

University of Texas at Arlington

MavMatrix

2022 Spring Honors Capstone Projects

Honors College

5-1-2022

MEASURING TEXAS HORNED LIZARD POPULATION BY CAPTURE-MARK-RECAPTURE IN ROBY, TEXAS

Erin Schillings

Follow this and additional works at: https://mavmatrix.uta.edu/honors_spring2022

Recommended Citation

Schillings, Erin, "MEASURING TEXAS HORNED LIZARD POPULATION BY CAPTURE-MARK-RECAPTURE IN ROBY, TEXAS" (2022). *2022 Spring Honors Capstone Projects*. 17.
https://mavmatrix.uta.edu/honors_spring2022/17

This Honors Thesis is brought to you for free and open access by the Honors College at MavMatrix. It has been accepted for inclusion in 2022 Spring Honors Capstone Projects by an authorized administrator of MavMatrix. For more information, please contact leah.mccurdy@uta.edu, erica.rousseau@uta.edu, vanessa.garrett@uta.edu.

Copyright © by Erin Schillings 2022

All Rights Reserved

MEASURING TEXAS HORNED LIZARD POPULATION
BY CAPTURE-MARK-RECAPTURE
IN ROBY, TEXAS

by

Erin Schillings

Presented to the Faculty of the Honors College of
The University of Texas at Arlington in Partial Fulfillment
of the Requirements
for the Degree of

HONORS BACHELOR OF SCIENCE IN BIOLOGY

THE UNIVERSITY OF TEXAS AT ARLINGTON

May 2022

ACKNOWLEDGMENTS

This paper and the research behind it would not have been possible without the support of my faculty mentor, Dr. Corey Roelke. His knowledge, attention to detail, and enthusiasm has been an inspiration and kept me on track from my first encounter with MARK to the final draft of this paper. I would like to extend my thanks to his team of field researchers, who went out to collect the data for the past ten years. Without the help of their team, I would have no data to work with. This work would not have been possible without the help of the graduate student, Stephanie Tran, for teaching me how to use the Program MARK to format the data. I would also like to thank Ms. Bobbie Brown, for her constant guidance and feedback throughout the semester.

I am grateful to all of my friends at University of Texas at Arlington for pushing me and keeping me motivated during this time. Nobody has been more important to me in the pursuit of this project than the members of my family. I would like to thank my family for always believing in me and encouraging me not to give up on my dreams. Thank you to everyone who has helped me along this journey.

April 12, 2022

ABSTRACT

MEASURING TEXAS HORNED LIZARD POPULATION BY CAPTURE-MARK-RECAPTURE IN ROBY, TEXAS

Erin Schillings, B.S. Biology

The University of Texas at Arlington, 2022

Faculty Mentor: Corey Roelke

The Texas horned lizard, *Phrynosoma cornutum*, is classified as a threatened species. They are known by the horns on their head and as the state reptile of Texas. This flat-bodied and fierce-looking lizard is important to our ecosystem by limiting the ant population, but is falling prey to larger predators, such as coyotes and rattlesnakes. To further conserve the species and study the population size, a team of researchers went to west Texas to capture and mark lizards with electronic Passive Integrated Transponder (PIT) tags. They had an encounter number of 164 from 2010-2021. The data consisted of: GPS coordinates, sex, gravid, Snout-Vent Length, total length, weight, temperature, and route data. The data was run through the MARK program to show the estimated population size and promote steps to preserve the diversity of the species. The findings show that the species has a healthy population in Roby, Texas due to conservation and rehabilitation

efforts.

TABLE OF CONTENTS

ACKNOWLEDGMENTS	iii
ABSTRACT.....	iv
LIST OF ILLUSTRATIONS.....	vii
LIST OF TABLES	viii
Chapter	
1. INTRODUCTION	1
1.1 Texas Horned Lizard Description.....	1
1.2 Conservation Status and Threats to Survival	2
1.3 Research Goal	5
2. METHODOLOGY	6
2.1 Capture-Mark-Recapture Analysis	6
2.2 Program MARK.....	7
3. RESULTS	9
3.1 Gross Population Estimate Results	9
4. DISCUSSION.....	10
REFERENCES	12
BIOGRAPHICAL INFORMATION.....	15

LIST OF ILLUSTRATIONS

Figure		Page
1.1	Texas Horned Lizard (<i>Phrynosoma cornutum</i>) distinguished skull	2
1.2	A female <i>Phrynosoma cornutum</i> showing a blood squirting response.....	2
2.1	Mark Recapture Formula	7
2.2	Design Matrix Example	8

