



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.

## Landscape genomics of Blainville's Horned Lizards in urban Southern California

(2018 Grant Recipient) *By Sarah M. Wenner*



Figure 1. Adult female Blainville's Horned Lizard sitting comfortably beside a harvester ant nest in the eastern Santa Monica Mountains. April 2019. *Photo by Sarah Wenner.*

Introduction: A major goal in conservation research is understanding how natural and anthropogenic processes affect the genetic connectivity of populations. The emerging field of landscape genetics combines principles of population genetics with landscape ecology to assess the effects of the environment on patterns of genetic diversity and functional connectivity (Manel et al. 2003; Holderegger and Wagner 2006). Functional connectivity, or the degree with which individuals of a species are able to effectively move through a landscape, is important for the long-term persistence of populations (Crooks and Sanjayan 2006). I used landscape genetics to determine how habitat fragmentation and landscape characteristics affect patterns of gene flow among populations of Blainville's horned lizards (*Phrynosoma blainvillii*) in the Los Angeles region of southern California.

The Blainville's horned lizard is endemic to California and northern Baja California, and is listed as a Species of Special Concern in California due to notable declines in distribution (Thomson, Wright,

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and Shaffer 2016). Some of the main threats are habitat loss due to urban development, invasive species, and over-collecting for the pet trade. In southern California, there is an estimated 45% reduction from its historical range, and many of the remaining populations are isolated by habitat fragmentation (Thomson, Wright, and Shaffer 2016). Blainville's horned lizards are often considered ecological specialists due to their strong preferences for native chaparral vegetation, sandy soils, and native harvester ants (*Pogonomyrmex* spp.), which is their main food source (Fisher, Suarez, and Case 2002). The primary aims of this study were to (1) examine fine-scale population genetic structure and (2) assess the functional connectivity of populations in the highly fragmented Los Angeles region. I expected to find evidence of high population structure based on the pattern of habitat fragmentation caused by roadways and urban development. Given the strong ecological preferences of Blainville's horned lizards, I hypothesized that vegetation type, soil substrate, microclimate, history of fire, and urban development would be important determinants of functional connectivity among populations of Blainville's horned lizards.

