JUAN CARLOS DÍAZ

Inserting a PIT tag into a Texas Horned Lizard (*Phrynosoma cornutum*) allows for individual recognition during the entire study.

The Texas Horned Lizard in Central and Western Texas

Emily Henry, Jason Brewer, Krista Mougey, and Gad Perry

Department of Natural Resource Management, Box 42125, Texas Tech University, Lubbock, TX 79409-2125, USA

Photographs by Emily Henry except where noted.

The genus *Phrynosoma* contains 13 species inhabiting the grasslands and deserts of the central and southwestern United States and much of Mexico. Horned lizards are characterized by a flattened body and enlarged spines surrounding the head. Their shortened legs and broad body leave them ill suited for speed over longer distances. As protection against potential predators, they depend primarily on their cryptic coloration. When threatened, a horned lizard's first line of defense is to flatten itself against the substrate. If pressed further, it will run a short distance and then "freeze" to reestablish its camouflage or seek cover under nearby vegetation. Horned lizards are well known for another defense mechanism employed primarily against canids, the ability to squirt blood from the eye socket. They are considered dietary specialists, with ants comprising 50% or more of their diet and the remainder of other small arthropods (Sherbrooke 2003).

The suite of characteristics mentioned above makes horned lizards unique among North American lizards. That many of these species have experienced declines in recent years (Fisher et al. 2002, Mathies and Martin 2008, Wone and Beauchamp 2003) is disturbing. The Texas Horned Lizard (*Phrynosoma cornutum*) is listed as threatened in the state of Texas and as a species of special concern in both Oklahoma and Colorado. Several studies have shown a reduction in both its range and numbers over the last 40–50 years. Habitat conversion for agriculture and urbanization appears to be the leading cause (Donaldson et al. 1994). Activities associated with farming, such as plowing and pesticide use, also may harm horned lizards. The destruction and fragmentation of habitat for urbanization seems to have a negative effect, but lizards are consistently found in suburban areas and even remnant habitats within urban areas (Stark 2000, Endriss et al. 2007, Moody et al. 2007). The introduction and spread of imported Red Fire Ants (*Solenopsis invicta*) also has been linked to the decline of the Texas Horned Lizard (Price 1990). Eradication efforts aimed at the invasive fire ant have included widespread use of insecticides. Although this is not likely to produce direct mortality in horned lizards, it does harm populations of Harvester Ants (*Pogonomyrmex* spp.) and other insects on which the lizards feed. Moreover, the invader effectively competes with native ants. Lastly, collection for the pet industry may have contributed in the past to the Texas Horned Lizards' dwindling numbers (Price 1990).

Since 2005, we have been part of an effort to understand the ecology of this species, determine the proximate causes of its overall decline, and develop management strategies to enhance its long-term survival. As a part of this effort, we have been studying two populations of *P. cornutum* in Texas, one near Post and the other outside of Brownwood.

Although horned lizards usually rely on crypsis to avoid detection by a predator, if discovered, they fill their bodies with air to look as large and fierce as possible.

Study Sites

A portion of this study was conducted on the Beach Ranch, a 3,636-ha private ranch located 21 km east of Post, in Garza County, Texas. Garza County averages 48 cm of rain annually, most of which falls in thunderstorms during May and June. The average minimum temperature in January is just below freezing, and the average maximum in July is 35.0 °C. Soils at the site are primarily clay and fine sandy loams (Richardson et al. 1975). The major vegetation communities are mesquite grasslands and desert scrub. The dominant woody species is Mesquite (*Prosopsis* spp.). Grasses such as Buffalograss (*Buchloe dactyloides*) and Sideoats Grama (*Bouteloua curtipendula*) and cactus species such as Prickly Pear (*Opuntia* spp.) and Cholla (*Opuntia imbricata*) are common. The rolling grasslands are fragmented by rocky valleys, artificial stock ponds, and a fork of the Brazos River. The Beach family leases this land for cattle grazing, but also works hard to restore and maintain it as good habitat for wildlife. No controlled burns have been conducted on the site in recent years, but a recent wildfire burned a large swath of the ranch.

An additional study site was located at Camp Bowie, a military training facility outside of Brownwood, Brown County, Texas. Precipitation in the area follows a bimodal pattern with a large peak in May–June and a smaller peak in September–October. Annual precipitation for Brownwood averages 72 cm (NOAA 2008). The climate is characterized by hot summers and cool, dry winters. Soils on the site are mostly fine sandy loams with clay subsoils (NRCS Soil Data Mart). Camp Bowie is situated in a transition zone between the Western Cross Timbers and Rolling Plains ecoregions (Omernik 1995). As a result, the vegetation varies from wooded areas of Post Oak (*Quercus stellata*) and Blackjack Oak (*Quercus marilandica*) with an understory of Greenbrier (*Smilax* spp.) and grasses to grassland areas with Mesquite (*Prosopis glandulosa*) scrub. The base is managed primarily for National Guard training activities, but some hunting and fishing is allowed by permit. Livestock grazing is currently suspended, but was historically a common practice.

