ninth Circuit Judge Noonan made the following observation that likely captured the Service’s frustration at this point:

How many Flat-tailed Horned Lizards are there? No one knows the answer to that question. Nor does anyone know how many lizards disappeared when portions of their range disappeared. It is supposed that a diminution in range correlates with a diminution in lizards. This hypothesis is plausible. It has not been shown to be probable. Yet the case turns on what measures are necessary to keep this unknown population in existence. The court concludes that the [Service] erred in finding that the lizard has not lost a significant portions of its range. The old method of counting lizards is out. A new method has not been tried very much. It’s anybody’s guess

Continued on page 6

whether the lizards are multiplying or declining. In a guessing contest one might defer to the government umpire. The court, however, finds the [Service's] conclusion impacted by over-reliance on fragmenting evidence of the lizard's persistence; so the court decides to give the [Service] another crack at the problem.

If the [Service] does not know what the lizard population was to begin with, or what it was in 1993, or what it is now in May 2009, how will [it] know if it is increasing, staying the same, or declining?

A style of judging, familiar to readers of the old English reports, characterizes the judge as *dubitante*. That is probably the most accurate term for me, which leads me to concur in the majority opinion insofar as it rejects the contentions of the Tucson Herpetological Society and to dissent from the remand whose command to the Secretary of the Interior is, guess again (Tucson Herpetological Soc'y v. Kempthorne, 2007 U.S. Dist. LEXIS 50740 *882-883; N.D. Ariz. 2007).

March 15, 2011 Withdrawal of Proposed Rule To List Lizard as Threatened

In its March 15, 2011 decision, the Service, as directed by the Ninth Court, addressed the lost historical range issue again. The Service determined the Lizard's lost historical range did not represent a significant portion of the Lizard's range for four reasons:

1. Historically lost habitat was lost decades ago and, despite the amount of time that has since transpired, the species has not experienced a continuing range contraction due to the past loss of habitat.
2. Historically lost habitat "did not provide any special or unique features or meet any life history needs of the [L]izards that made those areas any more significant than any other habitat."
3. Historically lost range was not continuous and contained natural barriers that separated relevant Lizard population segments.
4. The Lizard populations most in jeopardy do not separately contribute substantially to the resiliency, redundancy, or representation of the entire species (76 Fed. Reg. 14258).

The Service then found that threats to the Lizard's current range (including that in Mexico) "have been reduced, managed, or eliminated, or found to be less substantial than originally thought." The Service also found that implementation of the Interagency Conservation Agreement and associated Rangeland Management Strategy was reducing threats in the United States and was benefiting the species throughout its current range.

Therefore, we conclude that none of the existing or potential threats are likely to cause the [lizard] as an entire species ...

to be in danger of extinction or likely to become so within the foreseeable future throughout all or a significant portion of its range (76 Fed. Reg. 14267-8).

Whether the Service's analysis is legally adequate remains to be seen, and may be subject to further legal challenge. What is clear is that as urbanization continues apace in Arizona, and in northern Mexico's Baja region, the requirement that the Service take into adequate consideration the lost historical range of species that reside in Arizona and which are proposed for listing under the Act will take on greater significance.

It is also noteworthy that the Ninth Circuit's 2009 Tucson Herpetological Society decision was very recently followed by the Ninth Circuit in its November 22, 2011, decision to remand back to the Service its decision to delist the Grizzly Bear in the Yellowstone region of the United States. In that case, the Ninth Circuit found the Service did not adequately consider evidence that brought into question the Service's conclusion that the distinct population of grizzlies in the Yellowstone region was stable:

The Yellowstone grizzly has been the focus of a laudable, decades-long cooperative research effort—one that we hope continues. It may be that scientists will compile data demonstrating grizzly population stability in the face of whitebark pine declines. Such information, however, simply

is not in the record before us. The lack of any data showing a population decline due to white-bark pine loss is not enough (*Greater Yellowstone Coalition v. Servheen*, 665 F.3d 1015, 1030 (9th Cir. 2011), quoting *Tucson Herpetological Soc’y*, 566 F.3d at 879 (“If the science on population ... trends is undeveloped and unclear, the Secretary cannot reasonably infer that the absence of evidence of population decline equates to evidence of persistence.”)).

The Ninth Circuit’s 2011 decision is notable because its effect is, in general, to delay the removal of ESA protections for the Grizzly in the lower 48 states.

