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**INTERVIEWEE:** Janet Tyburec

**INTERVIEWER:** David Todd

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**David Todd** [00:00:03] Well, good afternoon. I am David Todd, and I have the privilege of being here with Janet Tyburec. Did I pronounce it correctly? Before we go any further.

**Janet Tyburec** [00:00:13] It's Tyburec.

**David Todd** [00:00:15] Tyburec.

**Janet Tyburec** [00:00:16] Yes.

**David Todd** [00:00:16] Thanks very much for correcting me.

**Janet Tyburec** [00:00:17] No problem.

**David Todd** [00:00:19] And, with her permission, we plan on recording this interview for a research and educational work on behalf of a nonprofit group called the Conservation History Association of Texas. And for a book and a web site for Texas A&M University Press and for an archive at the Briscoe Center for American History at the University of Texas in Austin.

**David Todd** [00:00:42] And I want to emphasize here that she would have all rights to use the recording as she sees fit, too.

**David Todd** [00:00:48] And I wanted to make sure, before we go any further, that that's okay with her.

**Janet Tyburec** [00:00:55] Yeah, absolutely.

**David Todd** [00:00:56] Great. Okay. Well, let's, let's get started, then.

**David Todd** [00:01:00] It is Monday, November 14th, 2022, and it is about 2:50 p.m. Central Time, 1:50 Mountain Time, where Janet is. And again, my name is David Todd and I am representing the Conservation History Association of Texas and I am in Austin and we are fortunate to be doing a remote interview with Janet, who is based in the Tucson area.

**David Todd** [00:01:34] She has spent her career, so far, there's more to come, I'm sure, heavily involved in bat research, conservation and education work. From 1989 to 2012, I believe, she worked full-time and as a contractor for Bat Conservation International, and since 1992, she's offered more than 600 training classes in bat survey techniques through her firm, Bat Survey Solutions and other partners. In this same bat realm, she's written chapters about bats in the books "Cave Creek Canyon: Revealing the Heart of Arizona's Chiricahua Mountains", and in "A Natural History of the Sonoran Desert". And she's also the co-author of

"Bats of Oklahoma". Currently, she is especially interested in echolocation, call recording and analysis.

**David Todd** [00:02:34] And today we'll talk about her life and career to date and especially focus on her work with bats, focusing on the Mexican free-tailed bat is just one example of the really dizzying variety of bats out there in the world.

**David Todd** [00:02:55] So, Janet, so I was hoping you might be able to tell us about any experiences from your childhood that might have led you into your later interest in wildlife, and in bats in particular.

**Janet Tyburec** [00:03:09] Well, probably, like most people back in the sixties and seventies, I never really thought much about bats. You know, we always lived in the suburbs of cities. We didn't live right in town. We always had like an acre of land. And we played outside a lot as kids, but we were always in by the time the streetlights came on because we always sat down as a family for dinner. And my family wasn't a camping or hunting family, so we didn't spend a lot of time outdoors at night.

**Janet Tyburec** [00:03:46] And my real first exposure to bats was when I moved to Tucson, Arizona, when I was starting junior high school, middle school. And I had a fantastic science teacher who taught us all about the flora and the fauna of the Sonoran Desert. And each week we had different taxa to concentrate on. One week it was plants like legumes. The next week it was arthropods. Then it was cacti. And once it was mammals, and mammals included bats. And so I really had no idea that bats existed until I was about 12 years old.

**Janet Tyburec** [00:04:31] And of course, being new to the desert, it was so fantastic to come home at night, when we sat down for dinner, I could, I could tell my parents all about the stuff that was right outside our back door.

**Janet Tyburec** [00:04:42] And, that's when I became really interested in nature and outdoors. And from there, in high school, college, that, that interest just grew.

**Janet Tyburec** [00:04:54] And when I graduated from college, I was fortunate enough to get to work in Mexico for a colleague of Merlin Tuttle's, Dr. Ted Fleming, who was then from the University of Miami. He was working on a, on a bat cactus project, trying to look at the pollination biology of the columnar cacti in the Sonoran Desert, the cardo and the organ pipe and the saguaro. And I was there for the plant part of it, because I always thought I wanted to study plants because they were stationary. They were there from year to year. You didn't have to catch them and chase them across the countryside.

**Janet Tyburec** [00:05:34] And, we were taking tissue samples from birds and insects and bats to try to see how much of their daily diet was determined by the nectar from these cactus plants. And that's when I caught my first bat, and it was a California leaf-nosed bat, *Macrotus Californicus*. And it's a great, it's a fantastic bat. It's got huge ears. It's got big eyes. And I was hooked. I just thought, wow, there is so much about this whole bat thing that I don't know.

**Janet Tyburec** [00:06:08] And, after a summer in Mexico, Merlin Tuttle offered me a job at Bat Conservation International on the recommendation mainly of Ted Fleming. Plus, my major professor in college at Trinity University was a colleague of Merlin's as well. So, it's not always what you know in, in school, but it's the connections that you make along the way.

