

**TRANSCRIPT**

**INTERVIEWEE:** Dean Williams

**INTERVIEWER:** David Todd

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**David Todd** [00:00:01] There we go.

**David Todd** [00:00:02] Well, good morning. I'm David Todd.

**Dean Williams** [00:00:06] Morning.

**David Todd** [00:00:06] Thank you. Good to be with you.

**David Todd** [00:00:09] I have the great privilege of being here with Dr. Dean Williams.

**David Todd** [00:00:14] And with his permission, we plan on recording this interview for a research and educational work on behalf of a non-profit group called the Conservation History Association of Texas, and also for a pending book and an existing website for Texas A&M University Press, and finally, for an archive at the Briscoe Center for American History, which is based at the University of Texas at Austin.

**David Todd** [00:00:43] And I want to stress as well that you would have all equal rights to use the recording as he sees fit. It is his.

**David Todd** [00:00:51] And I wanted to just check in with you and make sure this is all okay with you before we proceeded any further.

**Dean Williams** [00:00:58] Yes, definitely.

**David Todd** [00:01:00] Good, good, good. Well, let's get started, then.

**David Todd** [00:01:05] It is Tuesday, September 12th, 2023. It's a little after 10:20 Central Time.

**David Todd** [00:01:13] My name is David Todd, and I am representing the Conservation History Association of Texas, and I'm in Austin.

**David Todd** [00:01:21] We are conducting a remote interview with Dr. Dean Williams, who is based in the Fort Worth, Texas area.

**David Todd** [00:01:30] Dr. Williams is a biology professor at Texas Christian University and earlier worked at the University of Miami and Purdue University as well. Dr. Williams has been interested in population biology and behavioral ecology and more recently is focused more on conservation and invasive genetics, and how pest and species of conservation concern can be managed.

**David Todd** [00:01:57] One especially interesting current project focuses on learning more about the population structure and dispersal of Texas horned lizards and to help with their reintroduction.

**David Todd** [00:02:10] Today, we'll be talking about Dr. Williams' life and career to date, and especially focus on what he has learned about the history of horned lizard study, conservation and restoration.

**David Todd** [00:02:26] So, that's a little introduction to what we're up to today.

**David Todd** [00:02:29] And I thought that as a first question for Dr. Williams, we might ask him to tell us about his childhood and early years, and if he's able to point to any people or events of that young life that might have influenced his interest in animals and science and conservation.

**Dean Williams** [00:02:50] Yeah, definitely. So, probably. So, I was born in Iowa - Cedar Rapids, Iowa. When I was five years old, my parents moved to Central Africa, in the country of Burundi, and I grew up in Burundi and also some in Kenya for much of my younger life. And I think that probably had the biggest influence, you know, in terms of experience in me becoming interested or being interested in animals, plants, biology. I can pretty much since, you know, I was probably six, seven years old, this has probably been something I've always been interested in. Of course, when you're younger, you don't know exactly what it is you would be doing and stuff with this.

**Dean Williams** [00:03:43] But, you know, I did a lot of hunting and fishing with my dad growing up. In Burundi and Kenya, I collected butterflies all the time. I went out and found skeletons and skulls, dead animals. My mom was very, very patient. She let me stick dead animals in the freezer and bring them into my room and do dissections and taxidermy. And so, all of that stuff together, I was always interested in biology, basically.

**Dean Williams** [00:04:24] When I was really little, I mean, probably, there's a few people that, when I was really young, probably had a big influence on me, other than my dad and my mom, in my love of the natural world. There was an old lady that lived next to my parents when I was really little, Aunt Marjorie was her name, and she would take me out and we would catch ladybugs and dig up earthworms in the garden, do stuff like that.

**Dean Williams** [00:04:52] And my grandma kind of did the same thing and had a large garden. And so, I spent a lot of time with her there. We went out in the woods a lot together, looking for Indian arrowheads in fields, and did a lot of that.

**Dean Williams** [00:05:07] There was another woman at that time who also collected butterflies as a hobby, and she's the one that taught me how to catch butterflies, how to pin them, and mount them, and do all of that.

**Dean Williams** [00:05:21] So, I would say those people definitely had a big influence on me.

**David Todd** [00:05:29] That's fascinating. So, sounds like both immediate family and then neighbors and a grandmother.

**Dean Williams** [00:05:37] Yeah.

**David Todd** [00:05:37] Added a little bit to the mix.

**Dean Williams** [00:05:39] Yeah. Yeah.

**David Todd** [00:05:42] The whole spectrum: from hunting to fishing, butterfly collection, earthworm harvests.

**Dean Williams** [00:05:48] Yeah. Yeah.

**David Todd** [00:05:50] And bringing some of these home as well.

**Dean Williams** [00:05:54] Yeah. Yeah.

**David Todd** [00:05:58] Were there any tears, young people, or is this more like a generation-to-generation transfer?

**Dean Williams** [00:06:05] This is more, probably more generation-to-generation transfer.

**Dean Williams** [00:06:10] Yeah. I, you know, certainly growing up in Burundi and those places, I mean, we were kind of in the middle of nowhere where we lived. And, you know, it was pretty much just me and friends, you know, my Burundi friends and stuff that would take me around, show me stuff, go hunting together. Do all of that.

**David Todd** [00:06:35] And may I ask, what took your family to Burundi? That's not the typical stop for most people.

**Dean Williams** [00:06:41] Yeah, they were missionaries. Yeah.

**Dean Williams** [00:06:50] So, yeah, I came back to the U.S. for the final time when I was into my junior year of high school. So, there was a lot of political upheaval in that country at that time. You know, that was, if you ever saw Hotel Rwanda, I mean, that was the kind of stuff going on there. It was, you know, difficulties between the Tutsis and the Hutus there. And so, we had to leave the country at that time because of that, you know, the problems between the tribes and stuff.

**Dean Williams** [00:07:29] So, I finished off my senior year in high school here in the U.S. and then I've been here since.

**David Todd** [00:07:37] Well, so, I'm curious if, you know, you spent maybe close to a dozen years in Africa, a very different place from the United States. And did you find any sort of kind of interesting insights or perspectives that you got from folks who were from Burundi or from Kenya, who might have a different attitude or knowledge about the natural world?

**Dean Williams** [00:08:06] I don't know if I would say it was, maybe it was more of an awareness of the difficulties of conserving wildlife and natural areas in many of these places, just due to, you know, people's needs, how they make their livelihoods, things like that.

**Dean Williams** [00:08:34] You know, at that time, in Burundi, for instance, much of the large mammals, you know, many of the large mammals like cape buffalo, elephants and stuff like that, really were starting to disappear in that area of Africa at that time just because of human

population density, some of the highest densities in the world, basically, per kilometer. And, you know, it just pushed out a lot of those large animals and stuff.

**Dean Williams** [00:09:07] So, I kind of got to see, or witness that, firsthand. I guess maybe that was instructive seeing, you know, I was at that cusp at that time when I was there, when I was really little, you know, some of the last elephants, some of the last cape buffalo that came into that country were seen. And then, since that time, have not been seen since, right.

**Dean Williams** [00:09:34] If you go further east into Tanzania and those places, they still exist in places obviously. But, in that part of Africa, yeah, they started to disappear quite a bit at that time.

**David Todd** [00:09:48] Did that disappearance of these large mammals garner much attention, discussion, you know?

**Dean Williams** [00:09:56] Not within, not locally. I mean, you know, because most people were concerned with just getting enough food and living their lives and doing that there. You know, so, those kind of concerns at that time were not big on people's radar.

**Dean Williams** [00:10:13] I think more so in places like Kenya and Tanzania with the national parks and stuff that they had there that was maybe talked about, thought about more than, you know, some other places.

**David Todd** [00:10:28] Well, was the difference between Kenya and Burundi sort of a factor of whether there was an established park system, protected lands, guides, interpreters?

**Dean Williams** [00:10:40] Oh, yeah. Yeah, I mean, places like Kenya and Tanzania would have had, had a much more developed park system historically. You know, they had a much longer history with that.

**Dean Williams** [00:10:57] Burundi had had a couple, but they were small, you know, not big enough to hold lots of large game and stuff, but. Well, yeah, there was definitely a difference there.

**Dean Williams** [00:11:10] And Burundi, and Rwanda for a long time, I mean, has so much political upheaval for so long - genocide and things like that - not, not really conducive to thinking about conservation, you know, when that's going on. So, I think a lot of times that was not the first thing on people's minds. Basically, they had much more pressing concerns.

**David Todd** [00:11:35] So, in a sense, these conservation matters were maybe just a luxury that people couldn't afford when they were really worried about their livelihood or their life.

**Dean Williams** [00:11:44] Oh, right. Yeah. Oh, yeah, definitely. And that's, I mean, that's not an uncommon situation in a lot of the developing world.

**David Todd** [00:11:57] Well, so there were these people that were in your life, your parents, of course, Aunt Marjorie and your grandmother.

**Dean Williams** [00:12:06] Yeah.

**David Todd** [00:12:06] Of course, you also were leading a life in school. And I'm wondering if there were any classmates or teachers during grade school, or maybe later when you were at college or University of Alabama in Huntsville, Purdue, and then University of Miami.

**Dean Williams** [00:12:23] Yes.

**David Todd** [00:12:23] I mean, you've had a long educational trajectory. Did you find that there were some classmates or teachers that were important mentors or supporters there?

**Dean Williams** [00:12:36] I would say probably, you know, the biggest, the biggest change was going ... to college. So, as a high school, elementary school, middle school, all that, you really didn't, you know, I always wanted to, but there just really wasn't a lot of, I guess, opportunities to learn about biology, zoology, conservation, that kind of stuff. It just, at that time that just wasn't that common. And when I finally got to college, it was like, "Oh, I get to study stuff I'm really interested in."

**Dean Williams** [00:13:14] So, that was probably the, the biggest change, I think, there.

**Dean Williams** [00:13:19] And then I went to Coe College, a small liberal arts college in Cedar Rapids, Iowa, and there was a professor there, Harlow Hadow. He was my advisor. And he also encouraged me to do their study abroad program to Costa Rica for a semester, to go, and basically you go to Costa Rica for a semester. You lived with local families. And you had to do an independent research project as part of that. You also took Spanish classes and other classes about Costa Rican history and stuff.

**Dean Williams** [00:13:55] And so I went in my senior year, in high school, I went and did that program. And at that time, when I was there, for my independent research project, I met a woman named Marcy Lawton. Her husband, Bob Lawton, was also there. They were both professors from the University of Alabama in Huntsville. And she asked if I wanted to work on a project she had started, which was a while ago, which was working on cooperative breeding in brown jays.

**Dean Williams** [00:14:31] And so, I did that with her that semester and then ended up going and doing a masters with her at the University of Alabama in Huntsville. And then I continued on studying those birds for my Ph.D. as well at Purdue University with my advisor, Dr. Kerry Rabenold.

**Dean Williams** [00:14:55] So, you know, those people probably had a really big effect on my trajectory to where I am now.

**Dean Williams** [00:15:04] You know, I often think of, you know, a lot of this as kind of serendipity. I mean, starting when I started thinking about going to graduate school and things like that, I had really no idea, per se, in what it was I wanted to work on. Butterflies had always interested me, as I mentioned before, and I could have gone that direction. I also like birds. I was very interested in that.