LIST OF TABLES

Table		Page
2.1	Encounter History #1	7

CHAPTER 1

INTRODUCTION

1.1 Texas Horned Lizard Description

The Texas horned lizard (*Phrynosoma cornutum*) is a one-of-a-kind species that is known for being the state reptile of Texas. This lizard belongs to a group of North American lizards known as horned lizards. The scientific name for the genus, *Phrynosoma*, means “toad-bodied” and *cornutum* means “horned”. Because of the several features of the horned lizard that resembles toads, these reptiles are often referred to as “horned toads” or “horny toads” (Carpenter, 2014). Previous studies over the taxonomic history show that despite the common name, “*horny toad*”, they are in fact lizards and only distantly related to toads (Reeve, 1952). This spiny and ant eating lizard consists of unique characteristics and features. They have two long central horns separated by a short horn or enlarged scale at the back of their head, spiny backs, and a white middorsal stripe (Myers, 2020). The “horns” are specialized body scales to help protect the lizards from predators (Pianka, 2010) (1.1). Their dorsal body color consists of variations of red, brown, or gray. These features help them blend into vegetation and leaf litter to escape predators (Pianka, 2010). They also have multiple defense mechanisms, the most unique being the ability to shoot a stream of blood from their eyelid into the predator’s eyes when threatened (Adkins, 2014) (1.2).

Figure 1.1: Texas Horned Lizard (*Phrynosoma cornutum*) Distinguished Skull

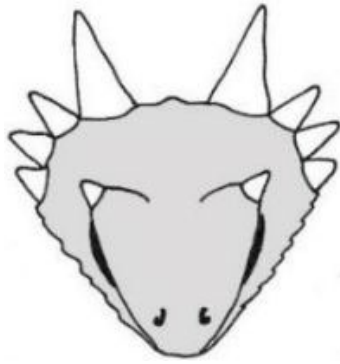


Figure 1.2: A Female *Phrynosoma cornutum* Showing a Blood Squirting Response



1.2 Conservation Status and Threats to Survival

Texas horned lizards were once common throughout eastern Texas and central Oklahoma, but sightings of the lizards have dramatically declined throughout its range since the 1990's (Busby & Parmalee, 1996). Recipients of a survey from 1994 on the abundance of Texas horned lizards in Texas noted a “significant decline” in parts of East, Texas (Donaldson, 1994). Results from a survey conducted in 1999, showed that the region with the greatest proportion of sites for horned lizards demonstrated a low abundance of lizards (Henke, 2003). Both of these surveys show that concern for the disappearance of *P. cornutum* has increased in awareness within the past thirty years (Carpenter, 2014). The primary threats to the Texas horned lizard species are habitat destruction, imported fire ants (*Solenopsis invicta*), and the use of pesticides (Adkins, 2014).

As cities begin to grow and highways are stretched across Texas, the lizards become more isolated and are less likely to thrive due to urbanization development and habitat alteration (Potts, 2021). There are various levels of habitat alteration that occur. Most urban development leads to planting non-native grasses which prevent the lizards from accessing the dirt to lay their eggs or dig burrows (Pianka, 2010). Urban development causes paved roads and fast cars to be a potential threat to horned lizards because of their defense mechanisms (Pianka, 2010). When horned lizards feel threatened, they tend not to move, hoping to blend into their environment or for their predator to eventually walk away (Pianka, 2010). This is dangerous for the lizards crossing the road because they will most likely stay still when a car comes and risk the possibility of getting run over by the vehicle. Habitat alteration in the form of agriculture conversion can also play a role in threatening the species (Carpenter, 2014). Studies show a lack of *P. cornutum* in agricultural fields across Texas and suggest a negative effect on horned lizard survival (Burrow, 2002). The absence of horned lizards in agricultural fields is due to the plowing of fields (Hellgren, 2010). These fields often contain hibernating lizards or eggs. Plowing of fields can directly kill the lizards that are hibernating or the eggs that are hidden (Hellgren, 2010).

Invasive fire ants (*Solenopsis invicta*) have also become a primary threat to the horned lizard species (Carpenter, 2014). This species of ants was introduced from South America in the 1930s and pose a serious threat to *P. cornutum* (Pianka, 2010). After the increase in the population of fire ants, a survey was conducted for the appearance of Texas horned lizards (Donaldson, 1994). About one-third of the respondents reported a decline in the number of horned lizards in Texas (Donaldson, 1994). Fire red ants negatively impact the lizards indirectly through competition with the lizard's main food item,

harvester ants (*Pogonomyrmex*), and directly by harming the lizards (Allen 1993). The fire ants have an underground tunnel system used for traveling food back to the colony. These tunnel systems make it more convenient for *S. invicta* to kill any hibernating lizards or incubated eggs (Donaldson, 1994).