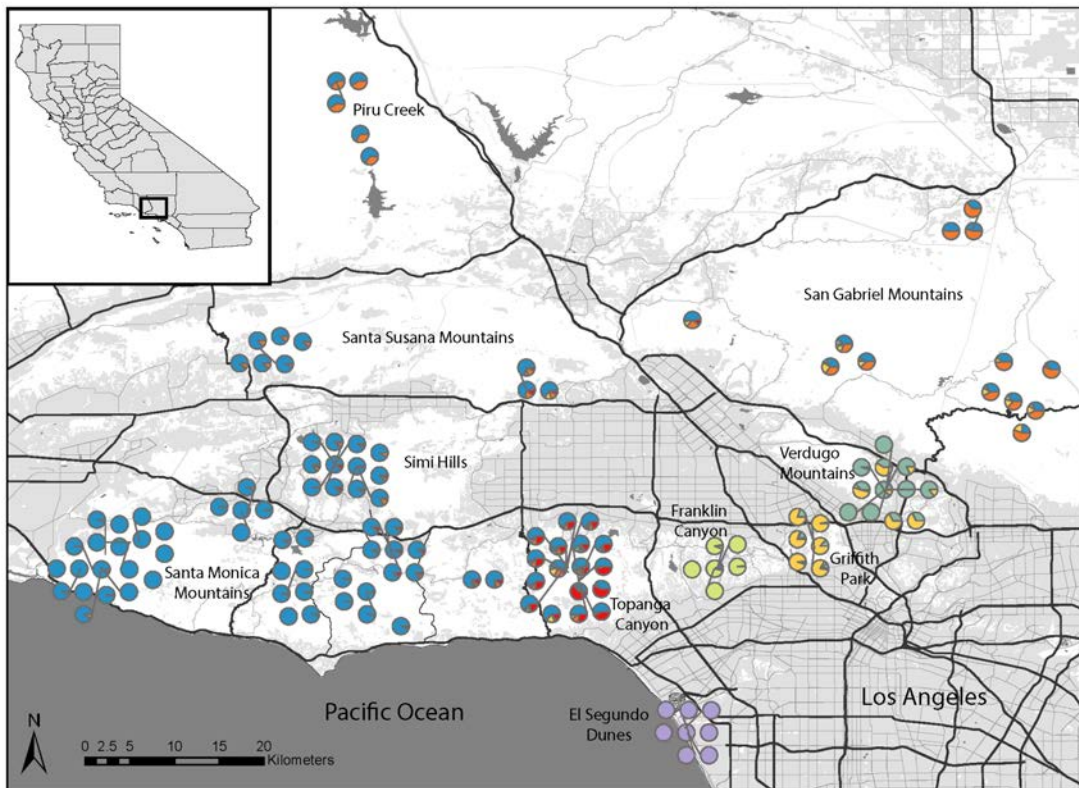


Figure 2. Map of the study region in northern Los Angeles and Ventura Counties showing major roadways and land use. White indicates natural parklands and undeveloped open space; grey represents residential, commercial/industrial, agricultural, and developed parkland. The pie charts summarize the genetic composition of each individual horned lizard included in the study based on Bayesian assignment tests. Data sources: Southern California Association of Governments and Geographic Data Technology, Inc.

**Methods & Analyses:** I obtained 134 tissue samples from several mountain ranges in northern Los Angeles County, including samples collected for a long-term monitoring program at Santa Monica Mountains National Recreation Area. I developed a SNP dataset using RADseq, a method of reduced-representation genomic sequencing, due to its cost-effectiveness and power in detecting fine-scale population structure with limited sample sizes (Andrews et al. 2016; Vendrami et al. 2017). I used a Bayesian clustering algorithm to estimate population genetic structure (STRUCTURE; Pritchard, Stephens, and Donnelly, 2000) and calculated pairwise differentiation between broad sampling localities (GENODIVE; Meirmans and Van Tienderen 2004). To assess the effect of landscape variables on functional connectivity, I used gravity models, a type of network model which correlates genetic distances to the product of three components: at-site variables, between-site variables, and geographic distance (Murphy et al. 2010). The models were built based on ecological

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variables hypothesized to be important in facilitating or impeding gene flow among populations of Blainville's horned lizards (Fisher, Suarez, and Case 2002).

Results: There are high levels of pairwise genetic differentiation among sampling regions, and notable population genetic structure among individuals occupying small habitat fragments that are heavily isolated by urban development. This indicates that there are low levels of gene flow among most localities in the study region. After model competition, the top performing model contains all ecological variables tested in this study. Only a subset of the components of the final model have a significant effect size, including geographic distance, time since last fire, heat load index, compound topographic index, % shrub cover, degree days > 5, and annual drying index.

Discussion: Population and landscape genetic analyses provide evidence for a role of the environment, including recent human-mediated habitat fragmentation, on patterns of functional connectivity and fine-scale population genetic structure for Blainville's horned lizards in the Los Angeles region. Tests for population genetic structure reveal 7 genetic demes (groups): Santa Monica Mountains, Simi Hills & Santa Susana Mountains; Topanga Canyon; Franklin Canyon; Griffith Park; Verdugo Mountains; San Gabriel Mountains and Piru Creek; and El Segundo Dunes. Contrary to our expectations, individuals from the Santa Monica Mountains, Simi Hills, and Santa Susana Mountains all are assigned to a single genetic deme, indicating high levels of gene flow despite the presence fragmentation within and among these regions, including two major freeways (US-101 and SR-118) which create discrete boundaries. Past studies have indicated that the roadways and the intervening urbanization in this area act as strong barriers to gene flow in small- and large-ranging species (Delaney, Riley, and Fisher 2010; Riley et al. 2006). The lack of a signature of population structure among these regions may be due to a time-lag in the genetic signature of barriers to gene flow (Richmond et al. 2009). Conversely, populations occupying habitat fragments in the eastern Santa Monica Mountains and Verdugo Mountains have notably high levels of population differentiation and genetic structure, and likely have small effective population sizes due to very limited connectivity and available habitat. Additionally, landscape genetics reveals a strong influence of climatic variables, vegetation composition, and fire history on functional connectivity of populations. These results combined with those of the population structure analysis highlight the importance of natural and anthropogenic features of the landscape when determining how best to restore connectivity for the long-term persistence of isolated, relictual horned lizard populations (Crooks and Sanjayan 2006). The findings of this study highlight the importance of understanding fine-scale patterns of gene flow among populations to develop effective management strategies in the face of further landscape change and urban development (Balkenhol et al. 2016; van Strien et al. 2014).