**Dean Williams** [00:15:29] And so, when I was in Costa Rica, you know, I had met Marcy. We were supposed to find an in-country advisor to work on a research project. Right? And I had been ... there was somebody else that I had thought about working on - this person was working on quetzals. But, we realized that just wasn't a project that would probably work,

especially in the short term. And I happened to just meet Marcy walking through the woods one day, you know, and I just started talking to her on the path.

**Dean Williams** [00:16:08] And that's how it all started, right? I mean ... I don't know if I hadn't been walking on that path that day, my life probably would have taken a completely different trajectory. Right? You know, when you go back and you think about those kind of chance encounters, it's kind of weird, right, that you don't know, really, what path you're going to end up on, you know. And so, you just take the opportunities as they come up and, you know, who knows what's going to happen.

**Dean Williams** [00:16:41] And so, yeah, you know, it turned out that that was a good move, really.

**Dean Williams** [00:16:45] And I worked with that population for a long time. I worked in Costa Rica for a number of years - off and on from about 1988, probably until 2002. I spent a lot of time in Monteverde, Costa Rica, which is where the study area was, and that was a very productive system. So, I was basically looking at cooperation and conflict in social groups of this bird, brown jays. So, I was looking at their population demography, behavioral ecology and stuff over a long time, over that long time. So, that had definitely a big effect.

**Dean Williams** [00:17:31] And it was really that project in my Ph.D. where I started using genetic techniques, because at that time DNA fingerprinting had just been developed and was starting to be used by ecologists and behavioral ecologists, and it allowed you to basically determine who the parents were within these social groups. Right? We could do paternity and maternity testing for the first time relatively easily, accurately.

**Dean Williams** [00:18:01] And so, that was the impetus for me starting to to use molecular techniques and so on. I first started with DNA fingerprinting, and we looked at paternity within these social groups and found out how closely related individuals were within groups, who was breeding with who, which individuals were dispersing, things like that.

**Dean Williams** [00:18:24] There was also a marker that was developed, a genetic marker, to determine the sex of birds at that time as well. This was all during my Ph.D. And I started using that. And, you know, once you knew who was a male or female (because you couldn't tell males and females apart otherwise), that just opened up this whole new perspective on the system, knowing, knowing who is breeding with who, and knowing who males and females were.

**Dean Williams** [00:18:56] And that made me realize, really, using these kind of genetic techniques, in a way, you're looking at the hidden life of animals, things that you just can't see by observing, you know, or that's very difficult to figure out, just through observation.

**Dean Williams** [00:19:14] And so, really, it was, it was this kind of really cool thing that, you know, it's really relatively simple. If you can get the genetic material and you can learn so much that you just have no idea.

**Dean Williams** [00:19:29] I mean, with this species, we found, for instance, that it's one of the few bird species that has male-biased dispersal. Most, many, birds or most birds so far that have been studied, you have female-biased dispersal, which is the opposite of mammals. In mammals, you tend to have male-biased dispersal. But this bird also had male-biased

dispersal, and we would not have known that really had we not been able to do the testing to determine the sex of these birds.

**Dean Williams** [00:20:03] But, once that was done, you start looking at the field notes, you realize, "Oh, all these birds that moved from one group to the other, those are all males." Or if you would see a bird just hanging out next to the territory of another one by itself.

**Dean Williams** [00:20:20] When you go back and look at that, you know, "Oh, those are all males." They were just checking out the neighboring groups, seeing if they could get in or not, you know. And they would disperse in little coalitions of brothers or, you know, maybe a little bit of cousins, brothers and cousins. So, the males would disperse together, just like, you know, in lions or something, where you have coalitions of males that then disperse into a neighboring group. And those, the neighboring group, would always chase them around, try and get them out. But if they stuck together in that little coalition, they could usually outwait everybody and then maybe be accepted into the group, you know, and eventually they would, you know, one of those males would breed and stuff.

**Dean Williams** [00:21:03] And so, so you had a situation.

**David Todd** [00:21:08] Fascinating.

**Dean Williams** [00:21:08] And females would stay in their natal group, generally. Rarely did females disperse. And the nesting and stuff was kind of passed down through the matriline. You know, basically, a mother's daughters and stuff would take her place when she died.

**Dean Williams** [00:21:30] So, yeah, but without having had access to that genetic information, we just wouldn't have figured a lot of this out, certainly not in that timeframe. So, that was very eye opening.

**Dean Williams** [00:21:45] And then, when I moved, after I finished my Ph.D., I moved to the University of Miami to do post-docs, and that's when I started using genetic methods to look at invasive species and also reef fish and things like that. You know, I kind of learned more techniques at the University of Miami. Dr. Collin Hughes, the first person I did a post-doc with, he really taught me a lot about developing microsatellite markers and all this kind of stuff.

**Dean Williams** [00:22:20] So, I learned a lot at the University of Miami, actually, started doing a lot of different techniques and working in a lot of different systems there. And so, that really started my work with invasive basic there.

**Dean Williams** [00:22:35] And then when I moved here, that's when I finally, you know, started switching to some other stuff like Texas horned lizards.

**David Todd** [00:22:44] Okay. Well, this is so fascinating. And I think you're, it's so fortunate when you are at a point where the curtains are pulled back and, you know, you see something that is absolutely new and unobserved.

**Dean Williams** [00:22:59] Right.

**David Todd** [00:22:59] And, you know, you're developing these new tools, these genetic methods that you're talking about. So, I'm curious about your relationship with your teachers, your mentors and professors, you know, what it was that they were imparting, whether it

was, you know, this, a world of facts, or a toolkit of genetic methods, or if it was a love and passion for this kind of research, or all th above.

**Dean Williams** [00:23:33] Oh, some of all of the above. But you know what? Some of this, I mean, obviously learning different techniques and stuff, you know, that has stuck with me.

**Dean Williams** [00:23:40] But, probably one of the bigger things, I think that I've realized over time. With Bob and Marcy, sitting with them in the house in Costa Rica and them talking about, you know, stuff they were doing. So, Bob worked on, he worked in the Aliphan forest, in the cloud forest. So, he worked with trees and tomography and stuff like that. And Marcy was more behavioral ecology. She worked with the brown jays. So, you know, listening to their conversations, and also talking with Kerry Rabenold, and stuff like that, it was more, I think the thing that was more interesting always to me was how they thought about questions, and their approach to trying to figure things out, more so than the information per se.

**Dean Williams** [00:24:32] And that was definitely true in grad school too. I was always more interested in what the professor thought about a particular theory or study, and what their rationale was for thinking what they thought. That, to me, I thought was always more useful long-term than just the facts of what we were learning. It was more kind of the process of how you go about thinking about stuff. What were their strategies? What was their rationale for thinking this hypothesis might be better than another one? What lines of evidence would you need to, you know, address this or that hypothesis. I think that probably, you know, had more of a, more of an impact in the long term.

**David Todd** [00:25:26] I think that's really interesting, because, you know, when you read in the paper and this may be a long aside, is that, when folks talk about science, they seem to think of it as this body of knowledge and not an inquiry of trial and error and hypothesis testing and...

**Dean Williams** [00:25:41] Right.

**David Todd** [00:25:42] And it sounds like you're talking about it more as the latter, that it's this, you know, method of looking at the world in a pretty structured way and trying to take insights from that. Is that right?

**Dean Williams** [00:25:56] Yeah. Yeah, I think that is. Because information, I mean, there's too much information out to know, really.

**Dean Williams** [00:26:01] I mean, yeah, I know Kerry Rabenold told me, you know, he had gotten his Ph.D. in the seventies, Marcy and Bob, and he was saying, like when he was doing his dissertation, he pretty much really could have read, and did read, all the important papers in ecology at that time.

**Dean Williams** [00:26:22] That would not even be close to being possible - even a subfield of ecology. It would be, I could say at one time I probably had read every single cooperative breeding paper there was. There was quite a few at that time when I was doing my Ph.D. and stuff. Now I've gotten behind even in that field I could not say that anymore.

**Dean Williams** [00:26:47] And so, yeah, information, per se, it's useful, but there just gets to be so much of it, and then it's, now, obviously constantly changing, being tweaked, being



updated. You know, so that learning a bunch of facts, per se, is not very useful. I mean, it is useful, but not in a way, I guess I would say.

**Dean Williams** [00:27:17] Much more, it is more useful learning how to take that information and put it into a larger context, or take that information and be like, "Okay, what needs to be done next? What is it that we don't still know?" Things like that: I think that's more interesting or useful in the long term. Memorizing stuff really isn't that useful, especially now because you can just look it up. I mean, you know, all that stuff is actually right here online, right? So, even memorizing stuff isn't much now. Just doesn't seem as useful, I guess. I don't know.

**David Todd** [00:28:04] Well, this is, it's really great to get a little insight about how a working scientist thinks about science. I mean, it's something, you know, it's like the fish in the sea. This is, you know, what do they say about being wet?

**Dean Williams** [00:28:20] Yeah.

**David Todd** [00:28:22] Thank you very much.

**David Todd** [00:28:23] So, I wanted to ask you about other ways you might be absorbing an interest and passion for natural science and these kinds of inquiries. Some people we've talked to talk about the general culture and this sort of osmosis of you pick up things from books and TV shows and movies.

**Dean Williams** [00:28:44] Right.

**David Todd** [00:28:45] Was that a factor for you?

**Dean Williams** [00:28:48] Somewhat. Now, the one thing, though, that was different, you know, when I was much younger, there's so much more stuff available now in terms of like TV shows and just books and online stuff. I mean, you can find out so much so easily compared to then. I mean, there just wasn't a lot of wildlife shows, you know, when I was little, even things like field guides. I mean, there were field guides and stuff, but not compared to what there is today.

**Dean Williams** [00:29:18] And so, probably, you know, Wild Kingdom - that is a classic. I mean, I'd watch that when I was in the States. We would watch that every week. I mean, that was definitely I liked that, growing up. That was a big thing.

**Dean Williams** [00:29:32] Had a lot of magazines in the house. You know, my dad had Field & Stream and Outdoorsman. I was always reading those ... hunting magazines, National Wildlife Federation, International Wildlife Federation magazine, National Geographic, you know. I'd always get field guides for Christmas or my birthday - birds or butterflies or whatever it was that I wanted a field guide for. But there really wasn't that many at that time. And now, if you wanted field guides as a kid, you can get just ones from all over the world, you know. That stuff just wasn't as common.

**Dean Williams** [00:30:14] I mean, I think that's definitely been a big change growing up is that a lot of that information, it's much more readily available now. So, if you were a kid now, you could just have access to so much stuff. That would have been great when I was a kid.

**David Todd** [00:30:33] And just to sort of pin down what period of time you're talking about: you were born in what year?

**Dean Williams** [00:30:38] So, '64. So, late sixties, you know, so this would have been in the seventies especially. Yeah. Just a lot has changed since then.

**David Todd** [00:30:50] Yeah, it is amazing. Oh, it must be like a torrent now - the fire hydrant.

**Dean Williams** [00:30:55] Yeah. Yeah.

**David Todd** [00:30:59] Well, that's interesting. So, of course, a lot of what you probably have worked with is one-on-one contact with the animals that you're studying. And I was wondering if you can recall your first encounter with the animal of the day, the horned lizard, one of the many horned lizards. Can you remember that first meet-up that you might have had?