**Janet Tyburec** [00:06:28] And, I started working for BCI in the fall of 1989, and I was there full-time until 2002 and then as a contractor until 2012.

**David Todd** [00:06:43] So, that is a great trajectory. And it does seem so true that sometimes it's what you learn in textbooks, and sometimes it's the people that you meet who encourage you and pass you on to other people who can help you.

**Janet Tyburec** [00:07:03] Speaking of folks who can help you, I think that in some of the notes that you were kind to share with me earlier, there are some, some people in school, I think you mentioned your science teacher in Tucson, but I think you'd also told me a little bit about Dr. Paul Robertson at Trinity and Dr. Peter Marchand at UC-Boulder who were also helpful. And I thought maybe that might be a way to talk a little bit about your education and what you gleaned from that before you actually came out into the working world.

[00:07:43] Paul Robertson - he's just absolutely fantastic. He is a true ecologist and scientist and educator. I went to Trinity University, which is just chock-full of super, super scientists. And it's one of the things that drew me to the university when I was applying for college. They had just enormous resources and fantastic personnel. But Paul was really super special. He really cared about his students understanding the curriculum. He wasn't just there to be on the academic track and to publish. He was there to inspire his students. And that takes a really special teacher who could not only be at the top of his field, but also have that rapport with somebody where they could look at you and say, "Do you understand this? Do you understand what's going on? How could I make this easier for you?", as opposed to just standing up in front of a class of 30 or 40 people and phoning it in, like a lot of unfortunately, super scientists that are on tenure tracks will do.

**Janet Tyburec** [00:09:01] And Dr. Paul Marchand, Peter Marchand, Dr. Peter Marchand is very much the same way, very soft-spoken person, very humble and an accomplished author on winter ecology books. He's written a book called, "Life in the Cold", all about how different animals and plants adapt to freezing temperatures, drying environments, and all of that.

**Janet Tyburec** [00:09:31] And I was fortunate enough that he was teaching a class that I took one summer when I was in college, and it was a comparative alpine and desert ecosystem class. And we traveled all throughout the Southwest, through Arizona, Utah, Colorado and New Mexico, and we looked at different alpine and desert habitats, and compared and contrasted them. And it was a field course and we spent time outdoors camping and that's probably what hooked me the most on, on wildlife study and natural history.

**Janet Tyburec** [00:10:02] Most everybody who went to Trinity went, in the science track, to go pre-med, and most of them took the MCAT afterwards and were on the doctor track. And I was one of maybe a dozen of my cohort that did not go pre-med. And where I went was into the field. And I just absolutely loved being able to learn about animals, on the ground, up close and personal, in plants as well. And then it turns out I just really enjoy taking people out into the field and teaching them about these animals, especially the stuff that happens at night where most folks who have taken field classes in biology, a lot of the labs happen during the day, very few of them happen at night. And a lot of the students that I teach now in my workshops are either undergraduates or graduate students who haven't had a lot of opportunity to study animals after dark and certainly haven't had a lot of opportunity to study bats.

**Janet Tyburec** [00:11:10] And I take a lot of the enthusiasm and the humility that people like Dr. Paul Robertson and Dr. Peter Marchand have exhibited towards me while I was coming through my graduate studies, and try to pay that forward, because it was just, it was one of the most eye-opening things, I think, in my college life.

**David Todd** [00:11:38] Yeah. It must be a sort of out-of-body experience to try to put yourself in a person who's new to this field. And you've spent decades now thinking about, you know, your discipline and to try to remember what it's like to, to be maybe a little naive and, you know, uncertain of what all this means. Nice to, as you say, "pay it forward" from other people who treated you well like that.

**David Todd** [00:12:12] You know, aside from kind of the formal education you've gotten both in classrooms and in the field, I'd be curious to know if there might have been any books, or TV shows, or films, or other sort of cultural artifacts that were out there in the, the media world of who, that might have just, you know, encouraged you or enlightened you and got you interested in this, this type of life.

**Janet Tyburec** [00:12:42] Well, I've always been a big reader. I was a really shy, kind of a loner of a child. Not, not nearly outgoing, certainly not as outgoing as my mother wished I was. But, I loved books. And from a very early age, my room was just full of bookshelves.

**Janet Tyburec** [00:13:03] And, I like a lot of nonfiction books. I've always loved the writing of Jon Krakauer. Some of the things that he has done, of course, "Into the Wild", "Into Thin Air".

**Janet Tyburec** [00:13:17] I'm fascinated by the mind of Malcolm Gladwell - "What the Dog Saw", "The Tipping Point", "Outliers", "David and Goliath" - just a different way of thinking about things. I listened to his "Revisionist History" podcast today, and it reminds me a little bit of growing up in Wisconsin back in the days where you had, you know, three network TV channels and radio, and that was about it for entertainment. I would listen to Paul Harvey's show, "The Rest of the Story", with my parents and my grandparents. And I just loved the the deep dive into these facts, and then a little twist at the end, where now you know the rest of the story.