Acknowledgements: I owe all of the success of this project to an extensive amount of research and funding support. First, I thank my Master's thesis advisor JM Robertson at California State University, Northridge; MA Murphy at the University of Wyoming; KS Delaney (NPS); JQ Richmond (USGS); and GB Pauly (NHMLA); and many others for their support in navigating research and life. Secondly, I thank the Horned Lizard Conservation Society for helping provide the funds for this project and for supporting horned lizard conservation in general.

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# 2021-2022 Board Candidates

Mason Lee assumes the Presidency as she has been the HLCS President-Elect under the out-going President, Leslie Nossaman. Elections for our new leaders occur every two years and we have a great slate for the incoming board. Enclosed with this issue of Phrynosomatics, is the ballot for our incoming Board of Directors. If HLCS has your email, we will be sending an email with a digital voting process. We've included an autobiography for each candidate on the ballot so you can get to know them. Tear the ballot out of the newsletter on pages 7 and 8. Please make your selections and mail the completed, stamped, and stapled ballot to the address preprinted on the reverse side of the ballot by November 30, 2020. Thank you for voting!

## **Cheryl Jenkins – President-Elect**

Hello, my name is Cheryl Jenkins and I am running for President-elect of the Horned Lizard Conservation Society. My love for horned lizards began at a very early age growing up surrounded by them in rural and sub-urban high desert areas of New Mexico. My passion for nature, wildlife, and conservation grew from there and inspired me to pursue a career in wildlife biology.

After relocating to California, I attended San Diego State University and earned a Bachelor of Science degree in Biology. During my senior year at SDSU, I was President of the Field Biology Club which involved planning and attending meetings, fundraising efforts, field trips, volunteer events, and community outreach programs. Around that same time, I also began an internship at a local environmental consulting company which transitioned into a full-time position as a wildlife biologist after graduation.

Over the course my 20-year (and counting) career as an environmental and wildlife biologist, I have had the opportunity to participate in training programs and extensive general and focused wildlife surveys involving California native reptile species including flat-tailed horned lizard, Mojave fringe-toed lizard, blunt-nosed leopard lizard, and desert tortoise. This work included interpreting and applying the Flat-tailed Horned Lizard Rangewide Management Strategy (FTHL ICC 2003) to provide protocol FTHL surveys and monitoring for several large renewable energy projects in Imperial County, California. I also provided oversight and project management for a flat-tailed horned lizard translocation project at the Marine Corps Air Station Yuma's Barry M. Goldwater Range in which over 500 flat-tailed horned lizards were translocated from a construction area to designated plots within the Yuma management area.

For the past two years, I have been working as an Environmental Biologist for the City of San Diego where I specialize in herpetology, ornithology, ecology, environmental compliance, and native habitat restoration. In my free time, I enjoy hiking, wildlife photography, volunteer work, and spending time with my husband and son. I am currently an active member of the San Diego Herpetological Society Junior club which provides outreach and education about reptiles and amphibians to our future generations of budding conservationists. I am currently serving as one of the southern California representatives for the HLCS, and I organized and lead a field trip for HLCS members last year to search for flat-tailed and desert horned lizards in the Yuha Desert management area near Ocotillo, CA. It would be an honor for me to serve as President-elect and future President of the HLCS and continue helping the Society grow and thrive.