In conclusion, neither the courts nor the Service have been able to provide a definitive answer as to what amount of “lost historical range” is “significant” enough to warrant a listing under the ESA. But the Ninth Court decisions regarding the Lizard in 2009 and the Grizzly Bear in 2011 make clear that whatever decision is made must be backed by firm data. As the following quote from the Tucson Herpetological Society case makes clear certain assumptions no longer apply:

There seems to be a tacit assumption that if grizzlies survive in Canada and Alaska, that is good enough. It is not good enough for me.... Relogating grizzlies to Alaska is about like relegating happiness to heaven; one may never get there. – Aldo Leopold, *A Sand County Almanac* (1966:277)

(Quoted by the Ninth Circuit Court of Appeals in *Defenders of Wildlife v. Norton*, 258 F.3d 1136, [9th Cir. 2001]).

2012 UPDATE

In part, as a result of the Flat-tailed Horned Lizard listing decision and resulting litigation, the US Fish and Wildlife Service and NOAA’s National Marine Fisheries Service (Services), the two federal agencies responsible for administering the Endangered Species Act (ESA), proposed a new federal policy that will help clarify which species or populations of species are eligible for protection under the ESA and will provide for earlier and more effective opportunities to conserve declining species. See 76 Fed. Reg. 76987 (9 December 2011).

The proposed policy will define the key phrase “significant portion of its range” in the ESA and provide consistency for how it should be applied, aiding the agencies in making decisions on whether to add or remove species from the federal list of threatened and endangered wildlife and plants. The phrase is not defined in the ESA, but appears in the statutory definitions of “endangered species” and “threatened species” in the ESA.

Until the policy is final, the Services have an obligation to meet statutory timeframes and make determinations in response to petitions to list, reclassify, and delist species. During this interim period, The Services will consider the inter-

pretations and principles in this proposed policy as nonbinding guidance in making individual listing determinations. As non-binding guidance, the Services will apply these interpretations and principles only as the circumstances warrant, and the agencies will independently explain and justify any decision made in this interim period in light of the circumstances of the species under consideration. The draft policy can be viewed at:

<http://www.regulations.gov>
Docket No. [FWS-R9-ES-2011-0031].

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Docket No. [FWS-R9-ES-2011-0031].

2014 UPDATE

This rule change was finalized in 2014. [<http://federalregister.gov/r/0648-BA78>]



Protection Sought for Rare Desert Lizard in California's Sonoran Desert

By Ileene Anderson

Reprinted from the June 10, 2014 press release from the Center for Biological Diversity.

LOS ANGELES— The Center for Biological Diversity petitioned the California Fish and Game Commission today to protect the rare and vanishing flat-tailed horned lizard as an endangered species. Habitat loss, off-road vehicles and global warming are pushing this rare horned lizard toward extinction.

“This charming little lizard used to be fairly common in parts of the Sonoran Desert, but it’s been declining throughout its range in recent years,” said Ileene Anderson, a senior scientist with the Center. “A 1997 voluntary conservation agreement was supposed to help the lizard recover but clearly it isn’t working. State protection will give this lizard a fighting chance at survival.”

The flat-tailed horned lizard once inhabited large regions of the Sonoran Desert in Southern California, but urban sprawl and agricultural development have destroyed much of its habitat. Only one small population remains in the Coachella Valley, where the lizards were once abundant. The animals face serious ongoing threats from development and off-road vehicles, which can crush them easily because of the “freeze in place” strategy they adopt when threatened. They’re also threatened by transmission lines, roads, global warming and U.S. border-related stresses. The lizard’s primary prey, harvester ants, have also been hard-hit by competition with

invasive argentine ants, habitat loss from invasive plants, and pesticides.

The voluntary Interagency Conservation Agreement, which has governed lizard management since 1997, has failed to prevent declines of the species. This agreement does not protect adequate lizard habitat and has been ineffective in reducing key threats. For example, the Bureau of Land Management recently opened more than 43,000 previously protected acres of lizard habitat in the Algodones Dunes in Imperial County to destructive and intensive off-road vehicle use. The Ocotillo Wells State Vehicular Recreation Area, designated as a lizard “research area” under the agreement, is severely degraded due to permitted and unrestricted off-road vehicle driving, and the other lizard management areas have been similarly damaged by legal and illegal ORV use.