Many of the insecticides that are used to control or eliminate the red imported fire ants are toxic to the harvester ant and eliminate the harvester ant more efficiently than they eliminate fire ants (Davis, 2021). A survey conducted in 2014 showed that 37% of property owners use pesticides specifically to kill harvester ants (Carpenter). The pesticides contain the insect growth regulator chemical, Fenoxycarb. This special chemical hinders ant's metamorphosis from larva to adult (Davis, 2021). Because the colony will run out of workers, the queen will starve and not be able to reproduce (Davis, 2021). These pesticides that are killing *Pogonomyrmex* are a threat to horned lizards because lizards rely on harvester ants as their main source of food (Davis, 2021).

Horned lizards are unique lizards that have been living in Texas long before humans and have evolved through millions of years of environmental changes. Unfortunately, the horned lizards are having trouble coping with rapid urbanization (Pianka, 2010). Protecting natural areas is essential for the continuance of horned lizards. Without the lizards, there would be a decline in a number of creatures including snakes, coyotes, and roadrunners (Potts, 2021). A stable number of each species is important to have a healthy and balanced ecosystem. The more life that is preserved, the healthier the ecosystem. Every species is a key component in the ecosystem, so it is important to ensure all species maintain a stable and balanced life for generations to come.

1.3 Research Goal

The goal of this research is to preserve biodiversity by measuring how many Texas horned lizards are within certain parameters of Roby, Texas. The research conducted will help conservationists and field researchers narrow down how they can further conserve and save the species from extinction. This conservation effort is important because without monitoring the population of Texas horned lizards, there will be a decline in the population of their predators: coyotes, snakes, birds, and rodents (Potts, 2021). This species of lizard is also an icon of Texas. Many Texans have fond memories of Texas horned lizards. To bring the population back to healthy measures will bring childhood memories back. The conservation efforts that are taking place across Texas will allow children to relive the same experiences of abundant horned lizards that past generations of Texans that enjoy wildlife have had the opportunity to enjoy.

CHAPTER 2

METHODOLOGY

2.1 Capture-Mark-Recapture Analysis

In order to get an approximate population size of *P. cornutum*, the Capture-Mark-Recapture (CMR, also known as Mark-Recapture) technique was used. This is one of the oldest population estimation methods that is performed by capturing a small number of horned lizards, marking them with a form of identification, and then releasing them back into the population. The marked lizards are allowed to mix with the rest of the population. The sites are later resampled, and the number of recaptured lizards is recorded. This process was repeated approximately 169 times throughout the period 2010-2020. Population size (N) can be inferred from the ratio of captured to recaptured individuals (Sutherland 2012). All horned lizards encountered were captured and scanned for an existing passive integrated transponder (PIT) tag. The field researchers kept track of the following data through an Microsoft Excel sheet for every horned lizard encountered: GPS coordinates, PIT Tag number, sex, gravid, snout-to-vent length (SVL), total length (TL), weight, alive or dead, date, and whether or not the lizard was recaptured. There are two assumptions when conducting a CMR study. First, is that CMR assumes that the population being tested is closed with regards to recruitment, emigration, and mortality (Kellner, 2014). Second, CMR assumes that all lizards are equally catchable (Fryxell, 2014). The program MARK can help detect probability (p) through manipulations.

Table 2.1: Encounter History #1

<i>PIT TAG #</i>	<i>900118001065500</i>	<i>900118001065367</i>	<i>900118001065340</i>
<i>Live</i>	Yes	Yes	Yes
<i>Recapture</i>	No	No	No
<i>Sex</i>	Male	Female	Male
<i>Gravid</i>	No	Unknown	No
<i>SVL (mm)</i>	77	57	76
<i>TL (mm)</i>	116	86	16.5
<i>Weight (gr)</i>	35.0	16.5	34.5
<i>Date</i>	6/18/10	6/18/10	6/18/10

Figure 2.1: Mark-Recapture Formula

$$N = \frac{(M * C)}{R}$$

Note. where N represents the estimate population, M represents the amount of lizards marked and captured, C represents the total amount capture the second time, with or without a mark, R represents the lizards that were recaptured with a mark.