## **Ryan Zach – Treasurer**

Ryan is a self-proclaimed Phrynosoma Addict with a passion for all Animals! Having spent the last 20 years working in Zoo's, He has turned that passion into a career. Ryan has a B.S. in Zoology from Southern Illinois University at Carbondale and is a United States Air Force Veteran and a proud Air

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HLCS Elections  
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2021-2022 ELECTION BALLOT

Please select a candidate below or write in a candidate of your choice. Please make sure the person has your permission to write their name on the ballot as a write-in.

President-Elect

\_\_\_\_\_ Cheryl Jenkins  
\_\_\_\_\_ other (write-in): \_\_\_\_\_

Treasurer

\_\_\_\_\_ Ryan Zach  
\_\_\_\_\_ other (write-in): \_\_\_\_\_

Secretary

\_\_\_\_\_ Dalton Neuharth  
\_\_\_\_\_ other (write-in): \_\_\_\_\_

Director At-Large

\_\_\_\_\_ Miranda Vespy  
\_\_\_\_\_ other (write-in): \_\_\_\_\_

YOUR NAME: \_\_\_\_\_

Ballots should be postmarked by November 30, 2020!

If you don't want to mail through the post, check your email for a digital vote process.

Be sure to add your name so we can keep track of it.



Force brat. Working to educate the general public about Reptiles is a driving force in his work. Further helping to stop the decline of Horned Lizards throughout their range has led him to his work with the HLCS. Ryan enjoys many outdoor activities and is a huge college football fan (Go Canes!) in his off time.

### **Dalton Neuharth – Secretary**

Dalton has been a nature-nerd since he was young. He grew up in central Texas and was often chasing frogs and small snakes. As he grew up, he developed a passion for wildlife research and conservation. He earned a BS in Wildlife and Fisheries Science from Texas A&M University, and worked there as a research assistant for a few years. Most of the projects he was involved in focused on lizard conservation, however he worked with a few other herpetofauna as well. He is currently finishing up his MS in Population and Conservation Biology at Texas State University, studying the responses of lizard communities to catastrophic wildfire. While he has never worked specifically on horned lizards, he has always held a special interest to him. He is particularly interested in the ecological role of species in their communities. He has been the Secretary of HLCS for the past two years, and looks forward to continuing by increasing awareness of lesser known species of horned lizards. He currently lives in Austin, TX with his two cats and fiancée.

### **Miranda Vespy – Director-At-Large**

After I received my Bachelor of Science in Biology from Youngstown State University in Youngstown, Ohio I relocated to central Oklahoma where I began a career in wildlife rehabilitation. During my years at WildCare Foundation, Inc., I held a leadership role overseeing a variety of interns, volunteers, and part-time caretakers. Pursuing a career more focused on applied conservation of threatened species, in 2014 I began working as a biological technician collecting field data for a research and monitoring project of Texas horned lizards at Tinker Air Force Base in Midwest City, Oklahoma. I have maintained an active role in this project since that time, transitioning from the role of technician to project leader as I began graduate school in 2017, focusing research on the population dynamics of young age classes of Texas horned lizards.

Throughout my time with the project, I have enjoyed many opportunities for community outreach and education about horned lizards with wildlife professionals, academics, and the public through a variety of presentation types and styles. I also maintained positive working relationships with biologists and other professionals from the University of Oklahoma, the Oklahoma Department of Wildlife Conservation, the Oklahoma City Zoo, and the United States Airforce. Most recently, I successfully defended my thesis entitled "Survivorship and Space Use of an Urban Population of Texas Horned Lizards", which is currently in review for publication with the Journal of Wildlife Management and received a Master of Science degree from The University of Oklahoma.