**Janet Tyburec** [00:14:05] And today, I still read. I read a lot of non-fiction. I'm fascinated by the natural world, about health and fitness, and even, you know, recent history. So, I've read a lot of David Quammen's books. I've read some of Barbara Kingsolver's more non-fiction type natural history books, and just a very broad interest in learning more things about things I don't know.

**David Todd** [00:14:38] Yeah. Isn't that great - to have that curiosity. That's a great arrow to have in your quiver.

**David Todd** [00:14:50] Were there any sort of TV shows or movies that you can recall that were meaningful to you?

**Janet Tyburec** [00:14:58] Well, as a child, I watched a lot of Mutual of Omaha's "Wild Kingdom". I didn't think I ever wanted to be Jim, you know, wrestling a water buffalo calf or anything in the Serengeti. But it was also fascinating to see that, yeah, people really do this.

**Janet Tyburec** [00:15:13] And it almost came full circle in that when I first got hired by Bat Conservation International, Merlin Tuttle was actually off filming his own sort of Mutual of

Omaha's "Wild Kingdom" with a British film company. And it was called, "The Secret World of Bats". And he traveled the globe. He went to Australia and Thailand and Africa, South Pacific Islands, and brought Dieter Plage, the cinematographer, along and showed them all the fascinating things about the world's then 980 species of bats is what I think that film had for the upper limit. And it was very much like that "Wild Kingdom" sort of TV show that I was watching back as a kid.

**David Todd** [00:16:06] That's nice. It must be very special to have seen it from the inside and the outside, from within the realm of people that really understood it, and then just as a kid learning about it.

**David Todd** [00:16:23] Well, so maybe you can help us learn a bit about, not all bats, today, because it's just too big a world, as you've taught me. But maybe we can just focus on one that's much loved here in Texas, the Mexican free-tailed bat. Could you possibly give us a quick introduction to its life history and the ecological niche that it fills?

**Janet Tyburec** [00:16:50] Well, the nifty thing about Mexican free-tailed bats is that they have a very broad range in the United States, not so much in the Northeast and the Northwest, but throughout the entire southern half of the country, they can be one of the most predominant bat species. So they may be the first bat that, that most of the general public come into contact with.

**Janet Tyburec** [00:17:17] They are more obvious than most species of bats. They roost in these huge colonies, in the tens of thousands, to hundreds of thousands, and into the millions. They live in big caves and old underground mines. But they'll also live in suburban and urban areas, in bridges and concrete stadiums, parking garages, culverts. And then smaller populations may roost in homes, in bat houses, under red-tile roofs. They are often the most ubiquitous species in in areas in which they occur.

**Janet Tyburec** [00:18:05] There are caves at national parks like Lava Beds National Monument up in Northern California, Carlsbad Caverns in New Mexico, that are open to the public for viewing. There are watchable wildlife places in bridges in Arizona and Texas, old railroad tunnels in Texas that have populations that are managed either by Bat Conservation International or by the Nature Conservancy, where people can go in and watch the out-flights. And to see the out-flight of a Mexican free-tailed colony is just magical.

**Janet Tyburec** [00:18:45] We had a group of people at a cave once. I don't know if it was Eckert James River or if it was Bracken Cave, but there was a little boy in the audience and he says, "Oh wow, they look like magic leaves". And they kind of do look like leaves that are caught up in a little, in a little eddy in the fall when it's nice and breezy and you've wrecked all your leaves up and then a little wind comes through. And the way the leaves spin into a little vortex, that's kind of what the bats look like when they emerge from a colony.

**Janet Tyburec** [00:19:19] And most of the populations that we have in the United States are transitory. They are active during the summer time. They arrive sometime in the spring, in April or May. The colonies usually build up to their largest numbers by June or July.

**Janet Tyburec** [00:19:40] A lot of the biggest colonies are maternity colonies, and after the females give birth, the young take about 4 to 6 weeks to learn to fly, and then they start making big out-flights with their mothers. And that's when the populations are the biggest and when the emergences are the most fascinating.

**Janet Tyburec** [00:19:59] But then, after the young can fly, they tend to break up into smaller colonies. They may be closer to foraging or drinking areas where there's not as much competition. And then they start planning their southward migration.

**Janet Tyburec** [00:20:12] They remain active year-round. They will go to Mexico, to warmer areas of the country, and hang out. Sometimes they drop into torpor when it gets especially cold, but for the most part they remain active.

**Janet Tyburec** [00:20:26] So, they have a mosaic of roosts across their known home range, and they are periodically in these roosts and will move around for reasons that only they know.

**Janet Tyburec** [00:20:42] So they're a little bit hard to study, especially when they're in these huge numbers that are very difficult to count and trying to figure out where the population goes in the fall. You'd have to tag so many of them, and then recapture them somehow to figure out what was going on.

**Janet Tyburec** [00:20:57] So, not much is known about any one population and those sort of fission / fusion dynamics of how they come together and split apart from year to year.