2.2 Program MARK

The program MARK was used to estimate the population size of *P. cornutum* from the CMR data. The data was organized into a Microsoft Excel sheet where the CONCAT function was used to calculate the capture encounter history. The values were copied and formatted into a matrix text file that was run through the program MARK using the POPAN (Population Analysis) method. The POPAN system was developed by Schwarz and Arnason (1996) and analyzes the CMR data from open populations using models from *Jolly-Seber* method (Arnason, 2010). The POPAN model assumes that all lizards have the same probability of survival, all marks on the lizards are not lost and can be read correctly,

CHAPTER 3

RESULTS

3.1 Gross Population Estimate Results

The gross population calculated from Program MARK showed positive results for Texas horned lizards. One hundred sixty-nine trips were taken to the study area of Roby, Texas during the course of the study period (2010-2020). A total of 2,340 lizards were captured and marked during the study period. Only 16 lizards were deceased when encountering. More than half of the lizards that were marked were classified as female (1,422), less than 1,000 (888) were classified as male, and 29 lizards sex remains to be unknown. Average weight for the lizards was greater for females than for males. Female lizards had a standard deviation weight of 18.39 grams and male lizards with a standard deviation of 11.83 grams. The estimated population size (N) for *P. cornutum* in Roby, Texas was estimated at 35,645 lizards. The standard error was zero and both the lower and upper limit showed to be 35,645.567. The confidence interval (95%) shows the margin of error for uncertainty was low and that the estimate was plausible.

CHAPTER 4

DISCUSSION

The Texas horned lizard remains a species of conservation concern in Texas due to urbanization, pesticides, and imported red fire ants (*Solenopsis invicta*). In addition, for the state of Texas, the Texas horned lizard has been identified as a threatened species since 1977. Despite the concerns, data collected from this ten-year study showed that the population level of Texas horned lizards in Roby, Texas is stable. This is because of the ongoing rehabilitation and conservation efforts that several projects are working on to restore the population throughout Texas and Oklahoma.

A local biology professor at Texas Christian University, Dean Williams has been conducting studies of horned lizards in small towns in Karnes County, Texas to better understand what factors allow or inhibit the ability of the lizards to live in areas modified by people (Williams, 2021). Williams has his own research lab in Fort Worth, Texas where his team breeds hundreds of horned lizards in captivity and then releases them into areas where they will hopefully survive and reproduce (Williams, 2021). The Williams lab also has their own Facebook page, *TCU Horny Toad Project*, where locals can raise awareness of the species and post observations of horny toads from surrounding areas.

The Fort Worth Zoo also shows reintroduction efforts of the Texas horned lizard species. Researchers from the Fort Worth Zoo have been studying how to restore the population of lizards to formerly occupied habitats. The zoo has been very successful with releasing over 1,000 zoo raised hatchlings back into the wild.

There are some concerns with the results of this study. The standard error shows to be zero, but this cannot be possible because this would mean that there are no errors that were made within this ten-year study. There are several factors that might indicate why the standard error is zero. The possibility of making errors when collecting data from the field is high due to the number of encounters throughout the ten-year time span. There could also be systemic errors from running the large data set through the Program MARK. The potential for error is large, considering the size of the design matrix that was used for the POPAN. Another systemic error could be from the parameters that were set within MARK. If one of the PIMS was off regarding the value, this could act as a catalyst and offset any proceeding values within the program.

The findings of this study show potential for the horned lizards to grow in population size and no longer be classified as an endangered species. The population estimation of over 35,000 horned lizards between the specific parameters of Roby, Texas predicts that the species of Texas horned lizards will continue to increase over time. We can look forward to increasing sights of Texas horned lizards throughout Texas and smiling faces when Texans see their state reptile for the first time.

REFERENCES

- A. Neil Arnason & Carl J. Schwarz (1995) POPAN-4: Enhancements to a system for the analysis of mark-recapture data from open populations, *Journal of Applied Statistics*, 22:5-6, 785-800, DOI: 10.1080/02664769524621
- Ackel, A. (2016). The devil in the details: Population estimation for conservation management of texas horned lizards (Order No. 10113204); ProQuest Dissertations http://library.tcu.edu/PURL/EZproxy_link.asp?/login?url=https://www.proquest.com/dissertations-theses/devil-details-population-estimation-conservation/docview/1802324065/se-2?accountid=7090
- Donaldson, W. L., A. H. Price, and J. Morse. 1994. The Current Status and Future Prospects of the Texas Horned Lizard (*Phrynosoma cornutum*) in Texas. *Texas Journal of Science* 46(2) 97-113
- “Horny Toads Are Disappearing across Texas and Oklahoma. Can They Be Saved?” *Los Angeles Times*, Los Angeles Times, 2 Mar. 2021, www.latimes.com/world-nation/story/2021-03-02/texas-horned-lizard-animal-conservation-oklahoma.
- Huerta, Javier O, et al. “Field Observation of Texas Horned Lizard, *Phrynosoma Cornutum* (Harlan, 1825), Blood-Squirting Behaviour Elicited by a Passing Vehicle.” *Herpetology Notes*, vol. 14, no. 383, ser. 384, 15 Feb. 2021, pp. 1–2. 384