**Dean Williams** [00:31:25] Yeah. I mean, you know, I'd seen them in pictures and stuff like that, but the first wild one, I think, was at the Matador WMA up in the Panhandle in Texas. So, this was after I had moved to Texas and started working at TCU, and we were going to start this Texas horned lizard project. And I decided to do this project before I even had ever seen one. I mean, I knew what they looked like, I but I mean, one that's actually in the wild, right.

**Dean Williams** [00:31:54] So, we went up there to the Matador to look at some methods of sampling them genetically, try some different things, catch some, see how it was.

**David Todd** [00:32:07] Well, so, you were saying you were at the Panhandle, at the Matador?

**Dean Williams** [00:32:12] Yeah.

**Dean Williams** [00:32:13] And you're trying to develop some of the new methods of trapping and study that might work for them?

**Dean Williams** [00:32:20] Yeah, ways to sample DNA, basically. So, Chip Ruthven, he was there. He's still up there. Actually, he's the guy that runs, is in charge of the WMA up there. And he had worked with horned lizards there and in South Texas. And he would always, at the Matador, as he drove around and stuff, which he would do on a consistent basis, he would always catch them, mark them, measure them, and put them back.

**Dean Williams** [00:32:51] And so, he had a pretty good handle on them there. And so, he showed us where they were. And then, the first one I saw, it was just driving along the road slowly and you'd see it on the edge of the road and we jumped out and grabbed it.

**Dean Williams** [00:33:08] And I remember at that time that the thing that struck me was like, "Wow, these are easy to catch." You know, once you see ... I mean, compared to other lizards, at least those that I had had some experience with, I mean, yeah, much, much easier to deal with.

**Dean Williams** [00:33:25] Because, I mean, they're not running 100 miles an hour, or trying to bite you the whole time you're holding them, you know.

**Dean Williams** [00:33:32] So, I think that was the first thing that kind of struck me is just how passive they really are.

**Dean Williams** [00:33:38] And the hard part is, of course, seeing them and finding them. But once you do, it wasn't so hard.

**Dean Williams** [00:33:47] And so, we were able to figure out at that time that we could do swabbing. Basically, it was a non-invasive way. You know, traditionally what people have done is cut off a toe. We would use a toe both to mark them by a missing toe, and then you could use that toe for DNA. And, you know, Chip had been doing that for many years, and he had given us a number of toe samples actually, that we got DNA from.

**Dean Williams** [00:34:16] But in the long term, we kind of wanted to see if there was another way. And so, we used just cotton swabs that we swabbed their cloaca and we were able to get enough cells from that to get DNA from.

**Dean Williams** [00:34:33] We originally were going to swab their mouths, but when we got out there, we found that and started trying this, we found out, they just don't open their mouths, really, when you catch them. Nor do they want to open their mouths when you try and put a swab there.

**Dean Williams** [00:34:48] It's totally different than a lot of lizards, because a lot of lizards are trying to bite you and stuff when you're holding them, so it's pretty easy to get a cotton swab in their mouth when they have it open.

**Dean Williams** [00:34:59] But horned lizards, so we had tried using guitar picks to kind of open the mouth a little bit and get the swab in there. And it was just like, gosh, it just took too much time, and then started worrying about, well, maybe you could accidentally hurt their jaw or something.

**Dean Williams** [00:35:13] So, realized that, yeah, we could just turn them over and just do the cloaca in less than 30 seconds, and we were done. We had a sample and it worked great.

**David Todd** [00:35:25] Now that's great. I love this sort of story of riding down the road and you see one. You've got your quarry in your sights and they're so curiously placid.

**Dean Williams** [00:35:37] Yeah.

**David Todd** [00:35:43] So, tell us, at this point, for those who are familiar with this really interesting creature, a little bit about their life history and the ecological niche that they might be filling. Maybe you can give us a sort of a primer on that.

**Dean Williams** [00:35:59] Yeah. So, Texas horned lizards occur over a fairly large range, actually, and historically a really large range - so, northern Mexico, most all of Texas, Oklahoma and Kansas, over into New Mexico, Arizona. So, fairly wide-ranging, occur across a number of different habitats.

**Dean Williams** [00:36:25] They are ant specialists. So, this is a species that eats mainly ants and so that has kind of, in a sense, it's been a kind of a selective force for its lifestyle it's believed to some degree, in that, you know, if you eat ants, you have to eat a lot of ants to get enough nutrition because ants are not a great food source, really. And so, organisms that eat

ants usually have to eat a lot. And so, horned lizards actually have a much larger stomach for their body size than other lizards, and that's so they can pack all those ants in there.

**Dean Williams** [00:37:12] But the fact that they have this kind of large stomach for all these ants, it kind of enforces this kind of tank-like body structure. So, they're not super fast runners, and that's not really part of their lifestyle is running down, you know, running away from stuff or climbing trees all the time, things like that.

**Dean Williams** [00:37:41] Instead, they're kind of close to the ground.

**Dean Williams** [00:37:45] And so, they rely on crypsis, as well as a variety of, you know, spines and horns, things like that, to basically either not be found by predators, or, if they are found by predators, the horns and stuff can discourage some types of predators.

**Dean Williams** [00:38:07] They have a number of defensive things that they use to keep from being predated. They'll puff up or flatten out to try and make themselves larger or in a shape that predators can't really, you know, swallow or grab a hold of.

**Dean Williams** [00:38:26] And they also have this blood-squirting ability where they can squirt blood from the sinus behind their eye. And that seems to mainly be a defense against canids, so things like coyotes, foxes, things like that. And it seems like their blood has some kind of compound in it that's very distasteful to things like coyotes and so that'll keep those kinds of predators away.

**Dean Williams** [00:38:57] They pop up and flatten out in response to certain snake predators. Sometimes that works, sometimes that doesn't. Snakes seem to be a big, big predator of these little guys as do birds, you know, things like roadrunners, things like that.

**Dean Williams** [00:39:13] But really, their first line of defense is to not be seen. So, they don't move a lot. And they're highly cryptic, which makes it very difficult to find them. So, even in areas where they're abundant, if you're just out walking around in an open field, it's hard to find them and you don't find them that often.

**Dean Williams** [00:39:34] I mean, that's why people oftentimes drive slowly along roads, especially dirt roads, gravel roads, where they occur, because they'll often come out to the edges of the roads to sun themselves. And that's when you can see them, is they'll move a little bit as you're driving slowly along the road and you can jump out and catch up.

**Dean Williams** [00:39:55] In an open field, it really is just luck. In large part, you have to see them as they're moving. If they just sitting there, you can be a foot away from them and, you know, you think you're looking for them and you think you have a search image down and no. It's, you know, what we did and we've done a lot of radio tracking with them. And that really kind of brings home just how cryptic they are, and that even with a radio tracker, you can get them down to, say, an area about the size of your desk. You know they're in there. And it could still take 15, 20 minutes to find exactly where they're at in that little patch of area where the radio tracking is saying they are at.

**Dean Williams** [00:40:47] And so, they're very good at hiding, actually. That's, by far and away, their best defense system.

**David Todd** [00:40:56] Well, while we're talking about their crypsis, can you maybe lay out some of their camouflage elements that are so good?

**Dean Williams** [00:41:07] Mm hmm. So, they're quite variable in the patterns and colors that are on their backs. You know, it's a lot of blacks, tans, yellows, orangey colors, all mixed in. And these seem to vary by geographic location, more or less.

**Dean Williams** [00:41:31] You know, it's always been suggested that they kind of match basically the color of the soils that they're found on. And some work that we did with a former graduate student, Dusty Rhoads. He went around and took pictures of them on different soil types, you know, from areas that they were from, and found that, yes, they do actually match the soil that they're found on more closely than, for instance, soil from other populations.

**Dean Williams** [00:42:06] So, it does seem, and it's probably just been selection, you know. Predators that are highly visual, like birds, for instance, probably select for a high degree of crypsis, I would imagine. You know, birds have extremely good eyesight, so. You know, probably, you know, the ability to hide from that type of a predator probably means that you have very good crypsis as actually.

**Dean Williams** [00:42:35] And so, they have the scales and the little protrusions and stuff on the back, as well as the color pattern, kind of breaks up the shape, you know. So, it kind of melds in with basically grasses, leaves, you know, litter on the ground, and the soil coloration. So, you don't really, I guess, you don't really see it as the outline of the lizard, per se, always.

**Dean Williams** [00:43:10] And in work by Wade Sherbrooke, who's really the, you know, I would say the world's expert on horned lizards. He's the one that's written probably most extensively on horned lizards and discovered a lot of stuff about their natural history, has suggested that the scales, the white fringe scales that they have on their sides of their stomach, it also helps break up the outline of their body, you know, so they don't stand out, basically.

**Dean Williams** [00:43:41] And that's definitely true. They don't. They don't stand out at all. I mean, they have to pretty much be moving, or in some kind of really obvious spot to just see them if they're just sitting there.

**David Todd** [00:43:58] Well, thank you. I think that's fascinating that there's this sort of passive strategy that seems really effective.

**Dean Williams** [00:44:07] Yeah, it's very ... I mean, another thing that kind of brought this home was in South Texas, where we had studied them for a number of years in a couple of small towns down there. We have all these little study plots, scattered throughout the towns. And you do transects on those study plots and we catch them and mark them, you know, as we find them.

**Dean Williams** [00:44:33] And over the course of a season, it will always start to plateau out the number of lizards that you find. And so, we're like, "Oh, we found everybody." You know, if you do a transect eight, ten times, you're going to find everybody that's, you know, in that area, it seemed like.

**Dean Williams** [00:44:50] But, you know, one study we did, we also collected scat in all of these areas. And you can use scat as a potential source for DNA and you can use it to identify

which individuals were responsible for the scat or how many different individuals were responsible for all this scat that you collect.

**Dean Williams** [00:45:12] And when we did that, we found, you know, there was close to 20%. We did find some of the lizards we had caught by hand, you know, in the scat. But we found about 20%, maybe a little less than that, maybe 17%, extra lizards that we never caught or ever saw, you know, on our transects.

**Dean Williams** [00:45:37] So, it's meaning that, even though you might go back to a place with multiple people and do transects and it's a relatively small area, say, ten times even over the course of a summer, you're still missing maybe close to 20% of the lizards that were actually there.

**Dean Williams** [00:45:56] You know, we'd find their scat, but we'd never actually find the lizard.

**Dean Williams** [00:46:01] So, that was kind of interesting. I thought at the time that, yeah, I mean, even with all the time we spend out there, and we're not in town, it's much more defined plots. You know, so it could be a park or an alleyway or something like that. You would think you'd be able to find all the lizards in that plot over the period of a summer.

**Dean Williams** [00:46:27] But we found oftentimes we did not. So, yeah, again, it's because they're so cryptic. We probably walked past a number of them in grass clumps and things like that, and just never had any idea.

**David Todd** [00:46:45] Well, elusive little guys.

**Dean Williams** [00:46:48] Yes.

**David Todd** [00:46:48] Well, well tell me, so, given their very crafty, cryptic nature, what do you think it is that has made them even harder to find and maybe has contributed to their decline that I think a lot of people have reported.

