

Effects of Military Training Exercises on Texas Horned Lizard, *Phrynosoma Cornutum*, Occurrence on Fort Hood, Texas

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ABSTRACT

Texas horned lizards (*Phrynosoma cornutum*) were once prevalent throughout central Texas but their population has recently declined in abundance and distribution. Fort Hood lies in the historic range of *P. cornutum*. The United States Army was concerned about the status of Texas horned lizards on Fort Hood, abundance of primary prey (i.e., harvester ants [*Pogonomyrmex spp.*]), invasive species (i.e., red imported fire ants [*Solenopsis invicta*]), and any impacts that military maneuvers may have on this state-threatened reptile. Our objectives were to: 1) determine the distribution and abundance of Texas horned lizards, harvester ants and red imported fire ants and 2) assess the impacts of military training exercises on Texas horned lizards. We walked line transects from 14 May to 21 August 2001. We captured and marked 8 Texas horned lizards (5 males, 3 females) on 11 occasions via road cruising. Age ratio of Texas horned lizards was 3 juveniles and 5 adults. We collected all horned lizards within the Live Fire Area (LFA), which is located in the center of Fort Hood. We suspect horned lizards were found in the LFA because of limited vehicular and foot traffic, the area burned frequently due to artillery, and contained their primary prey species, the harvester ant.

KEY WORDS: fire ants, harvester ants, horned lizard, *Phrynosoma cornutum*, *Pogonomyrmex spp.*, *Solenopsis invicta*, Texas

INTRODUCTION

Texas horned lizards (*Phrynosoma cornutum*) are not currently listed as federally threatened or endangered under the Endangered Species Act, but are a Texas state-listed threatened species. Historically, Texas horned lizards occurred throughout central Texas, but their distribution and abundance within this region has declined dramatically (Henke 2003). Fort Hood Military Reservation was within the historical range of Texas horned lizards (Horne 2000). Although Texas horned lizards have been

We thank P. M. Cavanagh for early project development, and M. C. Oviedo, E. S. Harton, E. Redeker, J. Hardin, D. B. Long, and R. S. Lyons for volunteering their time. We also thank F. Hernández and several anonymous reviewers for helpful comments on earlier drafts. Cooperative funding was provided by The Nature Conservancy. This is contribution number 08-102 of the Caesar Kleberg Wildlife Research Institute.

noted on Fort Hood (i.e. 6 documented sightings since 1994; Horne 2000), their abundance appears extremely low.

Two species of ants found on Fort Hood Military Reservation include the red imported fire ant (*Solenopsis invicta*) and the native harvester ant (*Pogonomyrmex spp.*). Texas horned lizards are dietary specialists (Whitford and Bryant 1979) with 69% of their diet consisting of harvester ants (Pianka and Parker 1975). Fire ants, an invasive species of concern, may negatively affect the diversity and out-compete native species (Horne 2000) such as harvester ants. Fire ants also tend to invade areas where the ground has been disturbed (Horne 2000), so large-scale activities that disturb the topsoil, such as military training exercises (MTE), may alter the distribution of fire ants.

The effects of MTE on Texas horned lizards are not well documented. Therefore, The Nature Conservancy requested preliminary data collection of the Texas horned lizard on Fort Hood. Our objectives were to: 1) determine the distribution and abundance of Texas horned lizards, harvester ants and red imported fire ants and 2) assess the impacts of military training exercises on Texas horned lizards.

MATERIALS AND METHODS

Study Area

Our study was conducted on the 217,181 acre Fort Hood Military Reservation located in central Texas, in Bell and Coryell Counties. A full range of MTE were conducted on Fort Hood including maneuver exercises, firing of live weapons, and aviation training (Horne 2000). The Army also allows grazing, fishing, hunting, off-road vehicle use, and recreational use. Fort Hood was divided into Military Training Areas (MTA's), designated by number, and a central core Live Fire Area (LFA) (Figure 1). Military training areas were grouped into 4 major sections: East Range, West Range, West Fort Hood, and the LFA. The East Range (55,384 acres) was used primarily for wheeled and dismounted exercises and small-scale tracked vehicle training. The West Range (69,419 acres) was primarily used for heavy mechanical, both tracked and wheeled vehicles, and maneuver training. The LFA (30,634 acres) was centrally located and maneuvers and access was restricted due to artillery fire. West Fort Hood (15,550 acres) was used for dismounted and small-scale training and ammunition storage (Greene 2005).