As the common name suggests, the flat-tailed horned lizard has a broad, flattened tail and long, sharp horns on its head. Adults range from 2.5 to 4.3 inches long, excluding the tail. In California, the flat-tailed horned lizard inhabits portions of the Sonoran Desert in Southern California’s California Desert Conservation Area in Riverside, Imperial and San Diego counties.

The Center for Biological Diversity is a national, nonprofit conservation organization with more than 775,000 members and online activists.

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2015 Grant Award Announcements

The Horned Lizard Conservation Society is pleased to announce grant recipients for 2015. The following two proposals by Coutney Heurig and Jared Fuller have been selected by unanimous vote by the Board of Directors. Both propos-



als will receive \$500.00. Look for a summary of their research results in future newsletters.



The Status of an Introduced Species (*Phrynosoma cornutum*) on Barrier Islands in South Carolina, USA

By Courtney Heuring, M.S. Candidate
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Advisor: Dr. Eric McElroy

Introduced species can diverge from their source populations as they adapt to the ecological conditions of their new ecosystems. The Texas horned lizard (*Phrynosoma cornutum*), native to the western U.S. where it is currently facing decline, has been introduced to several ecosystems in the southeastern U.S., including the dunes on barrier islands. This project will investigate the introduced lizard population in South Carolina and attempt to determine divergence from the western population based on genetics, morphology, and diet. Data will be collected via population surveys, dietary analysis, and microsatellite genotyping and will be compared to the western population. This study will examine the observations that these lizards are “abundant” on the South Carolina dunes and try to identify factors related to this abundance in comparison to the western population.

The main objective of this project is to determine if there is divergence in *P. cornutum* living on barrier islands in South Carolina from the stock populations in Texas by measuring genetics, morphology, and diet. I hypothesize that there will be no genetic, morphological, or dietary divergence between the South Carolina and Texas *P. cornutum* populations:

1. I expect a) the South Carolina populations to represent a subset of variation relative to Texas and b) South Carolina populations to represent a single (versus multiple) introduction.
2. I expect that there will be no differences in the limb length, body shape, and body size characters between the populations.
3. I expect a) *P. cornutum* in South Carolina to consume *Pogonomyrmex* harvester ants and b) harvester ants will compose at least 51% of the diet by number.

I expect that there will be no changes in the South Carolina populations because *P. cornutum* is highly specialized for its ecological niche. I believe that the species has filled a niche in South Carolina that is similar to the niche that it would normally occupy in Texas.

Cloacal swabs will be taken of each lizard that is encountered and fragment analysis for microsatellite loci using the same methods as Williams et al. (2012) will be performed. Then in collaboration with Dr. Dean Williams, the genotypes from the eastern and western populations can be directly compared. Haplotypes of the two populations can be compared to determine how much genetic variation the South Carolina population has relative to the Texas population. An AMOVA (analysis of molecular variance) will be used to compare genetic differences between these eastern and western populations. Also, phylogenetic tree construction will be used to identify which western population(s) genetically cluster with SC populations to determine where the introduced lizards originated from in Texas.

These data will allow me to determine the diet of *P. cornutum* living in South Carolina. Fresh fecal pellets will be located and collected in the field. Once obtained, the fecal pellets will be preserved in vials to be later analyzed. DNA will be extracted from the lizards' feces and then sequenced using a genetic shotgun technique to identify prey. Once we determine the location in Texas from which the SC lizard population originated, we may be able to quantify diet by obtaining museum specimens from the specific area of origination. Gut content analysis can be performed on the specimens as well as on individuals from SC so that a true comparison can be made between the populations.

This project will provide valuable information about the populations of *P. cornutum* that are currently living in South Carolina. By studying

the *P. cornutum* populations along the coast and acquiring genetic, morphological, and behavioral information, I can determine if there are any differences between the eastern and western populations. This could provide insight into potential evolutionary divergence in the years since the two lizard populations have been isolated. If the eastern population is healthy, I could potentially get some idea if there are certain characteristics in the eastern population that are enabling these populations to persist. If there are some factors that are enabling the eastern population to survive better, then this could be extremely useful

for future attempts to stop the population decline and reestablishing a healthy population in the West.

Receiving funding from the Horned Lizard Conservation Society will enable me to cover some of the costs of materials and travel to my field sites which are critical pieces to successfully completing this project. In addition, I hope to expand the scope of my research to include the scientific community in Texas where the lizard is native and of great conservation concern.