**Janet Tyburec** [00:21:08] They're also one of the most obvious bats because they've got a very distinctive smell. Sometimes you can smell a colony of free-tailed bats before you notice that you have them. It's kind of a musky, almost like a wet sneakers that have been in the cellar for too long. So they've got a very distinctive, pungent kind of odor.

**Janet Tyburec** [00:21:36] Some people don't like them, of course, because of that. But a lot of people who do like wildlife, will be, "Oh, do you smell that? Those are Mexican free-tails. There must be a roost around here. Let's come back at dusk and see what's going on."

**Janet Tyburec** [00:21:52] We've got a great bridge roost here in Tucson that I didn't really know about when I first moved back here. They weren't here when I grew up, but after I went to college in Texas, I came back in 1998 and I was at our local, local Trader Joe's, which is right on the Rillito River. And our rivers in Tucson don't have water in them, but we still call them rivers, because when it rains, they occasionally have water. But I was walking into Trader Joe's at dusk and everybody else was walking out and I thought, "Oh, my goodness, what's going on? Was there a fire alarm or something?" And I asked one of the cashiers who was walking out, "Oh no, the bats are coming out." And so everybody in the store walked out to the end of the parking lot that overlooked the bridge and watched the bats come out for five, 10 minutes and then went back in to go grocery shopping.

**Janet Tyburec** [00:22:39] So, they're a really, a really kind of special, popular animal in many areas of the country. So that's one of the reasons why they're kind of a touchstone species for people who know a lot about bats and also for people who you're trying to introduce into bats because they're, they're a lot more accessible than most species.

**David Todd** [00:23:02] And so you told us a little bit about where they live and, and their general cycle of maternity and then I guess, whelping, or whatever the bat term would be for growing old enough to be independent and fly on their own. Now, when they're out flying and foraging, what is it that they are feeding on?

**Janet Tyburec** [00:23:31] Well, this is another thing that, you know, until very recently, I mean, in the last couple of decades or so, we knew that they were insect-eating bats. Most of our bats in North America are insect-eating bats. But we didn't know exactly what they were feeding on. We knew what direction they went to. We knew what kind of habitats and roughly what kind of insect compositions were in those areas.

**Janet Tyburec** [00:23:55] But Gary McCracken from the University of Tennessee is one of the scientists that did the bulk of the research on Mexican free-tailed bat diets. He had some fantastic field surveys where he would go and put these acoustic microphones, bat detectors, up on weather balloons, and he would launch them into the areas where the bats were known to fly off at night. And then when the weather balloon would come back down, he would retrieve the bat detector and download the recordings that it had made.

**Janet Tyburec** [00:24:33] And, he would find feeding buzzes up at thousands of feet above the surface of the earth. And it turned out that the bats were feeding on these large migratory moth populations that were hopscotching into Texas from the Rio Grande Valley every spring. And the bats would exit their caves, and then they would converge on these areas of large moth migrations. And there was just this fantastic feeding frenzy going on up there.

**Janet Tyburec** [00:25:04] And then, with the advent of DNA barcoding, he was able to identify DNA signatures from certain pest species like the cotton bollworm moth and the corn earworm moth, and found these same DNA fragments in the guano of the bats back at the roosts. And so he could prove, without a shadow of a doubt, that the bats were not only foraging up at these high elevations where these moths were known to occur, but that their diet actually included these moths.

**Janet Tyburec** [00:25:45] And so, his studies have been replicated across the country and in foreign countries as well. In Australia, they've done some of the same type of experimentation. And it's been determined that these bats are contributing enormous amounts of economic services to the croplands across the United States, not just in central Texas, because they're the first line of defense in eliminating a lot of the moths that would make it into the grain belt of the Midwest and up along to the Canadian border. But a lot of these moths aren't making it up there because the bats are intercepting them beforehand.

**Janet Tyburec** [00:26:29] So they're contributing billions of dollars annually to agriculture in the United States and into other countries where similar species occur, mainly because if you don't have the larvae of these moths on your plants, you don't have to spray pesticides. And if you don't have the moths that are making it past the front lines of the Mexican free-tails in central Texas, then you don't have to worry about the moths reproducing and laying eggs on your plants. So it's this really wonderful, wonderful, synergistic relationship between the bats and the farmers that, because they're doing everything they do under the cover of darkness, has been largely unknown for centuries.

**David Todd** [00:27:23] Isn't that great - these sort of, these economic services, these kind of unseen servants, you know, the little elves that are toiling away, eating moths and protecting crops. That's a great story.

**David Todd** [00:27:41] So, I think you've given us a glimpse as to the lifecycle of these bats. And I'm wondering if you could help us understand sort of the longitudinal story, you know, how the population and habitat range may have been changing in recent years and maybe speculate a little bit about what may be some of the factors in the bats' fortunes that are bad.

**Janet Tyburec** [00:28:11] Well, like any bat species, anything that congregates in large, obvious colonies is at risk to disturbance at their roosts. And a lot of this is intentional disturbance from people who are afraid of bats, especially as you get further south. A lot of folks think every bat is a vampire bat and therefore bats must be destroyed.