**Dean Williams** [00:47:10] I don't know if that has contributed to their decline. They're highly cryptic in large part, I mean, the story behind that is probably because they're ant-eaters, they have to be out in the open, relatively in the open, eating ants a lot during the day to get enough ants, you know, get enough nutrition.

**Dean Williams** [00:47:34] And so, this has probably selected, you know, the ability for them to be out in the open a lot would definitely probably be a situation where predators would definitely select four crypsis in this case as you're more exposed, you know, and more exposed compared to maybe a lot of other lizards that are, you know, hunting in trees or bushes or under things.

**Dean Williams** [00:48:02] You know, the horned lizards go out in a field and they sit along a trail of ants and just wait for the ants to go by, and then they lick, you know, basically catch them with their tongues and eat them. But they are sitting out there, you know, where a roadrunner or something like that could potentially see them. And so, that's probably why they're so cryptic is they spend a lot of time in the open. And that's because they have to eat a lot of ants.

**Dean Williams** [00:48:29] They're not fast runners because they have such a strange body type, you know. I mean, that's why they're called horny toads is because they have this kind of fat toad-like body, really, that's different from a lot of other lizards.

**Dean Williams** [00:48:43] And so, you know, not being a fast runner and having to be in the open a lot, well, you have to, you better come up with something else to keep things from eating you. Right?

**Dean Williams** [00:48:54] And everything eats them, it seems like - a variety of snakes, a variety of birds and a variety of mammals.

**Dean Williams** [00:49:03] So, they probably don't live very long in the wild. It's estimated that, you know, 2 to 3 years is probably a good period of time. There's some that may get past that, but for a lot of them, you know, predation so high that they probably only make it a couple of years, really.

**David Todd** [00:49:24] Okay, well, that's good.

**David Todd** [00:49:27] And I am sort of puzzled about why an animal that I understand was considered pretty common.

**Dean Williams** [00:49:37] Yes.

**David Todd** [00:49:40] Not so long ago, maybe sixties, 1970s, seems to have gone, you know, to where they're just very difficult to locate and maybe have become less common. Do you have any ideas about why there might have been this sort of decline?

**Dean Williams** [00:49:59] Lots of ideas, but no answers.

**Dean Williams** [00:50:04] Yeah, I mean, so it is interesting, right, because it used to be that if we believe, you know, kind of historical accounts and just kind of people's basic recollections, you know, from earlier generations, it would suggest that maybe the species was one of the most common lizards in Texas, I mean, because everybody knew about them. They would say, "Oh, yeah, we could go and collect a shoebox full in less than an hour, easy."

**Dean Williams** [00:50:38] And kids did that, right? They would go and collect a whole bunch. Sometimes they'd sell them or take them home and play with them.

**Dean Williams** [00:50:45] And that's a story that you hear a lot of places in Texas. You know, that's not just from one place or a few people. I mean, this is just a thing that constantly comes up.

**Dean Williams** [00:50:58] "Oh, yeah. These are always in the yard." They were at places where, you know, baseball fields, football fields. They were just everywhere. Right? And people could very easily find them.

**Dean Williams** [00:51:13] And I think that's one of the reasons why they were so popular in large part. One, they're very passive. They're not aggressive. They're easy to catch. You know, this is a species that, in the past, you know, it was like one of the first wild animals little kids played with a lot, just because they were just there in the yard. You know, that's what it seemed like. Right?

**Dean Williams** [00:51:38] And people would, you know, I'd hear stories of, you know, one of the ladies down in South Texas, in Kennedy, actually, she was talking about how her and her sisters would actually sew up little dresses and clothes and stuff for the horned lizards. And they'd have little fashion shows. And then they'd have little rodeos that they would have with the horned lizards that they played with when they were kids.

**Dean Williams** [00:52:06] And those kinds of stories are really common.

**Dean Williams** [00:52:10] Well, you don't hear those anymore, right? So, they've really disappeared.

**Dean Williams** [00:52:14] And it's interesting because, you know, they did seem to be found a lot around people, back in those days, and they still are in some places, some small towns in South Texas especially.

**Dean Williams** [00:52:28] And so, then the question is, yeah, "Why did they disappear?"

**Dean Williams** [00:52:32] And, you know, part of it, and probably a big reason, is just loss of habitat in a lot of places. You know, development in Texas has really taken off since you think in the seventies, eighties, nineties. You have the I-35 corridor: it's just completely developed now for the most part and all areas surrounding that. And horned lizards have disappeared pretty much east, for the most part, of the I-35 corridor and it's probably, in large part, loss of habitat.

**Dean Williams** [00:53:08] Now there are other interrelated factors.

**Dean Williams** [00:53:10] So, you know, fire ants, of course, are the thing that's always brought up as being a big problem. And they are. I mean, it's a predatory ant. It does kill baby horned lizards. We do have evidence for that.

**Dean Williams** [00:53:25] And they certainly would eat horned lizard eggs. So, horned lizards bury their eggs. Female will dig a little burrow about 12 centimeters into the ground, and she'll lay, you know, 20 to 40 eggs in that tiny burrow. And she covers it up with dirt, and then leaves them after a few days.

**Dean Williams** [00:53:49] And other ground-nesting animals like bobwhite and stuff also had a big problem with fire ants. So, if fire ants find the eggs, they are going to eat them most likely. And so, that ... we don't have any evidence, though, like any direct evidence, that they actually eat horned lizard eggs. We assume they would just because they eat other animals' eggs. You know, there is evidence for that.

**Dean Williams** [00:54:19] And there is evidence that they will attack baby horned lizards and eat them. You know, we have some of that evidence from some reintroduction stuff.

**Dean Williams** [00:54:31] But fire ants, it's a little bit of a mystery.

**Dean Williams** [00:54:35] Fire ants may also have out-competed harvester ants to some degree. There are always exceptions, though. I never know how much of a problem it has been in all areas. If you go to South Texas in these small towns, there's a lot of fire ants. There's also a fair number of harvester ants. But there's also the horned lizards in those towns.



**Dean Williams** [00:55:02] Now, have they become adapted somehow to living around fire ants? There's evidence for some other lizards, fence lizards in other areas of the U.S. that had a problem with fire ants that they have come up with strategies and adaptations to deal with fire ants over a long period of time.

**Dean Williams** [00:55:22] I do not know if that same thing is true for horned lizards.

**Dean Williams** [00:55:26] But, you know, so they do co-occur in places. And so, it's not entirely clear if fire ants are always bad. How bad are they? That's a hard thing to get a handle on.

**Dean Williams** [00:55:42] A lot of places have also lost harvester ants, and that's probably been due to a mix of fire ants as well as overuse of broadcast insecticides. So, when people especially were trying to get rid of fire ants, you would use broadcast insecticides in the yards and places like that. Well, it kills off other ants, too. Right?

**Dean Williams** [00:56:06] So, horned lizards, probably, the reason for the decline is probably 101 different reasons. And those reasons probably interact in different ways in different places of Texas. You know, one might be more important in one area. Another might be more important in another area.

**Dean Williams** [00:56:28] So, loss of habitat, fire ants, loss of harvester ants, possibly loss of small ants that the hatchlings need to eat, especially if they're out-competed by fire ants. That could be another thing.

**Dean Williams** [00:56:45] You know, there's been some suggestion that herbicides and insecticides may have negatively impacted horned lizards themselves. You know, if you go into an area and spray, the horned lizards don't move. So, they just get sprayed with the poison as well. Right? We don't have a good handle on whether, you know, how negative of an effect that has had on them.

**Dean Williams** [00:57:16] So, you know, you put all that together: in the past, long time ago, probably over-collecting and stuff also played a role, at least in some areas. That's probably not so much a thing now. You know, maybe in very local areas, it's possible that people could be illegally collecting and then trying to sell them under the radar, which people do stuff like that, you know. But whether or not that's a big threat, you know, to the population now? I don't know.

**Dean Williams** [00:57:47] My feeling is it has a lot to do with loss of natural habitat. You know, it's just, that due to agriculture and urbanization has really, really reduced a lot of natural habitat in Texas.

**David Todd** [00:58:06] I think you mentioned that these red imported fire ants may have been a factor in the decline.

**Dean Williams** [00:58:14] Yes.

**David Todd** [00:58:14] And I'm wondering if another animal I think we might consider invasive, and that's feral cats, that have played any role. Or do you think that's insignificant?

**Dean Williams** [00:58:24] We don't. That's another possibility. So, that was always something we were interested in when we were working in Kenedy and Karnes City down in South Texas, since there's a lot of feral cats, you know, in these small towns. And people would even report that, yeah, sometimes their pet cats, which were always outside, it seemed, would bring a dead horned lizard up to the porch. You know, they would catch him and just bring him to the porch. I don't know.

**Dean Williams** [00:58:54] I don't know how big of a, you know, cats have definitely caused decreases in lizard and bird populations in other places. I mean, cats are terrible, you know, in terms of their destructive abilities for small animals. You know, if they're just left outside to their own devices, that's never a good thing.

**Dean Williams** [00:59:21] Now, we would oftentimes find horned lizards in yards that had cats wandering around. And my feeling is, is that if the horned lizard isn't moving, the cat probably doesn't see it, you know, and doesn't go after it, most likely. Cats can be very visual predators, you know. And so, how big of an effect cats are having? We just don't know. It's really hard to get a handle on that kind of predation.

**Dean Williams** [00:59:52] What would be really interesting is if, say, in one of those towns you could find cat scat in any number, you know, if you could reliably find cat scat and then extract DNA from that and see what it was they were eating. I always thought that would be a cool, cool study just to try and get a handle on, you know, how often might they eat horned lizards. Or, you know, it's also possible they just kill them and then don't eat them. I mean, cats do that too. So, yeah, it's hard to ... Yeah, I don't know. Yeah, it's, it's one of those things that you think, "Oh yeah, it's like fire ants too, you think, Oh yeah. I mean, it seems logical that they're causing big declines, but it's just we don't have direct evidence. We don't have a way to quantify that."

**Dean Williams** [01:00:41] So, so, I don't know.

**David Todd** [01:00:45] Okay. "I don't know" is a great answer.

**David Todd** [01:00:51] So, I think you mentioned development. Just there's so many aspects to development, I'm curious if roads and automobile traffic might be a factor, given that, I think you mentioned that these horned lizards tend to like to go out there and bask.

**Dean Williams** [01:01:08] Yeah.

**David Todd** [01:01:09] And maybe that exposes them to getting squashed.

[01:01:11] Ah, no, definitely. I mean it's been suggested. Both Wade Sherbrooke in some populations that he has studied for a long time as well as a study in Colorado suggested that, yeah, road mortality might be a significant source of mortality actually.

**Dean Williams** [01:01:32] You know, how much that has played in Texas, I don't know. But yeah, they definitely do get run over a lot.

**Dean Williams** [01:01:41] And, you know, it's like we haven't done any kind of, I guess I would say "structured surveys". Because, you know, to do road mortality stuff, you got to be out there every day checking them at regular times because, you know, stuff scavenge dead

stuff off the side of the road all the time. So, you, you know, you have to catch it after it gets run over, basically.