Phylogeography and Landscape Genomics of the Round-tail Horned Lizard (*Phrynosoma modestum*): Implications for Conservation and Management

By Jared Fuller, Ph.D. Candidate
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Advisor: Dr. Chris Feldman

gressive ant species as they prey upon and attack incubating horned lizard eggs and hibernating individuals (Saurez and Case 2002). They can also displace harvester ants, an important food source for these lizards (Hook and Porter 1990).

Horned lizards, genus *Phrynosoma*, are charismatic lizards with distinct physical features, such as prominent cranial horns and toad-like bodies, unusual behaviors, and unique ecological roles. As a result, they have achieved a mystique in North American folklore and hold a special place in the contemporary aura of the American Southwest (Manaster 1997).

Horned lizards are increasingly susceptible to habitat fragmentation and loss, which may reduce persistence probability (Mulcahy et al. 2006). This leads to a reduction of total habitat area, and restricts gene flow among habitat patches. Ultimately, this can lead to a loss of genetic diversity, increased inbreeding, and elevated extinction risks. The severity of habitat fragmentation depends on the size of the fragments, with smaller patches being the most problematic (Frankham et al. 2010).

Unfortunately, population declines have been occurring in species such as the Texas horned lizard (*P. cornutum*) and flat-tail horned lizard (*P. mcallii*), raising the public's concern for the long-term survival of these unique lizards (Donaldson et al. 1994, Mulcahy et al. 2006). Horned lizard declines may be due to a combination of factors, including: habitat loss and fragmentation, the introduction of the red imported fire ant (*Solenopsis invicta*), and the use of pesticides (Donaldson et al. 1994, Mulcahy et al. 2006). Sadly, fire ants have contributed to significant declines and population extirpation of the Texas horned Lizard (Donaldson et al. 1994). Fire ants are a very ag-

gressive ant species as they prey upon and attack incubating horned lizard eggs and hibernating individuals (Saurez and Case 2002). They can also displace harvester ants, an important food source for these lizards (Hook and Porter 1990).

These causes of population declines have been well documented in populations of Texas horned lizards and Coastal horned lizards (*P. coronatum*). However, little is known about their effects on populations of the round-tail horned lizard (*P. modestum*). Round-tail horned lizards can be found across Western Texas, New Mexico, Southeastern Arizona, and Northern Mexico. This species prefers rocky substrate, which leads to patchy distribution within their range. Its cryptic behavior coupled with its small size makes

it difficult to study (Whiting and Dixon 1996). Therefore, it generates less attention compared to its charismatic larger sister species, the Texas horned lizard, which ultimately hampers conservation efforts. In addition, although invasive ants are not currently found within the range of the round-tail horned lizard, they are projected to expand further north (Korzukhin et al. 2001). This expansion would encompass most of the lizard's range; potentially accelerating population declines as seen in other horned lizard species (Donaldson et al. 1994; Saurez and Case 2002).

Therefore, an assessment of genetic variation and structuring within and among populations of the round-tail horned lizard is highly warranted. Through a combination of phylogeographic and genomic analyses, I am addressing the following research goals: i) delineating the genetic variation and genetic structure within round-tail horned lizard populations across their range, ii) establishing a baseline of current genetic variation to compare future population declines, iii) identifying geological features and anthropogenic habitat fragmentation that result in divergence of genetic structure, and iv) identifying evolutionary significant units (ESUs), which will aid conservation efforts.

This baseline information is vital for wildlife conservationists and managers as they develop long-term management plans for the species.

Furthermore, phylogeographic and landscape genomic analyses can provide valuable information about the factors of genetic diversity and divergence across a species' range. These types of analyses can identify landscape-level features that result in genetic divergence within and among a species (Manel et al. 2003). This can be important in describing evolutionary significant units (ESUs), which are defined by differences in allele frequencies that indicate low levels of gene flow and suggest adaptive differences. These units are functionally independent, yet not phylogenetically unique (Mortiz 1994). ESUs are vital in management for the long-term persistence of an at-risk species. For instance, phylogeography analysis of the flat-tail horned lizard (*P. mcallii*) has revealed that the greatest genetic divergence in the population is due to fragmentation by historical isolation combined with human development (Mulcahy et al. 2006).