**Janet Tyburec** [00:28:34] But with Mexican free-tailed bats, you know, they're stinky and they tend to aggregate in large numbers. And if you had a cave on your property, you might not like to have the bats in the area.

**Janet Tyburec** [00:28:49] One of the other neat things about these bats and any insect-eating bat, but especially these large colonies, is that because they eat insects, their guano is very rich in nitrogen and makes an excellent fertilizer. And back in the 1700s, 1800s, guano caves in the West Indies and in Latin America were sought after for the fertilizer trade. And you would have large ships that would take fertilizer back to Europe - guano ships. And even in central Texas, back in the 1800s and early 1900s, a lot of the known large Mexican free-tailed bat roosts in the area had been mined for their guano.

**Janet Tyburec** [00:29:35] When the bats were gone during the winter, then people could go in and shovel out the guano. This was a kind of a crummy, sweaty, heavy job. A lot of the caves had been breached. They put, like drilled big, almost like oil wells, but they were guano wells into the backs of the caves so that the guano could be vacuumed out and siphoned out. And many times this would create a chimney in the cave, and the cool air would sink in to the entrance of the cave, and then it would push the hot air up the chimney. And the caves were no longer good for these bats to rear young in, because they were just too cold and drafty because these, these holes had been punched into them.

**Janet Tyburec** [00:30:23] In Bracken Cave, the guano shaft was actually sunk at the very back of the cave, which was a little bit lower than the domed ceiling area where the bats roost. So it traditionally did have a large population of bats in it.

**Janet Tyburec** [00:30:39] And, because these bats are so close to Mexico, a lot of them don't really care about international borders or border walls, and they'll forage anywhere. And a big problem for bats that do this is they're very susceptible to pesticides that are being used in neighborhoods and, of course, on crops as well.

**Janet Tyburec** [00:31:00] You know, back in the sixties and seventies, big DDT trucks would come through and they would spray neighborhoods to get rid of mosquitoes in the summertime. But that had all been banned, finding out how dangerous DDT was to the health of people and other animals, of course. So it's been banned in the United States since the early seventies, but it was still produced and actually widely used in Mexico until about 2000. And northern Mexico is home to a lot of the winter crops that are grown for U.S. markets. And if bats are flying over those crops and becoming exposed to DDT, then they can absorb small bits of the poison into their fat reserves. And whenever they use up fat very quickly, like when they're migrating, or especially when females are lactating, if they haven't received a lethal dose during the spraying or the feeding, then they're metabolized and then the bats will succumb to the poisons a very far distance in time and in space from their initial exposure. So it makes population declines hard to recognize.

**Janet Tyburec** [00:32:15] But we have other scientists who have looked at guano cores in some of these caves and found significant DDT residues in them. We had a cave in Arizona,



Eagle Creek Cave, out in eastern Arizona on the New Mexico border that presumably had 25 to 50 million Mexican free-tailed bats in it historically, but it has no more bats in it now.

**Janet Tyburec** [00:32:41] They have since put a fly-over gate at the cave entrance and small populations of bats have rebounded. Interestingly, it's on property that is owned by a major mining company here in Arizona, Freeport-McMoRan. And they were very amenable to helping out with the gating of this cave. They're not using the area for any of their active copper mining, but they're willing to do something nice for wildlife so that they can continue to operate their copper mine, so that we can continue to have our electric lights, and our Teslas, and everything else that requires copper.

**David Todd** [00:33:24] That is really interesting - all the challenges that these bats have faced, you know, from the guano mining to the DDT exposure.

**David Todd** [00:33:38] And I guess a lot of this is stuff that you learned during the course of your career and I understand that, from very early days, you were involved at Bat Conservation International. And from what I understand, BCI started in 1982, arrived in Austin in '86, and you arrived at BCI very shortly after that. And I was wondering if you could tell us a little bit about the birth of BCI and then your arrival there. I think you told us a little bit about your introduction, I guess, through Ted Fleming, but maybe you can just tell, elaborate a little bit about the this organization which has been so key to bat protection.

**Janet Tyburec** [00:34:33] Yeah, that's another very interesting, I don't know if you would call it synergistic or coming-full-circle story about my life. I, of course, grew up in Milwaukee, Wisconsin, and Merlin Tuttle formed BCI in Milwaukee, Wisconsin, when he was working at the Milwaukee Public Museum.

**Janet Tyburec** [00:34:53] And then he moved out to Austin right around the time the Mexican free-tailed bats moved into the Congress Avenue Bridge downtown. And this was a big concern to the citizens of Austin and especially the lawmakers just up the street at the Capitol. They were so worried about this infestation of bats at the bridge. And there were terrible headlines at the time. And, of course, you know, all the news media picked up on those and it went across the country.