**Dean Williams** [01:02:11] And we haven't done a lot of that.

**Dean Williams** [01:02:12] I'm sure roads do play a role, though. So, within town, one of the towns where we had good sample sizes, there was definitely genetic breaks across like the main road through town. And if you look at genetic similarity across different areas of town, what you find is that there is less gene flow or less dispersal across areas of town that have a lot of impervious surface - you know, houses, concrete, roads, things like that. And across the main road in town, there was a very strong genetic break between horned lizards on either side of that road, which suggests they don't successfully move across that road. You know, they may try, we don't know, but they don't successfully do it and then breed on the other side.

**Dean Williams** [01:03:21] So, roads and heavy traffic and stuff probably are barriers to them.

**Dean Williams** [01:03:27] And even within town, you know, they get isolated in these little patches in town due to things like roads and buildings, walls, things like that. So, they do seem to be susceptible to being easily isolated.

**Dean Williams** [01:03:44] And that would be another factor in their decline, basically, you know. When you start fragmenting populations, they start, they will eventually become small and inbred and, you know, wink out more easily than if you have a large interconnected population.

**David Todd** [01:04:06] Thank you.

**Dean Williams** [01:04:07] Yeah.

**David Todd** [01:04:08] So, I think that you mentioned in passing that horned lizards used to be pretty common, ubiquitous, across the state, but that in recent years they seem to have been particularly scarce east of 35.

**Dean Williams** [01:04:24] Right.

**David Todd** [01:04:25] Any theory about why that might be happening?

**Dean Williams** [01:04:27] Well, that's where most development has taken place. You know, if you think the I-35 corridor, that whole area, I mean, a ton of development has occurred in those areas. So, that's probably why, most likely.

**David Todd** [01:04:42] Okay. So, do you think that the horned lizard, as sad as its fate is just for itself, might also indicate something more broadly about problems among other species or systems? I mean, can you look at it as an indicator of anything?

**Dean Williams** [01:05:03] Yeah. Yeah, I think it could be considered kind of an indicator species, kind of like bobwhite quail, really, in a way. I mean, the overlap in habitat requirements between horned lizards and bobwhite quail are very close. You know, it's like if you have good horned lizard habitat, you have good bobwhite quail habitat, and vice versa. Usually, that seems to play out.

**Dean Williams** [01:05:28] And so, if you have horned lizards in an area, it probably means the habitat is pretty decent for that type of area, right, that they're found in. And so, there's going to be other native Texas species in those scrubby prairie-like habitats as well. So, it probably means that habitat's intact and good.

**Dean Williams** [01:05:55] You know, the town lizards are a little bit of an exception to that, the ones that live in town, because they live in a kind of a different type of habitat in some sense than the ones in more natural areas. But, I would say even within town they were indicative of more natural habitat within town because they were found in areas of town that, you know, the yards and around people's houses and alleyways and stuff, it was still pretty much native grasses, clump grasses, scattered bushes, mesquite trees, prickly pears, things like that. And so, you know, much more similar to their, you know, quote unquote, "natural habitat" in an area.

**Dean Williams** [01:06:42] You know, so if you go in an area of town where they have St. Augustine grass and, you know, very nice manicured lawns, horned lizards don't occur there. You know, they're just, they can't move through that type of grass very easily because of their body shape. Again, you know, they really require an area that has these clump grasses and things so that you have bare ground in between, and you can move around much more easily that way.

**Dean Williams** [01:07:10] And so, if a person has a nice yard, they are not going to have horned lizards, just basically. It was kind of funny: in towns, yeah, the crappiest yards always had, you know, were the ones that were most likely to have horned lizards, and it was kind of interesting.

**David Todd** [01:07:28] Well, that's sort of a consolation prize, I guess.

**Dean Williams** [01:07:31] Yeah. Yeah.

**David Todd** [01:07:33] If you don't get the best yard of the month club, at least you have some horned lizards.

**Dean Williams** [01:07:37] Yeah.

**David Todd** [01:07:41] Well, I think...

**Dean Williams** [01:07:42] No, go ahead.

**David Todd** [01:07:43] No, I was just going to ask. I think we discussed earlier that these lizards were pretty common, and that maybe people didn't take care to sort of track their populations, how many there were, where they were, and so on, and that maybe nowadays we're left with not a very good baseline to make projections from. Is that an issue in your view?

**Dean Williams** [01:08:12] No, that's very true. I mean, it's always a problem with common species. When they're common, people tend to ignore them. Right? In some way, they think, "Oh, there'll always be here." And so, yeah, there really wasn't a baseline.

**Dean Williams** [01:08:28] I mean all the stuff we go off is just this kind of historical, basically remembrances by people, you know, I mean, that's kind of our baseline is what are the stories that people tell about how common they were? Nobody ever sat down and kind of systematically started a long-term study. It'd be very interesting if they had, from like the sixties on, even in a single area, just to see, you know, what their population dynamics were like. Yeah, there's been very few long-term demographic studies of populations.

**Dean Williams** [01:09:16] And that has been a problem, because we don't really have a good handle, I don't think, on what are their natural population cycles like. You know, is their population size fairly constant over periods, or do they really go, do they have a lot of ups and downs, you know, and is that natural, you know, years of really high abundance and then years of extremely low abundance?

**Dean Williams** [01:09:43] You know, there's some species that's a natural kind of progression, right? It goes like this over time, and we don't have a good handle of that for horned lizards to know what are their normal population dynamics like? Do they reach a size and then stabilize? Or does it bounce around a lot?

**Dean Williams** [01:10:11] My impression is that it probably bounces around a lot, and just in part because they have such low survival. So, you can imagine that there'd be really good years, really bad years.

**Dean Williams** [01:10:24] But what that looks like and how that changes over space, you know, is that the same in far west Texas versus the Panhandle, versus south Texas? Nobody knows.

**David Todd** [01:10:40] Well, I guess that makes it a good research target. And in fact, that was something I wanted to ask you about. I know you've participated in a number of different research efforts, and I thought that maybe we could go through some of those that you've found intriguing and might like to share a little bit about. I think that some of your study has looked at the diet and foraging behavior of horned lizards. Anything you want to share with us about that?

**Dean Williams** [01:11:12] So, yeah, we originally started looking at that in the towns in South Texas. So, we had been studying horned lizards in these small towns since about 2013. And there was a wildlife biologist from Texas Parks and Wildlife, Ryan Darr, who, he now, I think, works for New Mexico Fish and Wildlife. But, at the time, he was stationed in south Texas. He knew about these town horned lizards, and he called me up, and had to call me up a few times, and eventually convinced us to go down and look at these populations.

**Dean Williams** [01:11:53] And so, we started that study and found, I mean, they can occur, certainly at that time, in really high densities inside these towns, you know. And normally out in more natural areas, you might see them at about ten individual horned lizards per hectare, you know, at the high end. And in these towns we were getting, you know, if we were to convert the space into hectares, you could get upwards of 50 horned lizards, you know, and, in hectares - a lot more.

**Dean Williams** [01:12:28] And the towns do have harvester ants, but not nearly enough mounds, it seemed, to support all those horned lizards. So, you know, it's been estimated that you need roughly about six harvester ant colonies to sustain one horned lizard. And that's

because they've got to move around between colonies to get enough ants. And there weren't nearly enough harvester ants in town to basically at least fit that rule.

**Dean Williams** [01:13:05] So, then the question became, what in the world are they eating, you know, in these towns? And so, we did start collecting scat and looking at also stable isotopes in their blood to see what it was they were eating.

**Dean Williams** [01:13:22] And this was done by a former graduate student, Rachel Alenius. And what she found was that, in town, they really don't eat that many harvester ants. You know, harvest ants make up a small proportion of their diet. You know, so in terms of just raw numbers, only about 8% of their diet, in terms of kind of the bulk overall of their diet, maybe 20%.

**Dean Williams** [01:13:51] And what they were eating, it turned out a lot, was big-headed ants, which is a little ant, and then also harvester termites. So, harvester termites is a species of termite that's only found in South Texas. And it gets up into the Edwards Plateau. And it belongs to this large group of neotropical termites called naustiform termites. And that group of termites, they forage on the surface like ants.

**Dean Williams** [01:14:24] So, normally when we think of termites, we think of them making these little mud structures, you know, around vegetation stuff that they eat, or they're eating, you know, parts of your house or things like that. But these are termites that basically come up out of the ground and then they just surface in a in a column on the surface, and they get that vegetation stuff and then they take it back down underground.

**Dean Williams** [01:14:48] And so, the horned lizards can just sit there and basically lick up these termites as they go by because there's just so many of them. And so, that's the first time that that had been described.

**Dean Williams** [01:15:02] And these termites aren't really well known just because it's not very common in the U.S. This group of termites is a much more tropical group of termites. And so, there are two species in the U.S. There's this one that the horned lizards are eating. And there's another one, I think, in New Mexico, that gets up into New Mexico a little ways.

**Dean Williams** [01:15:29] And, you know, so it was fortuitous for the horn lizards that this particular termite species happens to live in that area, and that provided a very good food source for them. And so, that, plus big-headed ants - it looks like that's mainly what they're eating in town.

**Dean Williams** [01:15:49] And that was interesting because, you know, the argument for eating large harvester ants is, one, they have more nutrition. And two, because of that, you don't have to spend as much time in the open eating them. Right? And so, you're not as exposed to predators as you would be if you had to sit out there and eat a million little ants.

**Dean Williams** [01:16:14] And so, what that would suggest is in town, then, maybe, maybe the reason they can do this is they have lower levels of predation. I mean, in those towns, it was interesting, like, for instance, you don't see, which I always found very strange, you don't see birds of prey, really, in those towns. Roadrunners are extremely rare in town. We saw them twice in all the, you know, since 2013, all the time we were out there.

**Dean Williams** [01:16:47] And so, they don't seem to have a lot of avian predators in town. Certainly, things like little kestrels and stuff. You know, it's not that they never occur there, it's just that they're rare. They don't hang out there a lot.

**Dean Williams** [01:17:03] Also, we found very few snakes in town, which was also interesting because, I mean, we're looking through brush and under stuff all the time when we're looking for horned lizards. But all the years we were there, over the nine years and rummaging around and stuff, we found one coachwhip and one bull snake, and then we found a few Texas rat snakes and then little patchnose snakes were fairly common: we'd see about a couple a year in town. And so, it looked, it seemed like, okay, maybe snake predation is not a big factor in town.

**Dean Williams** [01:17:41] We also put out little foam models of horned lizards, and we put them out in town, and then we put those same little foam models out in a ranch area that's in the same general region.

**Dean Williams** [01:17:55] And I mean, it was a dramatic difference, really. In town, nothing touched the models, but on the ranch, the models would have peck marks, they'd have limbs removed, they'd have their heads removed, they would be smashed, they'd be knocked around.

**Dean Williams** [01:18:14] And, you know, it looked like, from the markings left, I mean, a lot of it was there's a lot of bird predation. It could be roadrunners, things like that, possibly some mammalian predators as well, because you would see bite marks, you know, on their sides and things like that. So, it could be like raccoons maybe, or something like that.

**Dean Williams** [01:18:38] You know, those models aren't very good at, are not good at all, for measuring something like snake predation. They're also not good for cat predation, because in town we had cameras up on some of the models and you would get cats just walking right by them and not even noticing they were there. Right?