Grant funds for this research will be used to support the Illumina Sequencing costs associated with genetic analyses. Genetic samples will continue to be sampled through the 2016 field season throughout Texas, New Mexico, and Arizona. Collecting as widely as possible throughout the round-tail horned lizard's range will ensure a robust genetic analysis to inform conservation and management of this poorly studied species of horned lizard.



***Phrynosomatics* Design Editor Retiring**

By Fannie Messec

After around ten years of formatting this newsletter, I regretfully find it necessary to pass the torch to someone else. Oh how I will miss getting the news before everyone else, contributing ideas to fill space, finding the right clip art to add to an article, tweak the type and size photos so that the articles fit the space, and more. I have even contributed many photos and an occasional article.

Working with Leslie Nossaman, the copy, editor has been one of the joys of this position. She has the difficult task of getting articles for *Phryno-*

somatics. She does a fantastic job and sends the articles via e-mail for me to format. Working closely together, we have become friends and manned HLCS booths at several events.

I will continue to enjoy reading about HLCS activities. In the future, when circumstances allow, I plan to participate again in field surveys.

Someone will need to take over the position of design editor. Mastery of *InDesign* is a requirement. If needed, I can help train someone. If interested, please contact me at fmessec@me.com or one of the Board of Directors.



Member Highlight

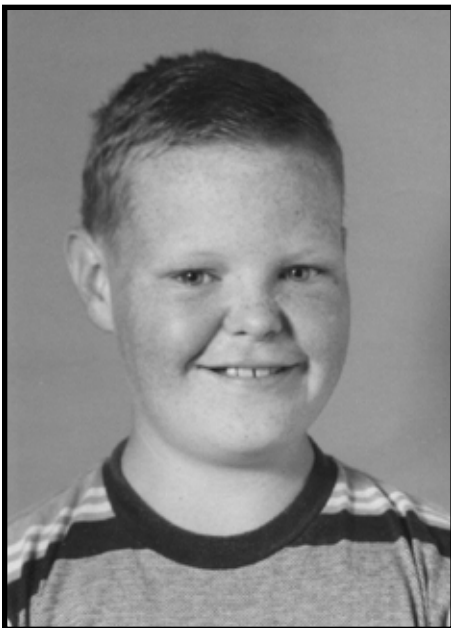
My Life with Horny Toads

By Thomas R. Van Devender

Greater Good Foundation
6262 N Swan Rd., Suite 150
Tucson, AZ 85718

I lived in Roswell, New Mexico for the first nine years of my life, where father Fred was stationed at Walker Air Force Base. My brother Wayne was born there in July 1947, within a month of the rumored crash of an alien spacecraft. He has given this explanation of his weirdness to students at Appalachian State University in Boone, North Carolina for more than 30 years! Finding horny toads (= Texas horned lizards, *Phrynosoma cornutum*) in Orchard Park was our first herp encounters. Mother Winifred never forgot the spiny surprise she found in her bed!

Wayne and I were the first herpetologists in the several



Tom in New Mexico.



Phrynosoma cornutum, Las Víboras, Sonora. Photo by T. R. Van Devender.

centuries of Van Devenders in the New World. Wayne went to the University of Michigan in Ann Arbor and Yale University in New Haven. I went to the University of Texas in Austin, Lamar State University in Beaumont, and the University of Arizona in Tucson. At Lamar, I took natural history from herpetologist Ernest Tanzer as part of a biology degree. Lamar memories include smelly water moccasins and watersnakes, chasing armadillos in lowland palmetto forests, and field trips to Mentone in the Texas Panhandle and Tamaulipas in northeastern Mexico. I found a Texas horned lizard in a power line right-away cut through East Texas piney woods. Now they have been extirpated from the eastern part of their range by red imported fire ants and are a threatened species.

In the summers, we attended meetings of the Strecker Herpetological Society at the Ft.

Worth Zoo. Whirlwind trips to the Big Bend of Texas with Ben Dial and Jerry Glidewell opened up the magical door to deserts and wondrous animals—gray-banded kingsnakes, black-tailed, Mohave, and rock rattlesnakes, Trans-Pecos rat snakes, and more. We collected lizards with electrical conduit blow guns and ate our seedless grape ammo when it got hot. One morning at Boquillas on the Río Grande, we saw a porcupine—it sure looked silly wandering away with grapes stuck on its spines! I saw round-tailed horned lizards (*P. modestum*). I was enthralled by this living rock and the concepts of natural selection and adaptive coloration. Later I saw them gray on limestone, pink on sand, and charcoal on cinder along railroad tracks. I saw their carcasses pinned to beaked yucca leaves by loggerhead shrikes.