## **Horned Lizard Conservation Conference**

The rescheduled Horned Lizard Conservation Conference will be on May 15, 2021! We hope you will join us in good health at the Phoenix Zoo to celebrate the amazing accomplishments of horned lizard researchers from the past few years. We are excited to announce that our keynote speaker will be the illustrious Dr. Wade Sherbrooke. Dr. Sherbrooke has published over 60 papers and notes on horned lizard biology, in addition to publishing a wonderful book, "Introduction to Horned Lizards of North America."

Registration information will be made available at [www.hornedlizards.org](http://www.hornedlizards.org) in early 2021. Abstract submissions will also reopen in January 2021. Please contact Mason Lee at [masonmlee3@gmail.com](mailto:masonmlee3@gmail.com) for any questions and abstract submissions. In the meantime, we are accepting donated horned lizard items for our silent auction to help raise funds for horned lizard conservation grants!



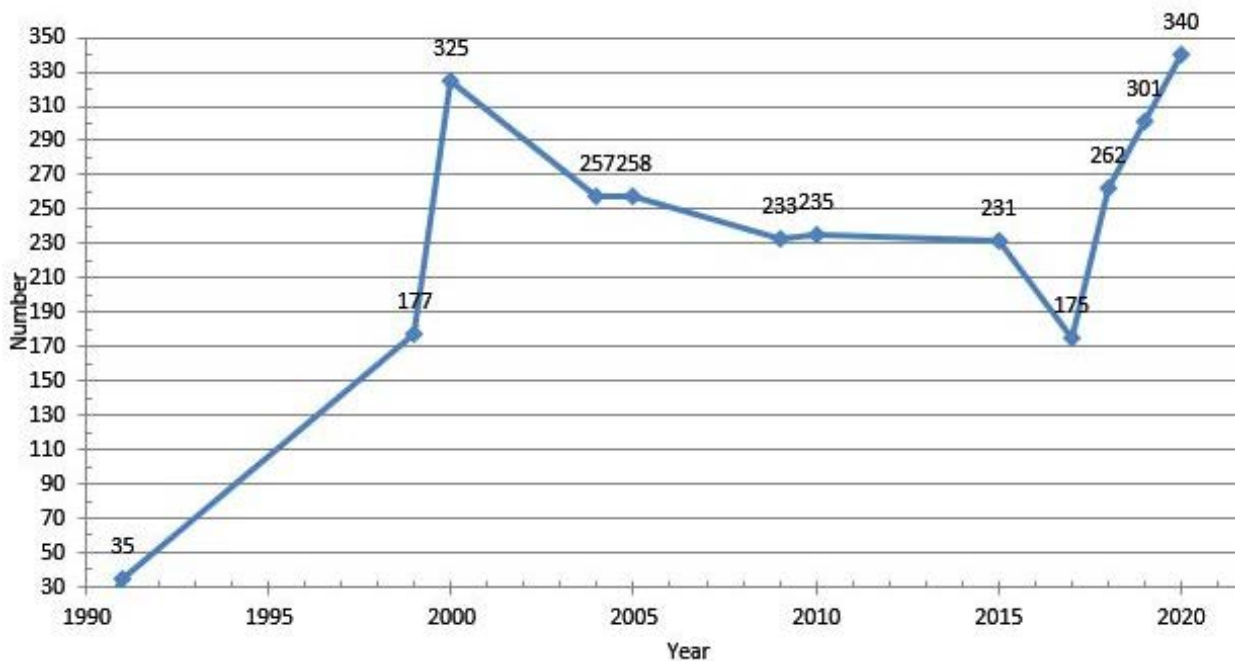
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Once you select the Horned Lizard Conservation Society as your charity to support, our society will receive 0.5% of the price of eligible purchases. And from then on, every purchase made through AmazonSmile will benefit the Horned Lizard Conservation Society. Every little bit helps!