**Dean Williams** [01:18:58] And I think if we had some kind of model that could move, periodically, that might have made a bigger difference, you know: then maybe you would see cats attempting to predate them. I don't know.

**Dean Williams** [01:19:11] But so, you know, models are good for measuring certain types of predation, especially some kinds of birds and mammals. But, you know, things like cats and snakes and stuff you don't really get a handle on with the models.

**Dean Williams** [01:19:26] But there was like a, you know, night and day difference in terms of how many got attacked on the ranch versus in town. So, it did suggest that in town there's just less predation. One, they don't have a lot of their natural predators in town.

**Dean Williams** [01:19:47] And the thing with cats we still don't have a handle on. So, you know, I don't know whether to confidently say cats aren't a problem or not. I don't, I have no idea, but I tend to think they are. But then again, I don't have data to really say that.

**David Todd** [01:20:05] Well, that's fascinating because, you know, as a layperson, so much of what I hear about problems of biodiversity is development-related and that there are these sort of weird exceptions that maybe prove the rule. I don't know.

**Dean Williams** [01:20:20] Right.

**David Todd** [01:20:21] That, you know, this horned lizard seems to be doing better in town than out in the country where you'd think he or she would have a less disturbed life.

**Dean Williams** [01:20:30] Yeah. And I, I think it was just the confluence of all these different things together in those small towns where you have crappy yards, decent habitat for them, lots of places to hide, you know, and thermoregulate. You have this alternative food source with these termites that happen to be there. And then, of course, big-headed ants everywhere. I mean they're common in town as well. And then you have lower predation, at least of some kinds.

**Dean Williams** [01:21:05] You know, all of that together probably really made an ideal situation for them in those small areas.

**Dean Williams** [01:21:14] And, you know, they've found that with some other species. There's this idea that, you know, urban areas, sometimes urban areas can have really high levels of mesopredators, you know, things like skunks or raccoons and things like that. But, they don't necessarily prey on native species in town because there's so much garbage and pet food and other stuff, you know, that they can more easily subsist on. And so, you can get really high levels of predators in town, but really low predation on native species just because they have other food available. Right. You know, people throwing stuff out and people leaving dog food out, you know.

**David Todd** [01:22:00] Things like that'll be easier to catch, you know?

**Dean Williams** [01:22:03] Yeah. Yeah.

**David Todd** [01:22:04] They don't run away. The dog food sits there and is easy markings.

**Dean Williams** [01:22:09] Yeah.

**David Todd** [01:22:10] So, you mentioned one thing in passing that I thought was intriguing, that maybe these horned lizards that lived in towns might have better access to refugia that that could help them regulate their temperature. I think you studied that, in fact.

**Dean Williams** [01:22:28] Yeah.

**David Todd** [01:22:29] Can you talk a little bit about that?

**Dean Williams** [01:22:31] Yeah. So, one thing, you know, and people had talked about this a lot in towns is that they definitely had been declining in town as well. And over the time that we've been there, many of the sites that we studied did decline over time and they disappeared from certain areas of town where they used to be really common.

**Dean Williams** [01:22:56] And during the time we were studying there, what we found was that when people would clear vegetation, especially bushes around the, you know, like so you'd have a park, and in that park the trees would have a lot of brush around the base of the tree. A lot of times, lizards would hang out in that brush.



**Dean Williams** [01:23:16] And when they decided to clean up the park and remove all of that, the horned lizards just disappeared from that area, like completely gone.

**Dean Williams** [01:23:28] In alleyways, when they would remove big sections of brush and bushes that occurred along the edges, horned lizards would just disappear from the area.

**Dean Williams** [01:23:39] And so, we did a bunch of, we put out a bunch of temperature loggers in different micro habitats that they hang out in, and found that, you know, I mean, unsurprisingly, really, is that during the summertime, if you're in the open, especially in the middle, there's about 5 hours during the day where the temperature on the ground gets above their maximum temperature limit, right, the maximum they can withstand before they'll start to die.

**Dean Williams** [01:24:13] And sometimes it'd be way above. You know, you could get, I think the highest temperature we recorded on the ground was like 60 degrees Celsius. It's extremely high. Their optimal temperature is 35 degrees Celsius, which is getting around close to 100 degrees.

**Dean Williams** [01:24:32] And so, yeah, the idea is they would remove vegetation and stuff. Basically, it just creates a situation where they then cannot cool down, you know.

**Dean Williams** [01:24:45] So, horned lizards, I mean, they're ectotherms. In that sense, they basically have to regulate their body temperature behaviorally by going in and out of the shade, things like that. And when they don't have a place to get out of the sun close by. You know, that's just, that's really bad, obviously. They'll either die or leave the area.

**Dean Williams** [01:25:12] And so, we would find, like, in alleyways, that's where the highest densities of horned lizards would occur. And it was kind of like a perfect little microhabitat for them, in that you had bushes alongside the fences in these alleyways. The alleyways were often dirt roads, and so, the middle of the alleyway would be kind of bare, would have a lot of bare patches of ground and then some grass on the side.

**Dean Williams** [01:25:38] And that was perfect, right? They could come out, eat, you know, thermoregulate in the open, get warmed up. But then there was a place to cool off just, you know, a couple of feet away. Everything was really close together that way. And so, they could warm up, they could cool off, they could forage all in this area. It was like kind of perfect for them, it seemed like.

**Dean Williams** [01:26:04] And they definitely occurred at very high density in the alleyways compared to open fields. Open fields: they were, their densities in those areas in town were more similar to what you would see in a natural area, you know.

**Dean Williams** [01:26:17] And I think it's just the distribution of thermal refugia in a big open field is more spread apart, you know. And so, in order to get to an area to cool off, potentially, from where you're eating at, you have to move a lot further. And so, you have those kinds of travel costs of moving between, you know, places where you're eating versus where you need to cool down, versus where you maybe need to hide.

**Dean Williams** [01:26:48] Once those areas get too spread apart, then it becomes less optimal, you know.

**David Todd** [01:26:56] Interesting.

**Dean Williams** [01:26:57] Landscaping is a big deal. I mean, you could probably sit down and you could probably create a nice yard that just had native species and enough bushes and stuff in it that it would be perfect for them, you know. But it would be convincing people not to have manicured lawns and to make sure you have native species and stuff in there. But yeah, you could probably have them as a common component, I would think, in small towns, but it would require doing the correct landscaping and not clearing out brush kind of wholesale right away, because that's where they live. I mean, they need that. Right? They won't stay if that's cleared out right away.

**Dean Williams** [01:27:45] So, let's say you wanted to clean a place up, you could probably do it in stages where you take out a little bit and then replace it maybe with something that was visually more appealing, you know, bushes that were more visually appealing or something, but make sure that they always had that configuration of brush and bare patches of ground and bunch grasses that they could move around in.

**David Todd** [01:28:10] I think it's so intriguing, and sort of tragic, I mean, that our ideas of esthetics and what's appealing visually are life and death issues for these creatures.

**Dean Williams** [01:28:25] Oh, yeah. Yeah.

**David Todd** [01:28:27] Well, let me ask you one other thing about some of your research projects. I think that you have studied their ectoparasite loads. And so, is that something that you could talk a bit about?

**Dean Williams** [01:28:41] We, we did some of that in those towns as well. And so, basically, like a lot of lizards, horned lizards will get these little mites that basically attach to areas around their neck or behind their legs, sometimes underneath them. Whether those mites cause an issue or not, we have no idea. But, you know, I think they're very common across a lot of lizard species.

**Dean Williams** [01:29:15] Now one thing we did find in town was that they were more common on males. You know, males had higher parasite loads. That has been shown in some other species too, that sometimes there's a sex bias there and it could be related to male immune systems or something. You know, there's this idea that with testosterone, you know, things like testosterone and stuff, lower immune function, you know.

**Dean Williams** [01:29:48] So, the idea is that females have stronger immune systems as a result. And so, they're not as likely to get parasitized as males are. Maybe that's what's occurring here.

**Dean Williams** [01:30:02] We also found that they got more parasites in those alleyways, actually. So yeah, it's probably just related to, you know, the microhabitat in those alleyways is also conducive to mites. You know, mites are ... you have a more humid, protected area there and there's also higher densities of horned lizards there, so that might also be another reason for that.

**Dean Williams** [01:30:28] Now whether that causes a problem for horned lizards or not, we really don't know.

**David Todd** [01:30:35] I love these unanswered questions.

**Dean Williams** [01:30:38] Yeah.

**David Todd** [01:30:39] Plenty to keep you and your students busy.

**Dean Williams** [01:30:42] Yeah.

**David Todd** [01:30:42] So, speaking of students, of course, you've been teaching at TCU for quite a while, and TCU has this special affinity for horned lizards, its mascot, I guess, is one reason. Do you find that, you've got an extra support because, you know, it is the mascot for your college, or is it a really interesting sort of study model that that appeals to you and works for your students?

**Dean Williams** [01:31:15] Ah, a little of both, I would say actually. Yes, I, you know, they have been very supportive in terms of, you know, TCU has a number of small grants that students or professors can get to help them with their research. Certainly, early on during this study, I was able to get a lot of those grants here at TCU to continue this work. And that has been really helpful, actually. So, there were lots of little pots of money, you know, available over time that we could use to support travel and buying equipment and things like that.

**David Todd** [01:32:00] Okay. I just know that, a lot of times, you know, money and research need to overlap or the research doesn't happen.

**Dean Williams** [01:32:10] Yes.

**David Todd** [01:32:10] Curious if that's been a factor here.

**Dean Williams** [01:32:14] Yeah, it is always. Yeah, money is always a factor.

**Dean Williams** [01:32:19] And it's difficult. It's more difficult to kind of get money for just pure kind of conservation questions oftentimes. So, you know, Texas horned lizards aren't critically endangered. They're not federally endangered. You know, and so, there's a lot of types of conservation grants to which, you know, because it's not a species of great concern across its range, it's harder to get money for it in that sense.

**Dean Williams** [01:32:51] It also doesn't necessarily have clear benefits to people, per se, I mean economic benefits or, you know, things like that. You know, so like, say, bobwhite quail, for instance, people are going to put a lot more money into managing bobwhite quails because of the hunting stuff, right, rather than horned lizards.

**Dean Williams** [01:33:14] So, getting money for them is always a, it's always a struggle. I try lots of places every year. Every year, you've got to chase money.

**David Todd** [01:33:27] So, I'm curious, you've researched many things. And you mentioned the brown jay studies that you did for a number of years. But I understand that you've also studied, you know, plants and mammals such as yellow bats and Mexican free-tailed bats, sharks, Kemp's ridley sea turtles. Is there some way you can sort of talk about how your research interests overlap and maybe how they tie in with the horned lizard work that you've been talking about today?

**Dean Williams** [01:34:03] Right. So, all those projects, I think one thread through some of those projects is it's basically looking a lot at how individuals move around, what their dispersal patterns are like, what their population structure is like.

**Dean Williams** [01:34:21] So, that definitely translates to the horned lizard work pretty easily.

**Dean Williams** [01:34:26] Some of the stuff that we have done with bats and sharks and stuff, it has mainly been using genetics to identify the particular species involved in those studies.

**Dean Williams** [01:34:42] And, you know, that kind of technology is transferred to horned lizards as well, in terms of identifying what they're eating. We've used DNA barcoding a lot for that as well. We've used genetics, some of those genetic techniques to identify individual horned lizards from scat or the horned lizard themselves.