**Janet Tyburec** [00:35:26] And so, when Merlin caught wind of it in Milwaukee, he figured, well, if there's any place that needs some information about education and conservation of bats, it's Austin. So he picked up and moved his budding Bat Conservation International organization down to Austin, Texas. And at the time, it was just he and Mary Murphy, his assistant secretary, director of publications, and they both moved to a office at the University of Texas and soon outgrew that and hired a science staff and education staff and somebody who could do grants. And they produced a catalog of bat-related items to raise money for bat conservation. And right about that time, there were probably about half a dozen, 12, maybe a maximum of 12 people on staff when I got there in 1989.

**Janet Tyburec** [00:36:34] And one of my first jobs was to help in the Education Department, to help Pat Morton, who was the director of education, respond to requests for information from school kids, from teachers, from just the general public, doing press releases, working with folks to help provide good information about bats and to kind of alleviate some of the misinformation that was out there. We worked with homeowners and pest control companies, people that were afraid of having bats in their attic.

**Janet Tyburec** [00:37:14] And then very soon thereafter, we started doing one-day, two-day, three-day educator workshops and providing teachers with information about bats and using bats as a subject to teach other scientific subjects, like information about wildlife and animals in mammalogy, information about the physics of sound, like how they use echolocation, and talking about world history and how bats figured into different cultures. So we were using bats as our foil to get people excited about not only bats, but how teachers could use them to teach other people.

**Janet Tyburec** [00:37:54] And one of the other things that I did, first-off, was learn how to identify bats and how to catch bats. Merlin took me on several trips with him to do some bat catching and bat surveys while he was perfecting his photography techniques. Because all of the photos that he's taken over the years have been of wild-caught bats that he's brought into his little tent studio and taught them over the period of two or three nights to come on call, to fly through a beam break, to drink out of a little tabletop pond that he constructed. And that way he was able to get the most accurate looking photos of bats in the wild, without having to actually sit in front of a pond and wait for a bat to show up.

**Janet Tyburec** [00:38:43] And, at that point, we started thinking, well, there are a lot of folks out there who don't know how to catch bats, how to survey for bats. We found this out when we got some of our permits for catching bats in Arizona and New Mexico. And we would have some of the permitting agencies ask us if they could tag along with us. And so Merlin said, "Well, hey, why don't we teach bat survey workshops, bat conservation and management workshops?"

**Janet Tyburec** [00:39:11] And so he came up with a curriculum that not only included information about how to identify bats, the natural history of the different bats of the area, but also highlighting some of these bat conservation challenges and using his non-confrontational technique to build allies for bat conservation.

**Janet Tyburec** [00:39:35] We called it win-win solutions for bat conservation, where we would get members of industry and agriculture and forestry excited about doing just a little bit of good work for bats. But yet they were still going to cut down trees so that we could have paper and lumber, and they were still going to drill for oil so we could still drive our vehicles, and they were still going to mine for copper so that we could have our electric lights and all of this. But just making them aware of the very simple things that they can do to promote bat conservation, and to promote bats, and to promote habitat set-asides that would give them a good name for working with conservation and make them a little more aware of just how integrated our entire planet is and how we share all the same resources. And some of those resources happen to be wildlife and a lot of them happen to be bats.

**David Todd** [00:40:29] You know, you mentioned that some of your partners and collaborators at BCI were in the, a sort of industrial field, from forestry to oil and gas to mining. And one of the things I've always been intrigued by, and maybe you can explain a little bit more about it, is this idea of gating mines to protect them and yet to allow them to still be used for colonies. So can you talk about how that might have developed while you were at BCI?

**Janet Tyburec** [00:41:07] That is one of our best success stories for building partnerships for bat conservation. There are thousands of hard-rock mines across the country - huge, huge limestone mines in central Pennsylvania, in central Illinois, all along the karst regions of the country, and other iron ore mines up in the north, hard-rock mines in the western United

States, gold, silver, all of that. And once the ore, or the resource, plays out, then a lot of these places are boarded up and folks move on. Or they're not boarded up at all, they're just fenced off.

**Janet Tyburec** [00:41:57] One of the big limestone mines in central Pennsylvania had huge entrances, three or four of them, that you could drive an enormous dump truck through. And the mine happened to intersect some natural cave areas. And they were very dangerous for people who could just walk in after the mining of the limestone ceased. And it, the land, was purchased by a state park to interpret the mining history, but also to keep it safe for the park goers. And so the park back-filled all of these entrances with just tons and tons of earth and subsidence happened at the top of the fill. And just a little, probably 3- to 4-foot tall section of the entrance was then opened. And what this backfill did is it trapped a lot of cold air in this otherwise drafty mine and the temperatures became really stable and perfect for hibernating bats.

**Janet Tyburec** [00:42:58] And so the bats moved in and at one time we had ten, 15,000 bats hibernating in this mine, including some endangered Indiana myotis, which have been on the endangered species list since the mid-seventies. And so it became a very important conservation success story.

**Janet Tyburec** [00:43:16] And, we realized how a lot of these old hard-rock mines could be modified to become bat hibernacula, places where the bats could go and spend the winter and be completely undisturbed.