Fort Hood encompassed 2 ecological regions; the Edwards Plateau and Cross Timbers and Southern Tallgrass Prairies (Greene 2005). Climate was characterized by warm summers and mild winters. Annual precipitation averaged 30.7 inches for Killeen, Texas and was concentrated in spring and autumn (Greene 2005). Mean July high temperature was 93.0 F and mean January low temperature was 37.9 F (Greene 2005). For a complete study area description see Greene (2005).

Methods

We used MTA's to systematically search Fort Hood for horned lizards via line transects. We attempted to walk each transect at least once during the morning (0630 to 1200 hr) and late afternoon to evening (1500 to 2030 hr) from 14 May to 21 August 2001. We conducted transects in the LFA as opportunities became available, such as military holidays, and when live-fire operations were cancelled. However, due to restricted access by the military, we did not complete all transects within the LFA. The number of transects and transect lengths were proportional to the size of the MTA's.

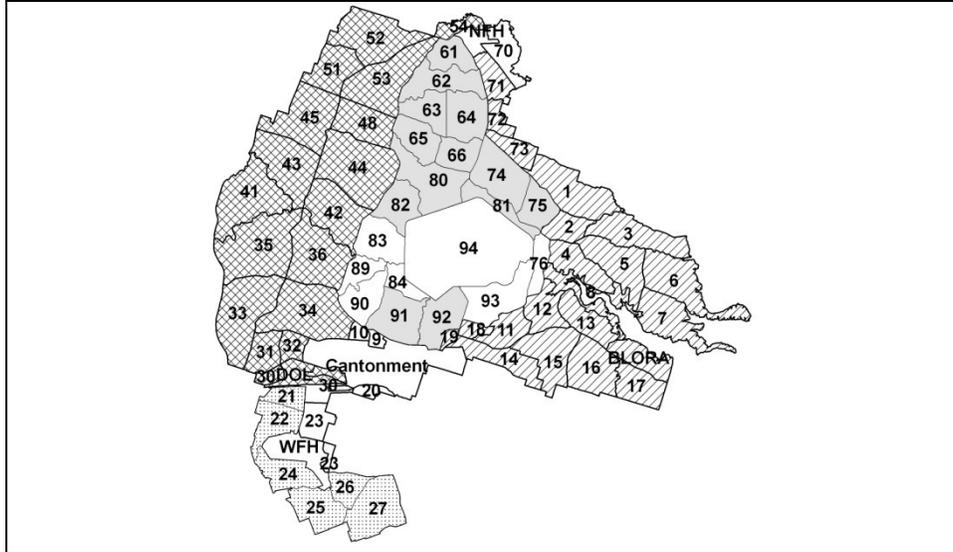


Figure 1. Military training areas (MTA's) located on East Range (diagonal), West Ford Hood (dots), West Range (cross-hatch), and Live Fire Area (grey) of Fort Hood, Texas. White MTA's were not searched.

Transects paralleled existing roads, based on previous experience with horned lizards (Fair and Henke 1997a), and consisted of searching for horned lizards and their sign (i.e. scat, tracks).

We recorded date, beginning and ending times, soil compaction, habitat disturbance, habitat type (i.e. % grassland: % woodland), and number of harvester and fire ant mounds per transect. We estimated densities (mounds/acre) of fire ant mounds via the Fourier estimator (Burnham et al. 1980) and densities of harvester ants based on methods by Davis and Winstead (1980) due to low number of mounds encountered.

We took soil compaction readings every 0.2 mile along each transect using a hand-held penetrometer (Land, Inc., Gulf Shores, Alabama, USA). Compaction was recorded from 14-284 PSI; with 14 being the least compact and 284 being the most.

We assigned each area a habitat type (% grassland: % woodland) and relative disturbance rating of 0-6, both by means of an ocular estimate. The following system was used to issue a disturbance rating: 0 = no disturbance, area not used by military; 1 = light disturbance, area used primarily for recreational purposes; 2 = mild disturbance, area used for dismounted foot maneuvers only; 3 = moderate disturbance, area used for dismounted foot maneuvers and non-track vehicles; 4 = heavy disturbance, area used by tracked vehicles or artillery, but ≤ 5 days/month; 5 = extreme disturbance, area used by tracked vehicles or artillery, 6-15 days/month; and 6 = ultimate disturbance, area used by tracked vehicles or artillery, but ≥ 16 days/month.