**Dean Williams** [01:35:09] Yeah. So, in a lot of ways, I think, you know, when I go back and think ... and also mating system stuff, you know, with the Kemp's ridley and with the birds and that, you know, I've had a long, I guess, standing interest in mating systems in natural populations. And that is also an area that we know virtually nothing about in horned lizards, really?

**Dean Williams** [01:35:39] I mean, we know some about their nesting and breeding, but we really have no idea, for instance, like how many males will a female horned lizard mate with? Is it, you know, when she lays a clutch of eggs, is that all from one male? Or is it from a couple of males? We're hoping it's from a couple of males, because that will just increase the genetic diversity more, especially with this reintroduction project and stuff. But we have no idea.

**Dean Williams** [01:36:17] We really don't know much about, you know, how they choose mates. Is there any female choice involved? You know, do they just mate with any male that comes by? We don't know.

**Dean Williams** [01:36:32] So, you know, we're actually, I have a student now, a Ph.D. student, who's really starting to dig down into the details of their nesting ecology, and following females around a lot and getting a handle on how, you know, how successful they are. We're also going to use that data to try and get an idea of paternity in nests, you know.

**Dean Williams** [01:36:58] And what does it look like if a female makes two nests during the year? Is it both from the same males? Is it separate males? You know, we don't know.

**Dean Williams** [01:37:09] Do female store sperm? That's not uncommon in reptiles, you know. So, maybe she mates with one male at the beginning of the season, and she can use that stored sperm to fertilize eggs for the rest of the season. We don't know.

**Dean Williams** [01:37:25] So, those kind of questions ... that's something we're definitely starting to look at now.

**Dean Williams** [01:37:32] And that has been a lot, you know, with the bird stuff and other stuff like that, that's been a long-term kind of interest of mine, is, you know, mating systems and then also dispersal and population structure, I guess, kind of ties a lot of this together.

**Dean Williams** [01:37:47] Even in the invasive species stuff. I mean, that's what we're looking at, is their population structure in the invasive range versus in the native range. Where did exactly did they come from in the native range, you know, and use genetics to try and retrace their pattern of introduction and their point of origin, you know.

**Dean Williams** [01:38:11] So, I guess, a lot of the thread that ties a lot of stuff together is kind of population structure, dispersal, how things are moving, how, you know, who's mating with who, that kind of thing.

**David Todd** [01:38:28] So, I guess a lot of this research, of course, is at your instigation and direction, but you're collaborating and leading students. And I'm curious what sort of impact or response you feel like you've gotten from students when you've been working on these horned lizard issues?

**Dean Williams** [01:38:53] Oh, they're always very interested in the horned lizard. I mean, obviously it's a mascot for the school at TCU. And so, you know, sometimes students are surprised that it's an actual organism, you know. And, you know, especially as time goes on, I mean, that becomes more of a thing.

**Dean Williams** [01:39:11] I have a little horned lizard display outside my office, and there have been several groups of students the past few years that, you know, they stop and you can hear them out there talking and they're like, "Oh, those things are real!", you know, things like that. Like, they did not realize that this is based on a real organism, right? It's not a Pokemon or something. And so, that that is kind of funny, I think, you know.

**Dean Williams** [01:39:41] Now, in ecology class and stuff that I teach, I always do a lecture on horned lizards, just natural history, basically, just so they have a baseline of, yeah, these are real things. This is important. It's a cool organism, you know.

**David Todd** [01:39:58] And it's real!

**Dean Williams** [01:39:59] Yeah. It's real.

**David Todd** [01:40:00] It's not a Pokemon. Well, good.

**Dean Williams** [01:40:02] Very few students have ever really seen one now. I mean, we get a few students that maybe come from areas of Texas where they have seen them, but that's becoming less and less common, actually. Yes. Most students have never seen a horned lizard in their lives, or I would say the majority of TCU students have not.

**David Todd** [01:40:25] Well, I understand that you have been trying to help support efforts to maybe return some of them to the wild. And I was hoping you could describe some of those projects to reintroduce them.

**Dean Williams** [01:40:40] Yeah. So, that was originally kind of how I started getting into horned lizard research was, you know, when I first came to TCU, I started teaching in the ecology class then. And traditionally here at TCU, in the ecology class, they always had a guy from TPW. And John Davis was his name. He would come and give a lecture on horned lizards to the students. It was usually towards the end of the semester. And you know, I don't know how many years he did that, but he was still doing that when I arrived at TCU.

**Dean Williams** [01:41:20] And when he came and gave his lecture, afterwards, he had heard about me coming to TCU and stuff, and then he came and talked to me and said, "You know, TPW's been thinking they would like to start a reintroduction program for Texas horned lizards. One of the big outstanding questions that people have is, you know, what's the population structure of the species like in Texas? How different are horned lizards across the state?" Because you really kind of need to know that information when you reintroduce them into areas.

**Dean Williams** [01:41:54] And so, he's like, "You know, would you be interested in potentially doing a project like that?" And I was like, "Well, yeah, that would actually be pretty interesting."

**Dean Williams** [01:42:06] So, TPW actually funded the first project that I did with them, and that was develop genetic markers for Texas horned lizards. And then, you know, with volunteers from TPW, Master Naturalists across Texas and other people, we basically sent out collection kits to get DNA samples from horned lizards all over the state. And Lee Ann Linam, who was running the Horned Lizard Watch program for TPW at that time, was really instrumental in helping, you know, making contacts and sending kits to people.

**Dean Williams** [01:42:53] And, you know, over time, took a few years, really, I mean, because again, they're hard to find. You need to have a certain number of individuals from an area in order to, you know, do a good study to really estimate genetic diversity and how different they are.

**Dean Williams** [01:43:12] And so, over years, you know, we ended up collecting over 500 samples really, that we were able to analyze. And when we analyzed that, we were able to see that, within Texas there's a very strong genetic break between Western, far Western Texas versus everything else. And, you know, the Western genetic group really occurs kind of around the Big Bend, on up through the El Paso area, and then into New Mexico, and also into Mexico.

**Dean Williams** [01:43:55] So, the Eastern grouping is everything else in Texas. And that we were able to split up into a northern and southern group. And the dividing line there seemed to be the Balcones Escarpment. So, there was a southern group south of that, and north of that, there was the northern group. And that northern group goes all the way up into Oklahoma, Kansas, Colorado, those areas.

**Dean Williams** [01:44:28] And so, those splits, you know, south Texas versus north Texas, versus far west, are really different habitats, you know, very different ecosystems, ecoregions. And that suggests, when you see a genetic split like that, that matches also these different ecoregions, it suggests that, okay, maybe these horned lizards, you know, in far west Texas are adapted to that more desert ecoregion, compared to, say, horned lizards that occur in more prairie-like habitats in the eastern part.

**Dean Williams** [01:45:11] You know, and then you can imagine, you know, north Texas versus south Texas - also very different, you know, in terms of rainfall, vegetation types, all of that.

**Dean Williams** [01:45:21] And so, in terms of like reintroducing lizards or captive breeding them, the idea is we probably should keep those three areas separate from each other. You know, we wouldn't want to take Western ones and try and reintroduce them in the Panhandle

or, you know, some place like that, because it'd be so different. Right? The habitat would be so different.

**Dean Williams** [01:45:45] Or take ones from south Texas and try and reintroduce them into central Texas. It just, the habitat's too different.

**Dean Williams** [01:45:53] And so, that kind of set up the breeding strategy that we now have in the zoos, so that the Fort Worth Zoo and the Dallas Zoo, for instance, are only breeding lizards from the northern grouping, and those lizards are only being returned to an area in the north where they historically had occurred. So, that's, you know, we're trying to match as close as possible their habitat that they're found in.

**Dean Williams** [01:46:31] And then the San Antonio Zoo is going to concentrate on the southern group of horned lizards, and just breed those. And then their reintroduction is occurring in an area that more probably would historically have matched the southern grouping, is what we're hoping.

**Dean Williams** [01:46:53] And then the Western ones, you know, that occurs in a relatively small area of Texas. Plus, those populations don't seem to be in as much trouble. You know, it's still fairly common in those areas, compared to other places in Texas. And so, there's no plans to do any reintroductions or stuff in those areas.

**Dean Williams** [01:47:16] But right now, the reintroductions really are occurring just in two spots. In large part, it's because we're trying to figure out what's the best way of doing this.

**Dean Williams** [01:47:28] So, San Antonio Zoo has an area down in south Texas that they're working at. And then, Texas Parks and Wildlife and the Fort Worth Zoo and Dallas Zoo are working at Mason Mountain WMA (it's near Mason, Texas). And that's the site for reintroductions there.

**Dean Williams** [01:47:51] And basically, we are trying to figure out, what's the best way to release them, and how many need to be released, over how long of a period to get a population established?

**Dean Williams** [01:48:06] And so, you know, that study was also done, has been done by other students. So, Rachel Alenius, has done some of this, my current grad student, is working in that area as well with female nesting in that.

**Dean Williams** [01:48:21] A previous grad student, Rachel Alenius, has found that, you know, a couple of interesting things as far as releases is that, you know, the way you release them makes a difference, it appears. So, if you release them ... so originally, the way ... I guess I should back up a little bit.

**Dean Williams** [01:48:43] The first try of repatriating these lizards into the area was to take adults from one area of Texas, which is from the northern population, and then move them to Mason. And there was another WMA where this was done. And then they were radio-tracked and followed.

**Dean Williams** [01:49:02] The problem with translocating adults is they seem to behave fairly normal, at least from the tracking data and stuff. It's just their predation levels are so

high. Most of them got predated right away. A few made it out to a year or two, but then they got predated.

**Dean Williams** [01:49:24] And so, you kind of realize, okay, I mean, high predation seems to be normal for this species. And so, you realize you would never be able to go out and collect enough adults. I mean, you'd have to do hundreds, right, probably, to reintroduce in an area. And that's just not really feasible. And it's probably not good for those other populations removing that many individuals to move them somewhere else.

**Dean Williams** [01:49:50] And so, that's then what really started the move to breed them in the zoo, and then repatriate hatchlings. And so, that's what's being currently done is, is they're bred in the zoo and then the hatchlings are taken and released into the wild.

**Dean Williams** [01:50:13] And so, we've been trying to learn as much about the hatchling ecology as possible. And so, the first way that they were reintroduced was ... normally, you know, when they would dig their way out of a nest, they'd come out and they're kind of in a little group, right? And they kind of stay, and they don't really stay in a tight-knit little group, but they're all found fairly close to each other for quite a while because they don't move very far. I mean, they're really tiny. They're about the size of your thumbnail, you know, when they first come out.

**Dean Williams** [01:50:45] And so, at first, you know, they were released in little groups. They still suffered really high predation like that. And so, they tried to then, what they did was an experiment where they were released in either small groups or singly, kind of randomly through the habitat, and found that if they were released singly, they had a higher survival rate than if they were released in little groups.

**Dean Williams** [01:51:12] So, that was interesting. And that, we think it might have something to do with like, it seems like the coachwhips are by far and away one of the big problems for hatchling lizards. I mean, they find these little things and just eat them non-stop, right? So, if they found a little group of them, they'd probably just eat them all in one shot. And you would find that. You would find ... they have these little tags put on them and you would find little bunches of tags in the snake scat, sometimes. And so, releasing them singly was, probably, was better.