**Janet Tyburec** [00:43:31] But we had to keep people out. And so we outfitted these entrances with gates. And these gates are heavy-duty, steel, custom-made, build on-site structures that get set in the entrance or just inside the entrance that the bats can navigate and fly through, but that people can't squeeze through. And they're built with this angle iron construction, so that it's almost like the bars on the gates are louvers, like in a, in a shutter, like in a plantation shutter, so that the airflow does not get impeded by the width of the iron that is blocking the entrance now and creating the gate.

**Janet Tyburec** [00:44:20] So, it had almost no effect on airflow, but it had a great effect on keeping people out. And whenever you can keep people out of a hibernation site, if it happens to have the right temperature, then the bats will move back in because they can sleep all winter and be undisturbed.

**Janet Tyburec** [00:44:36] And so, this was a great technique for protecting some of these threatened populations of bats that had lost a lot of their traditional hibernation sites because traditionally they hibernated in caves, caves like maybe Carlsbad Caverns or Mammoth Cave in Kentucky and the karst regions and mountainous regions of the Eastern United States are just chock-full of caves. But once you commercialize a cave and put lights in and paths in and make the entrance bigger so people can walk in, you change the airflow. So the temperature changes inside the cave. And with the constant disturbance of all of the tourists, the bats can't rear young in the summertime. They can't hibernate in the wintertime. So they have to go elsewhere.

**Janet Tyburec** [00:45:21] And it turns out that they sought out these hard-rock mines. They weren't being mined anymore. People weren't generally going in them because there were no lights and paths, and the bats could spend the winter sleeping in these hard-rock mines, or they might spend the summer rearing young in them in different areas of the country.

**Janet Tyburec** [00:45:42] But, these mines, a lot of them, are also on private property or on public property or in private property that has been given to the state parks or the national parks or the forest system during land swaps. And there was a tremendous effort to backfill these mines, to make it safe for people who were recreating on these public lands. You know, people who were driving ATVs around in the desert out West here, they don't want to fall down a 200-foot mine shaft that isn't gated.

**Janet Tyburec** [00:46:14] And so, the traditional way of making these places safe was to backfill them. And a lot of times people would explore these areas because they knew there might be some nifty minerals in them, some tanzanite or some turquoise. Or some rock hounds would know that these things existed. But it was still a big liability.

**Janet Tyburec** [00:46:39] And, there was a certain site up in the Upper Peninsula of Michigan called Millie Hill Mine. And it was an old iron mine and it was a pit entrance. And the community up there who worked for the mining company knew that that particular mine had been played out and it was just up the hill from a town and they didn't want anybody to fall in and, you know, die and become a liability to the mining company. So they had a perimeter fence around it, but they decided they were going to backfill it permanently, and they were going to just dump tons and tons of earth down the shaft.

**Janet Tyburec** [00:47:18] And, a few of the folks knew of these plans, and they had been part of the mining company, they had been part of the mining community. They had maybe snuck over the fence a few times to rappel down into the site to practice roping techniques, or to see what was down there. And they heard that it was going to be backfilled. And so they said, "Okay, this is it. This is our last chance to go down there. Let's do this at midnight next week, and then we can say we've done it and then it'll be lost to us forever."

**Janet Tyburec** [00:47:53] And they don't usually go down in the winter time, but I guess the plans were to backfill it in the winter when it would be easier to get the equipment up to the hill through the trees that had no leaves. I don't know what it was.

**Janet Tyburec** [00:48:06] And these folks went down into the mine and they started exploring around and they got into a little side passage and there were thousands upon thousands of hibernating bats in this mine, and they didn't know what to do because first of all, they jumped the fence to get down there. And it wasn't really technically legal for them to be trespassing anyway.

**Janet Tyburec** [00:48:30] But they figured somebody had to know about this because, you know, they're hunters and fishers and they like wildlife. And they didn't think that the idea of entombing tens of thousands of hibernating bats while they slept was a very good idea.

**Janet Tyburec** [00:48:46] So, they called up Merlin Tuttle. They Googled "bats" or tried to figure out who knew anything about bats. And Merlin's, Merlin Tuttle's name came up, and the secretary at the time listened to the story and thought this was pretty important. And so they put him straight through to Merlin without a, without an appointment.

**Janet Tyburec** [00:49:09] And, they explained the story to Merlin. They said, "You know, we did this. We saw these bats. You're Mr. Merlin Tuttle, Mr. Bat Conservation International. Do something about it, but don't tell anybody that you heard it from us because we'll get into big trouble."

**Janet Tyburec** [00:49:28] And so, Merlin was, of course, in a quandary. He's like, "Well, what do I do? What do I do?"

**Janet Tyburec** [00:49:32] Well, he called up the Department of Natural Resources in Michigan, and he said, "Hey, I'm Merlin Tuttle, and I'm working with a bunch of folks in the upper Midwest about, you know, bats and hibernacula, and protecting hibernacula for bats. And we've talked to Wisconsin, we've talked to Illinois, we've talked to Indiana. And, you know, we'd like to talk to you too. We'll come up there and we'll do some surveys. We'll help you do some surveys, and see what you've got.