## Membership numbers

Membership is at an all-time high. We are currently at 340 members with the last check in mid-October. It is predicted to continue to grow until the end of 2020. HLCS has seen a big jump in membership numbers over the past three years and is close to doubling in numbers from three years ago. There is still 2 1/2 months to go in 2020 so we might make it. The word is getting out that an organization exists to protect the horned lizard and people want to help with their membership and donations. We currently have members in 3 countries: Canada, Mexico, and the U.S. and may have another soon. In the U.S. we have members in 30 states and Washington DC which is also a big increase over the past three years. The graph indicates the number of members over the years.



## President's Message *by Leslie Nossaman*

With the new Board term poised to begin on January 1, 2021, this will be my last President's message. I am honored to have been your President the past two years. It has been such a dream come true for me to lead this wonderful organization that I have admired for so long. The Society has done so much to help the horned lizard and in the past two years has expanded into new countries and U.S. states, so we are now able to help additional species and ranges. The Society is set up to expand even further across their ranges in North America.

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I am also so grateful for this Board the past two years. Their ideas have been amazing and so has their commitment especially since it has been a tough two years of incredible growth and changes. It has required so much time on their part to participate in all decisions and discussions that we have had to make. We are a much stronger organization due to their efforts. Thank you, Lynn, George, Ryan, Mason, and Dalton. What an amazing group of people to work with! I also want to thank Taylor Dee who is our newsletter print manager for getting all these issues printed and mailed. This is not an easy task and is even more difficult to manage during a pandemic. Please consider going digital with the newsletter to help her reduce the printings and mailings and saving HLCS funds. And thank you to Amy Trost who checks our P.O. Box for mail and sends us a summary of what she finds each time.

I cannot name all the items and details here that have changed since our Board term started because there are so many. But almost everything has dramatically changed and improved: sales process, sales numbers, document storage – both digital and physical (in fact, all of our physical storage space), membership database, grant awards, banking, social media (Instagram, private Facebook member page, increase in Followers and posts), education materials, website, video series on horned lizard conservation on social media, YouTube channel, HLCS Regional Contacts, expansion into new countries and U.S. states and building new contacts, ... We also increased our funds by around 75% during the Board term so far which is significant and that was with a large amount of spend for all the growth and increases with our grant program. Thank you for all your membership and donations to support horned lizard conservation. It is being put to good work.

We also requested Dr. Wade Sherbrooke to write a paper creating a standard for horned lizard species and names. It also included what country they are found in. This was a major accomplishment as there has been so many different lists in previous publications and we are grateful to Dr. Sherbrooke for his expertise and time it took to write this paper. This will now set the standard. It has been reprinted in other publications, so the word is spreading. It is important to have a common language and terminology when discussing horned lizard species. Check the February 2020 issue of *Phrynosomatics* for the article and share it with your friends, family, and colleagues.

We also have new sales items and improved other sales items, business frame, professionally made National Geographic videographer video, increase in media interviews, increase in donations, increase in membership, ... We have also been asked to participate in some horned lizard reintroduction releases which had not happened until last year. We have also been addressing some pet trade issues in states such as Washington and Nevada. And have sponsored some fantastic horned lizard field surveys in the Yuha Desert in Southern California and in Central Texas. We have continued to rescue horned lizards taken from the wild which saw an increase in people contacting us this past two years. People are more aware of our presence than ever.

Different groups are now contacting HLCS for our expertise in horned lizard conservation and to partner with us. We also took a major member survey in 2020 that has helped HLCS with ideas on how to improve our website and what we do as an organization that we have already been addressing. It will also provide a baseline when we can provide the survey again years from now. Thank you to everyone who participated.

This new slate of candidates for the election look so wonderful. If everyone is elected, the Board will have members in five U.S. states and all four time zones! Please take the time to vote.

I am just so grateful to all the people who have helped this organization become so successful the past two years and the previous years too. And I am so excited by its future.





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