In addition to line transects, we utilized road cruising, another capture method used for time efficiency (Fair and Henke 1997a), while traveling by vehicle to and from

transects. Road cruising consisted of traveling existing roads at <9 mph and searching for horned lizards on or traversing the road.

We sexed, aged, measured (snout-vent length; inches), weighed (ounces), and released Texas horned lizards at the site of capture. We also individually marked horned lizards with passive integrated transponder tags (Avid Company, Norco, California, USA) or by toe clipping. We analyzed ant density, compaction, disturbance, and habitat type based on sections (i.e. East Range, West Range, West Fort Hood, LFA) because use was relatively equal by area within a section. We used chi-square goodness-of-fit tests ($\alpha = 0.05$) to test the hypothesis that the likelihood of Texas horned lizard captures and vegetation composition did not vary by section. We used percent of transects within sections to calculate expected proportions. Thus, we weighted the expected number of captures within section by the percent of transects in the respective section. In addition, we compared densities of ant mounds, disturbance factors, and soil compaction between military sections using a completely randomized 1-way analysis of variance (PROC GLM; SAS Institute Inc. 1989). Distributions were tested for normality by Shapiro-Wilk tests (PROC UNIVARIATE; SAS Institute Inc. 1989). Homogeneity of variances among treatments was evaluated with the Bartlett's Test (Steel and Torrie 1980). Means were compared using Tukey's studentized range (HSD) test when a significant ($P < 0.05$) F -test was noted (Cochran and Cox 1957).

RESULTS

We captured 8 Texas horned lizards (5 males, 3 females) on 11 occasions via road cruising; 6 horned lizards were captured once, 1 horned lizard was captured twice, and another captured on three occasions. Capture rates of horned lizards varied by section ($\chi^2 = 27.6$, $df = 3$, $P < 0.001$) with all captured horned lizards coming from the LFA (Table 1). We found road cruising yielded higher captures than line transect. Neither horned lizards nor their sign were observed throughout the remainder of Fort Hood. Age class of captured Texas horned lizards was 3 juveniles and 5 adults. Weight and SVL ranged from 0.2-1.3 ounces and 1.6-3.1 inches, respectively.

A total of 113 transects totaling 189.9 miles were walked 3 times in 56 areas (i.e. MTA's and LFA; Table 1). Average transect length walked was 1 mile for every 698.7 acres. Mound densities of harvester ants across all areas of Fort Hood ranged from 0.04 to 2.3 mounds/acre. Mound densities of harvester ants within the LFA section was 0.3 ± 0.1 (SE) mounds/acre (Table 1), and 0.44 mounds/acre in the 1 MTA within the LFA where horned lizards were found. Harvester ant mounds within the LFA coincided with horned lizard occurrence. Mound densities of fire ants ranged from 0.0 to 84.8 mounds/acre across Fort Hood. Mound density of fire ants was greatest in the LFA, followed by West Fort Hood and East Range, then by the West Range section (Table 1). Average fire ant mounds within the LFA was 26.3 ± 5.8 (SE) mounds/acre; however, fire ant mounds occurred in sporadic pockets and appeared greater at the periphery of the LFA.

Soil compaction (PSI) for 46 of the 56 training areas tested ranged from 128 ± 8.5 to 247.5 ± 9.9 but, on average, was lowest in the LFA (Table 1). Disturbance for 45 of 56 areas (i.e. MTA's and LFA) ranged from 2-6 and although was highest in the LFA, disturbance factors were not different between the military sections (Table 1). Although

disturbance in the LFA was highest, disturbance (e.g., artillery fire) was considered positive for Texas horned lizards. We found that 2.2, 44.4, 26.6, 20.0, and 2.2% of the 45 areas rated had a disturbance rating of 2, 3, 4, 5, and 6, respectively. Percent grassland:woodland was equal between West Fort Hood and in the LFA, but not different between the military sections (Table 1).