In 1968, I went to the Univer-



Phrynosoma modestum, Black Gap, Texas. Photo by R. Wayne Van Devender.

sity of Arizona for a master's degree in zoology and a PhD in geosciences. I worked in Dr. Charles Lowe's lab at the University of Arizona. He was an eccentric professor with a booming voice, who always seemed larger than his 6'5" height. He was an astute herpetologist, ecologist, natural historian, and biogeographer who taught me to observe nature with open, curious eyes. In Arizona and Sonora, I met regal horned lizard (*P. solare*), a species of desert scrub, grassland, and tropical thornscrub and deciduous forests. They are like flat reptilian sumo wrestlers, whirling to eat every ant that approaches their nest. Like all herpetologists new to Arizona, I went to the Huachuca Mountains looking for

ridge-nosed rattlesnakes. I did not find them, but was seduced by the feel, smell, and abundance of life in these forests. Later I was to appreciate that Sky Island mountains are extensions of the Sierra Madre Occidental with amazing biodiversity. I am still exploring them 47 years later! Here I met the greater short-horned lizard (*P. hernandesii*), a species of grasslands and montane woodlands and forests. Like other horned lizards it can squirt blood from its eyes and often color matches habitat. Wade Sherbooke showed that the 'blood' squirted into the mouths of young kit foxes taught them not to eat horned lizards.

In the early 1970s, entomologist Vince Roth, Lowe, Wayne

Howard, and Michael Robinson rediscovered the endemic Ditmars' horned lizard (*P. ditmarsii*) in northern Sonora. By this time, I was studying fossil reptiles and amphibians, and discovered that the skull bones of *P. ditmarsii* and *P. hernandesii* were very different. Richard Montanucci followed this lead to conclude that they were not closely related. It was 43 years later that I saw *P. ditmarsii* in the wild!

In the early 1980s as a botanist with the Arizona Natural Heritage Program, Frank Reichenbacher and I were sent to Puerto Peñasco, Sonora in July to look for the flat-tailed horned lizards (*P. mcallii*). By 10:00 A.M., we found an adult perched on a dry cow patty, but temperatures of 120°F and lack of shade shortened our visit by several days. This cryptic sand specialist with a flat body and tan coloration is a threatened species, and much better adapted to the Lower Colorado River Valley Sonoran Desert than we were!

From 2009 to 2014, I was the manager of the Madrean Archipelago Biodiversity Assessment (MABA) program at Sky Island Alliance in Tucson. This program documents the



Phrynosoma solare, West of Benjamin Hill and near Aconchi, Sonora. Photos by T. R. Van Devender.





Phrynosoma hernandesi, Sierras del al Madera and la Púrica and near Cananea, Sonora. Photos by R. Wayne Van Devender, Charles Hedgcock, and T. R. Van Devender.



Phrynosoma ditmarsii. Northeast of Babiácora and above Rancho Toribusi, Sonora. Photos by Erik F. Enderson and T. R. Van Devender.

distributions of all species of animals and plants in the Sky Islands Region in Sonora and Arizona for use in conservation, research and education. Observations and images from nine expeditions to Sonoran Sky Islands are publicly available in the MABA database (Madrean.org). There are 1112 *Phrynosoma* observations in the database.



Phrynosoma mcalli, east of San Luis Río Colorado, Sonora. Photo by R. Wayne Van Devender.



Tom in Arizona in 2000. Photo by David A. Yetman.