GAD PERRY

Horned lizard habitat at the Beach Ranch, Post, Texas (top and middle) and Camp Bowie, Brownwood, Texas (bottom).

GAD PERRY

Jason Brewer measuring the snout-vent length (SVL) of an adult horned lizard.

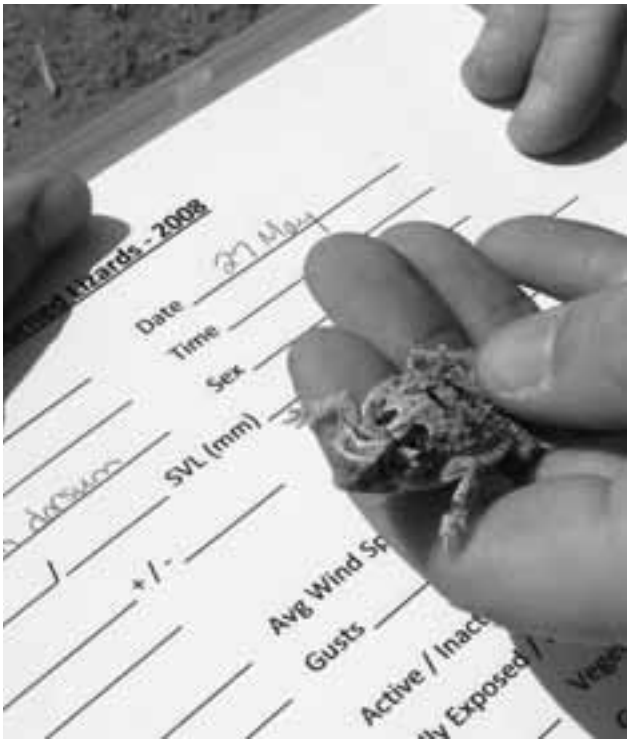
Materials and Methods

Each field season began shortly after horned lizards emerged from hibernation in April or early May. Throughout the activity season, we captured lizards by hand and recorded data on collection location, morphology, and weather conditions. Lizards over 20 g were implanted with a passive integrated transponder (PIT tag) for

JUAN CARLOS DÍAZ

JUAN CARLOS DÍAZ

Attaching radio-transmitters to horned lizards: To prevent the radio transmitter from becoming separated from the lizard during shedding, a plastic zip tie collar was put around the neck of the lizard and fishing line was used to attach the transmitter to the collar (top); Krista Mougey attaching the radio transmitter to the collar using fishing line (middle); Kelly Bollin sealing a transmitter with silicone (bottom).



Recording data on a juvenile Texas Horned Lizard.

GAD PERRY

JUAN CARLOS DÍAZ

After transmitters were attached (top), the transmitter was covered with silicone pressed into dirt to act as camouflage (bottom).

future identification. These tags work somewhat like a barcode; each has a unique number that can be read with a specialized scanner. We fitted each lizard over 40 g with a radio transmitter, attached between the shoulder blades using silicone adhesive, so that it could be located again over the rest of the season. The lizards were re-located at least three times per week during the spring and summer and once or twice per week during the fall, when activity declined greatly. We repeated the morphological measurements once a week to keep track of growth and identify when a female had deposited a clutch. We plotted the location information onto satellite images of the study sites and calculated home range size for each animal using the minimum convex polygon method. In 2008, we also characterized habitat use at both study locations, using digital photographs to quantify the availability of bare ground, rocks, grass, and other plants.

GAD PERRY

GAD PERRY

Once the transmitters were firmly attached (top), animals were released (middle). Emily Henry uses a handheld receiver and antenna to track a lizard (bottom).

JUAN CARLOS DÍAZ

Because the effect of radio-transmitters on lizards has been debated in previous studies, during the 2008 season at the Beach Ranch, we fitted lizards with transmitters of varying sizes and weights (top: small; bottom: large). Rocks were added to some for additional weight. Calculations of home range sizes of these lizards will be used to evaluate the impact of different weights.