“Lizard’s Plight Highlights Need for Landmark Federal Proposal to Aid Wildlife and People.” *Texas Horned Lizard Hatchling Release Marks Milestone to Save State Reptile*, Fort Worth Zoo, 17 Sept. 2021,
<https://www.fortworthzoo.org/default.aspx?p=125122&naid=27755#dismiss>

Mark-Recapture, Northern Arizona University,
www2.nau.edu/lrm22/lessons/mark_recapture/mark_recapture.html.

Michelle. “The Texas Horned Lizard.” *San Diego Zoo Kids*, San Diego Zoo Wildlife Alliance, https://www.youtube.com/watch?v=rhfrCJeqqvI?cc_lang_pref

National Geographic Society. “Endangered Species.” *National Geographic Society*, 9 Oct. 2012, <https://www.nationalgeographic.org/encyclopedia/endangered-species/#:~:text=A%20species%20is%20classified%20as%20endangered%20when%20there%20are%20fewer,is%20also%20classified%20as%20endangered>

Pianka, Eric R, and Wendy L Hodges. “Horned Lizards.” *Horned Lizards*, Biological Sciences at UT Austin, <http://www.zo.utexas.edu/faculty/pianka/phryno.html>

Price, Camilla. “Comrades True: TCU Students Take Part in Horned Frog Conservation.” *TCU 360*, 10 Feb. 2022, <https://www.tcu360.com/2022/02/comrades-true-tcu-students-take-part-in-horned-frog-conservation/?fbclid=IwAR3bNV4Bf9rWsJKTrcIfl1dkA9ayo87a6QEJ7vmxpWqkseU1EGszwBZze6>

Sheffield, Steve. *Endangered Species Protection Sought for Oklahoma's Disappearing Horned Lizards*, The Center for Biological Diversity, 2014,
www.biologicaldiversity.org/news/press_releases/2014/texas-horned-lizard-12-18-2014.html.

“Texas Horned Lizard.” *Oklahoma Department of Wildlife Conservation*,

<https://www.wildlifedepartment.com/wildlife/field-guide/reptiles/texas-horned-lizard>

Texas Horned Lizard (*Phrynosoma Cornutum*), Texas Parks and Wildlife Department,
tpwd.texas.gov/huntwild/wild/species/thlizard/.

Vitt, Laurie. *Texas Horned Lizard*, Oklahoma Department of Wildlife Conservation,
www.wildlifedepartment.com/wildlife/nongamespecies/reptiles/texas-horned-lizard.

Walker, A. 2018. "Phrynosoma cornutum" (On-line), Animal Diversity Web. Accessed
April 22, 2021 at https://animaldiversity.org/accounts/Phrynosoma_cornutum/

Webb, S. L., & Henke, S. E. (2003). Defensive strategies of texas horned lizards
(*phrynosoma cornutum*) against red imported fire ants. *Herpetological Review*,
34(4), 327-328. Retrieved from
http://library.tcu.edu/PURL/EZproxy_link.asp?login?url=https://www.proquest.com/scholarly-journals/defensive-strategies-texas-horned-lizards/docview/212013981/se-2?accountid=7090

White, Gary & Burnham, Kenneth. (1999). Program MARK: Survival Estimation from
Populations of Marked Animals. *Bird Study*. 46 Supplement. 120-138.
10.1080/00063659909477239.

BIOGRAPHICAL INFORMATION

Erin's academic career as an undergraduate student at the University of Texas at Arlington has been nothing short of engaging and insightful. She has learned more about herself and how to be a better friend, leader, and student while taking advantage of opportunities to serve on campus. Her love to help and encourage others will benefit her future endeavors by practicing as a Pediatric Dentist. She will be graduating with an Honors Bachelor of Science in Biology and a minor in Psychology in Spring 2022. While waiting on dental school admissions, she will spend the next year taking Post Baccalaureate classes, volunteering, and working as a dental assistant to gather more experience in the dental field.