JOIN US and Help Protect the Texas State Reptile



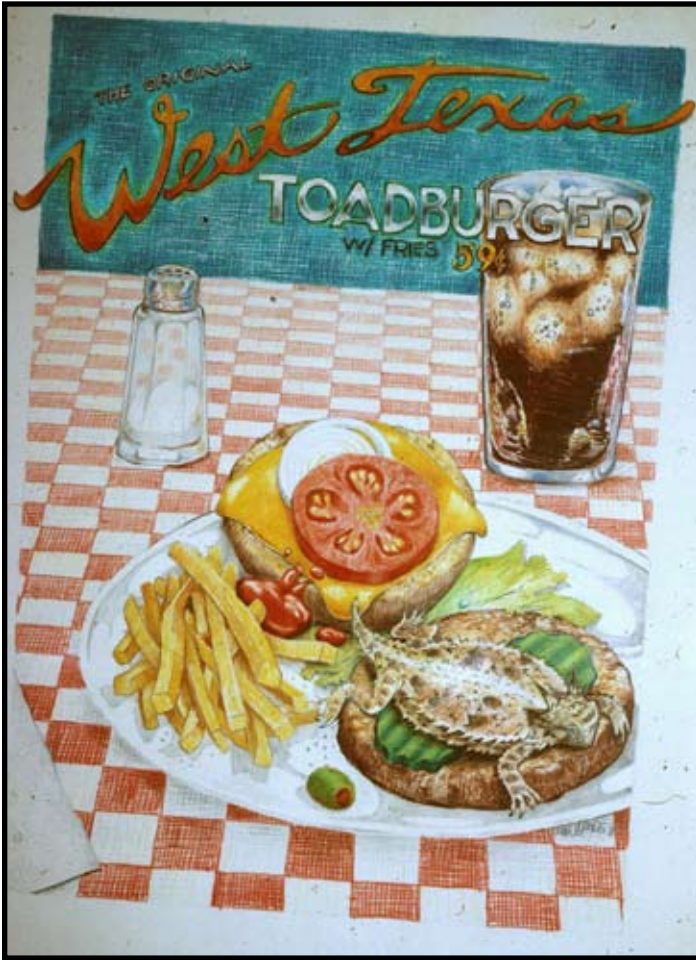
www.hornedlizards.org

HORNED LIZARD CONSERVATION SOCIETY

West Texas Toad Burger

By Tom Van Devender

In August of 1992, I traveled with my professor Paul S. Martin from Tucson, Arizona to Texas Tech University in Lubbock. Paul was to give a presentation on Pleistocene Overkill. Along the way, we stopped at a small gas station-cafe in Pine Springs, Texas along U.S. 62-180 on the edge of Guadalupe National Park. The cafe was in a rickety old building and run by an aging Texan; both predated the park. As I ate my cheeseburger, I admired a painting on the wall of a 60s style 'cheeseburger, fries, and a Coke 59 cents' advertisement except with a Texas Horned Lizard instead of a beef patty! The owner said that an artist came through, admired the rustic store, and later sent the painting. Although I was a poor graduate student at the time, I tried in vain to buy the painting. Alas, the building burned down a few months later, and my photo was the only record of this attempt at herp humor.



HLCS...It's Been Real!

By Bill Brooks, outgoing President

It has been a memorable two years for me at the helm of the Horned Lizard Conservation Society. It takes a village to run a non-profit and we have a dedicated Board and more than a few talented members. I thank you all for doing your part to keep this group growing and improving.

I did say we have a few dedicated people running the society. To keep this a dynamic and current group we need participation from more people. I propose that we have a current projects page on our web site. If you have the time and ability to work on any of these projects, you can contact the project leader and help us accomplish our goals.

Please consider donating your time and talents



Your President, Bill Brooks, representing the HLCS booth during the 2014 Old Rip Festival.

to the HLCS and please support our new president Tim Tristan.



Return Service Requested

PLEASE JOIN US! Students/Seniors: \$10; Regular: \$25; Contributing: \$50; Corporate: \$250; Lifetime: \$300
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Table of Contents

The Latest Piece in the Endangered Species Act “Puzzle”... pages 1, 3 - 7
 Richard Campbell

Protection Sought for Rare Desert Lizard in California’s Sonoran Desert. page 8
 Ilene Anderson

2015 Grant Award Announcements. page 8

The Status of an Introduced Species (*Phrynosoma cornutum*) on Barrier Island in
 South Carolina, USA pages 9 - 10
 Courtney Heuring

Phylogeography and Landscape Genomics of the Round-tail Horned Lizard (*Phrynosoma modestum*):
 Implications for Conservation and Management. pages 10 - 11
 Jared Fuller

Phrynosomatics Design Editor Retiring.. page 11
 Fannie Messec

Member Highlight—My Life with Horny Toads pages 12 - 14
 Thomas R. Van Devender

West Texas Toad Burger. page 15
 Thomas R. Van Devender

HLCS...It’s Been Real! page 15
 Bill Brooks

***Phrynosomatics* is now sent electronically.**

To receive the electronic copy and be taken off the newsletter print list, please contact Katie Talbott at kmtalbott@mail.fhsu.edu.