Results and Discussion

We observed a total of 442 lizards at the Beach Ranch from 2005–2008 and 26 at Camp Bowie during 2007–2008. As expected, females were significantly larger than males in both populations. Montgomery et al. (2003) suggested that this species follows the reverse of Bergmann's rule and decreases in body size with an increase in latitude (contrary to what is typical of mammals and birds), presumably because the shorter warm season does not allow animals to grow as large. Compared to the mean sizes found in other studies (Stark 2000, Henke 2003, Montgomery and MacKessy 2003, Moeller et al. 2005, Endriss et al. 2007), the lizards at the Post site were somewhat larger than expected and those at Camp Bowie were somewhat

We characterized habitat by using digital photographs to quantify the availability of bare ground, rocks, grass, and other plants.

smaller than expected. We suspect that the larger adult size observed on the Beach Ranch indicates superior habitat; although grazing occurs, the prairie remains mostly in its natural state. A substantial Harvester Ant population has been observed, perhaps because the site is not treated with pesticides. Sex ratios at the two sites were similar, with females slightly outnumbering males at both locations. Previous studies suggest that this may be caused by differences in capture rates, rather than true differences in numbers between the sexes (Sherbrooke 2002). According to capture numbers, adults outnumbered juveniles at both sites. Once again, however, we suspect that this is at least partially a result of differences in detectability; hatchlings are very small, highly cryptic, and very difficult to see in the field.

Mating was observed at both study sites during May and June, with oviposition dates from mid-May to late July. We repeatedly observed double clutching (an instance of a female laying two clutches over a single summer) at the Post location. Hatchlings were generally first seen in early August, but, in 2008, we observed hatchlings at Post in early July. Survivorship at Post ranged from 19–53%, and similar values were noted at Camp Bowie. We have noted mortality resulting from predation by birds (especially Roadrunners and shrikes), mammals (especially coyotes and rodents), and snakes (especially Coachwhips and Diamondback Rattlesnakes). In some cases, death was caused by management actions such as road maintenance during the winter; for others the cause of mortality could not be determined.

Horned lizards were most active when temperatures were between 27 and 35 °C. As in previous studies, activity remained high from April through July and then tapered off, although we

JUAN CARLOS DÍAZ

Radio-transmitter-equipped lizards among native grasses and forbs.

In addition to casting shade, forbs and grasses provide lizards with a way to elevate their bellies off the hot substrate.

When mating, the male holds the female's horn in his mouth and wraps his tail around hers.

noted minor variations between the sexes and among years (Henke and Montemayor 1998, Fair and Henke 1999, Montgomery and MacKessy 2003). Based on movement levels, previous studies have noted that lizards remained active throughout the day during the spring and then exhibited a strong bimodal pattern during the summer, with peaks occurring in the cooler hours of morning and evening (Montgomery and MacKessy 2003). We prefer a broader definition of activity, and classified lizards as active if they were engaged in behavior such as moving or foraging, similar to previous researchers, but also if they were stationary but alert, with open eyes and clearly responsive to the environment. Using that definition, lizards on our study sites were indeed active all day during spring, but their activity did not decline much during the summer.

Based on Stark's findings that male lizards moved considerably longer distances than females during the mating season (Stark 2000, Stark et al. 2005), males would be expected to have correspondingly larger home range sizes. Our results do not support this hypothesis; male and female horned lizards had home ranges of similar sizes at both of our study sites. The variation among individual lizards was much greater than that between the sexes, years, or even between sites. Texas Horned Lizards at Beach Ranch were often found in close proximity to each other and had overlapping home ranges. At both study sites, lizards frequently used dirt roads, cattle trails, and adjacent areas. In 2007, lizards at both sites were almost exclusively found on or in the immediate vicinity of roads, presumably because this was an unusually wet year and the vegetation was particularly dense. In years with low summer rainfall, however, we noticed lower overall activity and found considerably fewer lizards along roadsides. As observed at other locations (Burrow et al. 2001, Fair and Henke 1998) lizards at both of our study sites made use of all

A female horned lizard emerging from her overnight burrow.

GAD PERRY

Even with transmitters providing information, well-camouflaged lizards were sometimes hard to find.

habitat categories except embedded rock. Open areas allow the animals to increase their body temperatures and also facilitate movements. Litter and vegetation shelter them during the hottest parts of the day and provide protection from predators. This mosaic is critical in providing suitable habitat for this species.

Conclusions

Studies carried out on native range habitat such as the Beach Ranch, even in remnant pockets within urban areas (Stark 2000, Endriss et al. 2007, Moody et al. 2007), have shown healthy and stable populations of Texas Horned Lizards. This suggests that loss of habitat is the most important factor in this species' decline, and other factors may have more localized effects. This makes preservation and proper management of remaining habitat especially critical. Common land management practices can have both beneficial and harmful effects on horned lizards. Low to moderate levels of grazing appear to improve the habitat for horned lizards, perhaps by increasing open space at ground level. Fire is likely to have a similarly positive effect on habitat. An increase in mortality from vehicles and maintenance activities can result because lizards often frequent roads and other disturbed areas, but this was minimal at our low-traffic sites.