**Dean Williams** [01:51:47] The other thing, and this was actually a surprise, was it looked like not all areas ... and this is at a small scale, right? these are areas that are separated by 100 meters. So, not super far. Not all areas are ideal for releases, and it seems to be related to how many little ants are in a given area.

**Dean Williams** [01:52:13] So, the assumption going in was, you know, these little ants like acrobat ants and big-headed ants and stuff seem to be pretty ubiquitous, you know, on the landscape. And you think, you know, this area is going to have as many little ants as that other area.

**Dean Williams** [01:52:29] Turns out that's not true: that it's more patchy than what we had thought.

**Dean Williams** [01:52:36] And we found that these had been released in two different areas and these two different areas were separated by 100 meters. The habitat looks the same and stuff. You wouldn't think they were any different. But, in one area all the babies died. In the



other area, many survived to their first hibernation or a decent number. I mean, when we're talking high, we're saying, you know, somewhere between ten and 20%. If ten or 20% make it to hibernation, that's really doing well, you know, so but in the other area, they all died.

**Dean Williams** [01:53:14] And Rachel, in her studies found, you know, she had collected scat from the babies and gone through and seen what they're eating and all of that, and also measuring their weight on a regular basis, and found that at the one site where they all died, they had very few ants in their scat. And they didn't gain weight very fast.

**Dean Williams** [01:53:38] And so, and then she did some ant surveys and stuff and found that, yeah, there just wasn't many little ants in the areas where they all died. Whereas in the other area, they ate a lot of ants. They ate some termites there. Seemed to just be better.

**Dean Williams** [01:53:57] And so, now we've realized, before you release them, you're going to have to ant surveys, and not for harvester ants, because they can't eat harvester ants - they're too little. Right? They have to have the little tiny ants.

**Dean Williams** [01:54:10] And so, that's something we realized, yeah, we're going to have to do surveys for little tiny ants, things like big-headed ants and acrobat ants and things like that that the hatchlings actually eat, and then make sure that if you release them in an area, that there's plenty of those around.

**David Todd** [01:54:27] It's always more complicated than you think.

**Dean Williams** [01:54:30] Yeah.

**David Todd** [01:54:31] I guess is the maybe the moral of the story. Well, there's so much to learn from this. I was interested that some of your students, of course, are grad students. They're adults. But that you've also managed to, I guess, sort of transport some of these genetic studies about horned lizards into K through 12 outreach. And I'm wondering how you've done that and what sort of impact you've had from that project.

**Dean Williams** [01:55:03] So, so, yeah, that was a, so one of the little pots of money that you can get at TCU is through an organization called the Andrews Institute over in the College of Education. And one of the programs they have is a program where you can get some money for whatever research you're doing, but you have to try and basically teach that to K through 12 teachers and their students.

**Dean Williams** [01:55:37] And so, there's a high school that's right next to TCU, called Paschal High School. And, you know, fortuitously, the biology department there had a teacher who had been a former grad student here actually at TCU, and he worked with herps a lot. And so, he would bring his students from environmental science as well as biology over to TCU. And we had a few exercises that we would do with those students.

**Dean Williams** [01:56:09] So, we would do things like ... one time, we did some radio-tracking and stuff where you could put stuff out, see if the students could find them.

**Dean Williams** [01:56:19] But from the genetic side, I would do things like I'd collect scat and bring it back. And so, I'd always keep a bunch of scat, dry, up in the lab, and then we'd have students, like, go through the scat. You know, they'd break it apart under the microscope to

see all the different ants and other stuff they'd been eating and so on. And so, students liked doing that.

**Dean Williams** [01:56:43] We also, I made up some kind of fake genetic material for that, because, you know, realistically going through and doing real genetics on horned lizards in that kind of setting is not possible. But I did come up with some exercises that mimicked what it is they would see, you know. So, they would run some stuff on gels. And then the samples that they ran were presumably from individual fecal pellets of horned lizards. And we could use the pattern of the amplification products on the gel to tell individuals apart, you know, which is basically what we're doing when we're identifying individuals from feces.

**Dean Williams** [01:57:32] And so, they would do that and then determine, okay, how many different individuals did they find, you know, in this exercise, by looking at these genetic profiles on the gels? How many different individuals would that represent, from how many different pieces of feces? And so, they would do that as an exercise in class.

**Dean Williams** [01:57:54] And so, he would usually bring them over, you know, it was usually like once a semester, the class would come and then we'd do these lab exercises with them.

**Dean Williams** [01:58:04] Yeah. And that the students were always like super excited, right? Because just using pipettes or, you know, running gels and stuff like that they thought was really fun, you know.

**Dean Williams** [01:58:14] I mean they're at that age still where everything's exciting and they're not all jaded yet about how boring lab is. Yeah, they were super into it.

**David Todd** [01:58:25] It's nice to know that there's that kind of natural inquisitiveness that you're able to tap into.

**Dean Williams** [01:58:34] So, let's talk just a little bit about the public in general. I think it's been really interesting that the horned lizard has been featured on license plates, and has state reptile status, and, you know, TCU's mascot.

**Dean Williams** [01:58:55] Yes.

**David Todd** [01:58:55] And I'm curious. What is it that seems to draw people in to this little lizard.

**Dean Williams** [01:59:02] I think it was, you know, basically I mean, what I had talked about before is that this lizard was ubiquitous in Texas. Horned lizards are also this kind of symbol of the American West. I mean, it's one of those creatures like coyotes and roadrunners that, you know, you think of when you think of the American West or American deserts, prairies. You know, that's one of the organisms.

**Dean Williams** [01:59:33] But, it was one of those organisms that people had first-hand experience with, right? I mean, like they could pick it up and look at it and do things with it. Where, you know, roadrunners, you're not out there as a kid catching a roadrunner and playing with it. That's just not an option. Right?

**Dean Williams** [01:59:51] And so, I think because of that, there was a lot of folklore, stories, you know, about horned lizards. And so, I think that, yeah, it's just one of these, kind of like, cultural symbols almost, really.

**Dean Williams** [02:00:10] It's a very Texas thing - a horned lizard, right? And so, it's kind of, you know, it's one of those symbols of Texas, really. And so, I think that's why people like it. Right?

**Dean Williams** [02:00:23] I mean, it's something that, at least in the past, was very accessible.

**Dean Williams** [02:00:29] They're weird. You know, you notice them. They're interesting to look at and to think about, and they do interesting things. So, I think that, you know, added to it, the mystique of, you know, blood squirting and all of this, you know, had built up a lot of stories and everybody had stories about horned lizards and what they did with them as kids and, you know, other people did and.

**Dean Williams** [02:00:55] And so, I think, yeah, it just becomes a thing: that people just liked them.

**David Todd** [02:01:01] It's very cool. I mean, you know, I wish that every animal had that kind of resonance with folks.

**Dean Williams** [02:01:07] I mean, there would be times when we would go to a place in Texas to do some DNA collecting or something, and we'd stop at a small hotel where we were staying, and "Oh, what are you guys working on?" "Oh, we're working on horned lizards." And they're like, "Oh my God, you're working on horny toads? Like, we love horny toads."

**Dean Williams** [02:01:29] You know, that's basically the ... I never met anybody that said, "Oh, God, those things are terrible." That has never been like the feelings that people have, right? It's always the opposite, you know, it's just, those things are wonderful. We love those things.

**David Todd** [02:01:50] That's great. Well, maybe it's infectious from your enthusiasm.

**David Todd** [02:01:55] Well, one last question. You know, we've covered a lot of ground thanks to you and your stamina and so much knowledge about these creatures. I just wondered if there's anything you'd like to add that we may have just overlooked, that I gave short shrift to, that, that you wanted to mention about horned lizards or just your interest in, you know, natural sciences and research and conservation.

**Dean Williams** [02:02:26] No. I mean, I guess nothing specific. I mean, we're continuing to help with the reintroduction program with Texas Parks and Wildlife and the zoos.

**Dean Williams** [02:02:40] You know, those kinds of studies always take way longer than you ever would think. I mean, because I think I've been here 16 years now, and most of the 16 years I have been involved, some one way or another, with this project.

**Dean Williams** [02:02:58] And, you know, I mean, we've learned a lot more. But I think, for successful reintroductions especially, we need to learn even more. I mean, we need to learn a lot more about what the requirements are for hatchlings and also much more about nesting strategies for females and stuff.

**Dean Williams** [02:03:21] There's been some success at Mason. Now, for the past few years, we've had females that were introduced as hatchlings there that have grown up and successfully made nests of their own on the site and successfully produced young. So, that's a good sign.

**Dean Williams** [02:03:43] Now, it's not at a level yet where I would say that population is self-sustaining. So, for instance, if we just start doing introductions completely, right now, I think the population would probably die down again.

**Dean Williams** [02:03:57] I don't think there's a, you know, we don't know what that threshold is, but it must be pretty high in terms of population size, because predation is so high. We have to get a better handle on predation levels and stuff. But that's the big problem. They probably would do a lot better if predation wasn't so high. I would guess it'd be easier to get them established.

**Dean Williams** [02:04:24] It's interesting because people have introduced them to other areas like North Carolina, South Carolina and the Florida Panhandle, Georgia. These things have gotten introduced, you know, by people taking them over there and letting them go. And then they get established in the dune areas in these coastal areas, you know, and seem to be doing great.

**Dean Williams** [02:04:50] But you move them around in Texas and it's just like almost impossible to get them to stick.

**Dean Williams** [02:04:57] And it's probably, I'm guessing, it's just more natural predators, more of their natural predators occur here.

**Dean Williams** [02:05:05] And, you know, it's getting high enough population numbers that they can overcome that predation level, I think is the key because, you know, they have very large clutch sizes for a lizard of their size. Most lizards, like spiny lizards and stuff, are not laying that number of eggs. And when you see that, that suggests that they probably are under high predation. They have to produce a lot, you know, in order just so that a few can make it into the next generation.

**Dean Williams** [02:05:39] And so, I think you probably will have to have multiple, many multiple females producing nests, successful nests, in order for a population to kind of be able to go on its own, basically after that. But that's something else we're trying to figure out is how to determine when you reach that threshold.

**David Todd** [02:06:09] Lots of challenges.

**Dean Williams** [02:06:11] Yeah.

**David Todd** [02:06:11] Well, I know that it's an intriguing thing, and I hope that it draws you in further and further. And thank you so much for sharing..

**Dean Williams** [02:06:23] Yeah.

**David Todd** [02:06:24] This whole adventure with us. It's fascinating.

**David Todd** [02:06:29] So, I should say thank you, and I guess fare-thee-well.

**Dean Williams** [02:06:35] Yeah.

**David Todd** [02:06:37] And hope that our paths cross sometime soon.

**Dean Williams** [02:06:40] Yeah, definitely. Yeah. Thank you. Yeah, It's been fun.

**David Todd** [02:06:45] Thanks.

**Dean Williams** [02:06:45] This has been fun, and the past 16 years have been fun. So.

**David Todd** [02:06:49] Well, good. And keep at it. I look forward to learning more about your studies.

**David Todd** [02:06:56] All righty. Well, you take care.