DISCUSSION

Texas horned lizards occur on Fort Hood, albeit in extremely low numbers. Similar to previous research (Fair and Henke 1997a) we found road cruising yielded higher capture rates of Texas horned lizards. Via road cruising we found an isolated population surviving within the LFA. The LFA is used for light to heavy artillery fire and burns frequently due to artillery fire, which was considered a positive disturbance because fire maintains the area in an early successional stage (i.e. grassland habitat). Previous research found Texas horned lizards preferred open areas that were recently burned (Fair and Henke 1997b). Harvester ant queens also search for open areas to initiate new colonies (DeMers 1993); therefore, the potential for colony initiation may be greater in the LFA due to frequent fires and grassland habitats. Mortality due to vehicles is considered one of the leading causes of death for horned lizards. The Army limits vehicle use in the LFA due to obvious dangers; thus reducing the probability of direct vehicular mortality and decreasing soil compaction. Although the LFA had the highest density of fire ants and lowest density of harvester ants, fire ants were found in sporadic pockets and at the periphery of the LFA, whereas harvester ant mounds were greater where horned lizards occurred compared to the remainder of the LFA.

Impacts caused by MTE often include disturbance of soil and vegetation, but may include incidental killing of wildlife. Soil disturbances include soil displacement, earthmoving or excavation, and soil compaction, which is more pronounced and longer-lasting when vehicles pass over wet soil. Vegetation disturbances can include upheaval, crushing and/or uprooting of vegetation, wildfires, loss of lower vegetation, damage to trees, and alteration of root systems. Soil changes induced by maneuvers may affect burrowing vertebrates associated with the soil surface and subsurface. However, the LFA had the lowest soil compaction ratings, thus soil compaction was probably not a factor for horned lizards in this area. Vegetation changes in areas of horned lizard occurrence were positive due to frequent fires with habitat consisting primarily of bunch grasses. Management options for horned lizards on Fort Hood may include translocation of horned lizards to areas with an abundant prey base (i.e. harvester ants), low red imported fire ant densities, susceptible to cyclic wildfires, and reduced heavy equipment maneuvers. Although Texas horned lizards were not found on other areas of Fort Hood, a number of MTA's appeared promising as a site for potential translocations. These areas contained low densities of fire ant mounds, ample harvester ant mounds, limited vehicular traffic, and an open habitat composed primarily of bunch grasses.

Table 1. Survey effort (number of transects and length), red imported fire ant (*Solenopsis invicta*) and harvester ant (*Pogonomyrmex spp.*) densities (mounds/ha), and habitat characteristics (disturbance, compaction, and vegetation) for East Range (21; number of MTA's searched within section), West Range (17), West Fort Hood (6), and Live Fire Area (12) of Fort Hood, Texas, USA.

Section	Transects		Lizards ²	Ant density ¹			Habitat	
	n	Mile		Fire	Harvester	Disturbance	Compaction ³	Vegetation ⁴
East Range	39	61.7	0 A ^{5,6}	12.6 ± 2.2 B ⁷	0.4 ± 0.1 A ⁸	3.3 ± 0.2 A ⁹	207.7 ± 2.8 A ¹⁰	48:52 A ¹¹
West Range	35	67.4	0 A	4.1 ± 1.1 A	0.5 ± 0.2 A	4.3 ± 0.2 A	231.8 ± 4.3 A	62:38 A
West Fort Hood	10	17.8	0 A	13.7 ± 2.3 BC	0.4 ± 0.2 A	2.8 ± 0.2 A	226.2 ± 1.4 A	73:27 A
Live Fire Area	29	43.0	8 A	26.3 ± 5.8 C	0.3 ± 0.1 A	4.7 ± 0.3 A	157.9 ± 5.7 B	73:27 A

¹Mounds/acre; ²All lizards were captured via road cruising; ³PSI; ⁴Percent (%) grassland:woodland; ⁵Means with the same capital letter within a column are not different ($P > 0.05$); ⁶ $\chi^2 = 27.6$, $df = 3$, $P < 0.001$; ⁷ $F_{3,44} = 8.75$, $P < 0.001$; ⁸ $F_{3,44} = 0.25$, $P = 0.86$; ⁹ $F_{3,44} = 1.46$, $P = 0.27$; ¹⁰ $F_{3,44} = 7.97$, $P < 0.001$; ¹¹ $\chi^2 = 7.0$, $df = 3$, $P < 0.08$

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