Acknowledgments

We thank the Beach Family, the National Guard, and the Taylor family for allowing us to conduct this work on their land. Our gratitude goes out to the colleagues and assistants who helped in the field: Jacob Goldfarb, Juan Carlos Diaz, Kelly Bollin, Alan Sosa, and Jacqueline Forbus. Funding for this project came from the Texas National Guard, the Horned Lizard Conservation Society, and Prairie Biotic Research. This is manuscript T-9-1151 of the College of Agricultural Sciences and Natural Resources, Texas Tech University.

Literature Cited

Burrow, A.L., R.T. Kazmaier, E.C. Hellgren, and D.C. Ruthven III. 2001. Microhabitat selection by Texas Horned Lizards in southern Texas. *The Journal of Wildlife Management* 65:645–652.

Donaldson W., A.H. Price, and J. Mosre. 1994. The current status and future prospects of the Texas Horned Lizard (*Phrynosoma cornutum*) in Texas. *Texas Journal of Science* 46:97–113.

Endriss, D.A., E.C. Hellgren, S.F. Fox, and R.W. Moody. 2007. Demography of an urban population of the Texas Horned Lizard (*Phrynosoma cornutum*) in central Oklahoma. *Herpetologica* 63:320–331.

Fair, W.S. and S.E. Henke. 1998. Habitat use of Texas Horned Lizards in southern Texas. *Texas Journal of Agriculture and Natural Resources* 11:73–86.

Fair, W.S. and S.E. Henke. 1999. Movements, home ranges, and survival of Texas Horned Lizards (*Phrynosoma cornutum*). *Journal of Herpetology* 33:517–525.

Fisher, R.N., A.V. Suarez, and T.J. Case. Spatial patterns in the abundance of the Coastal Horned Lizard. *Conservation Biology* 16:205–215.

Henke, S.E. 2003. Baseline survey of Texas Horned Lizards, *Phrynosoma cornutum*, in Texas. *Southwestern Naturalist* 48:278–282.

Henke, S.E. and M. Montemayor. 1998. Diel and monthly variations in capture success of *Phrynosoma cornutum* via road cruising in southern Texas. *Herpetological Review* 29:148–150.

Moeller, B.A., E.C. Hellgren, D.C. Ruthven III, R.T. Kazmaier, and D.R. Synatzske. 2005. Temporal differences in activity patterns of male and female Texas Horned Lizards (*Phrynosoma cornutum*) in southern Texas. *Journal of Herpetology* 39:336–339.

Montgomery, C.E. and S.P. MacKessy. 2003. Natural history of the Texas Horned Lizard, *Phrynosoma cornutum* (Phrynosomatidae), in southeastern Colorado. *Southwestern Naturalist* 48:111–118.

Montgomery, C.E., S.P. MacKessy, and J.C. Moore. 2003. Body size variation in the Texas Horned Lizard, *Phrynosoma cornutum*, from central Mexico to Colorado. *Journal of Herpetology* 37:550–553.

Moody, R.W., D.A. Endriss, E.C. Hellgren, and S.F. Fox. 2007. Studying a population of Texas Horned Lizards (*Phrynosoma cornutum*) in an urban/military environment. *Iguana* 14:8–17.

National Oceanic and Atmospheric Administration. 2003. United States Climate Normals, 1971–2000. National Climate Data Center, Asheville, North Carolina <www.ncdc.noaa.gov/oa/climate/normals/usnormals.html>.

Omernik, J.M. 1995. Ecoregions: A spatial framework for environmental management, pp. 49–62. In: W.S. Davis and T.P. Simon (eds.), *Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making*. Lewis Publishers, Boca Raton, Florida.

Price, A.H. 1990. *Phrynosoma cornutum. Catalogue of American Amphibians and Reptiles* (469):1–7.

Richardson, W.E., D.C. Grica, and L.A. Putnam. 1975. *Soil Survey of Garza County, Texas.* United States Department of Agriculture Soil Conservation Services, Washington, D.C.

Sherbrooke W.C. 2002. Seasonally skewed sex-ratios of road-collected Texas Horned Lizards (*Phrynosoma cornutum*). *Herpetological Review* 33:21–24.

Sherbrooke, W.C. 2003. *Introduction to Horned Lizards of North America.* California Natural History Guides, No. 64. University of California Press, Berkeley.

Stark R.C. 2000. Habitat Use, Daily Movements, and Body Size of the Texas Horned Lizard in North-Central Oklahoma. Unpublished Master of Science Thesis, Oklahoma State University, Stillwater.

Stark, R.C., S.F. Fox, and D.M. Leslie, Jr. 2005. Male Texas Horned Lizards increase daily movements and area covered in spring: A mate searching strategy? *Journal of Herpetology* 39:169–173.

Wone, B. and B. Beauchamp. 2003. Movement, home range, and activity patterns of the horned lizard, *Phrynosoma mcallii*. *Journal of Herpetology* 37:679–686.