**Janet Tyburec** [00:50:00] And, the Department of Natural Resources said, "Oh, well, we don't have any bats that hibernate in Michigan."

**Janet Tyburec** [00:50:08] And, Merle says, "Well, that's, I find that so hard to believe. I've been studying bats all my life. I mean, I'm originally from Wisconsin. I know they have bats there and you're just across the lake. You must have bats."

**Janet Tyburec** [00:50:19] And, he says, "Well, let me check our heritage database".

**Janet Tyburec** [00:50:22] And, he says, "Well, I'm embarrassed to say, but we don't even have bats listed in our heritage database".

**Janet Tyburec** [00:50:26] And so, Merlin says, "Well, I'll tell you what, I've got a free week next week. How about if I come up and you show me some of your underground resources up there and I'll teach you about how to recognize signs of bats."

**Janet Tyburec** [00:50:41] And, I guess it must have been a slow winter. And he says, "Yeah, sure, fine. If you want to come up, we'll put somebody on the project."

**Janet Tyburec** [00:50:48] And so, Merlin came up to Michigan and they put some poor brand new biologist on the project, and Merlin took them down into these mines and they found so many hibernating bats. They of course didn't go into the Millie Hill mine, but they went into some other areas that were accessible and the biologists said "Wow, I don't know what I'm going to do".

**Janet Tyburec** [00:51:10] And, Merlin says, "You know, these hard-rock mines, they're just like these places here. They're going to have bats in them too."

**Janet Tyburec** [00:51:17] And, he says, "Well, you know, mining is the industry up here. There's no way I can go against the industry and say, 'Hey, wait, you know, we can't have these bulldozers come, we can't backfill these mines.'"

**Janet Tyburec** [00:51:27] And, Merlin says, "Well, I'll tell you what, why don't you book me into some of the grade schools here, and I will give a presentation on bats to the kids at the school".

**Janet Tyburec** [00:51:39] And, they said, "Okay, whatever you want".

**Janet Tyburec** [00:51:42] So, they booked him into a grade school and they filled the auditorium up with students, standing room only for the parents. And a lot of the parents of

course, were part of the mining industry and introduced Merlin as this National Geographic quality photographer who's traveled the globe studying bats.

**Janet Tyburec** [00:52:01] And, he happened to bring one of his flying foxes up with him too. We used to do this back in the nineties. We would travel with our, our ambassador bats.

**Janet Tyburec** [00:52:10] And, he showed a bunch of fancy pictures that he had taken. He told some really fantastic stories about his exploits. And then he told the kids, "Now, do you want to meet a real bat?" And so he pulled out this flying fox. Flying foxes look like Chihuahuas with wings. They've got really cute faces, big eyes. And they're very personable.

**Janet Tyburec** [00:52:31] And, the kids were just fascinated. They thought bats were the coolest animal in the world.

**Janet Tyburec** [00:52:36] And, Merlin ended his presentation saying, "Well, yeah, this is a really cool animal, but do you know you have even cooler bats here, and they are really cool because they're hibernating right now. They are asleep underground and they're in places like mines and caves. And you should never go into these roosts and disturb these bats in the winter time. But in the springtime, they are going to come back out. They are going to move into your barns and they're going to move into attics. They're going to move into hollow trees, and they're going to make it so much more comfortable for you to go fishing and boating and canoeing because they're going to eat their weight in insects every single night. And you're not going to have to worry about gnats and moths and mosquitoes. So you guys are super lucky here. You've got bats that are every bit as cool as this bat that I brought with me today."

**Janet Tyburec** [00:53:28] And, at the end of his presentation, the director of the mining company came up to him and said, "I have loved bats all my life and we have a site that we're about ready to close. But if you want to spend an extra day here, you can come down here and you can survey it for us and see if there's any bats in there."

**Janet Tyburec** [00:53:44] And, of course, that was the Millie Hill mine. They go down, they see all the hibernating bats and the mining engineer says, "We're going to do everything it takes to protect these bats."

**Janet Tyburec** [00:53:53] And so, they designed a very special cupola gate for this pit entrance because the entrance is just flush with the ground and it just goes down hundreds of feet. And the cupola is like a cage that sits on top of the entrance. And so, come spring, after the bats had left, they poured a footer they put a big culvert down in the entrance so that it would stabilize the entrance, and they put this cupola gate up and they had a press conference. The Department of Natural Resources, who didn't even know anything about bats before Merlin showed up, was there. The mining company and their representatives were there. The public was there.

**Janet Tyburec** [00:54:31] And, the representatives of the mining company actually started joining forces with BCI to teach bats assessments of mines workshops. And they went all over the Midwest with their curriculum about how easy it was to work with the Bat Conservation people, and that the cost of building these custom gates that the bats could go in and out of, that people couldn't, was actually less than the cost it would take to backfill some of these places, and then deal with the subsidence, and then deal with anybody who might be breaching the site to get in, or creating just a continual maintenance problem.

**Janet Tyburec** [00:55:13] So, it was a big win-win situation and because of that, we have excellent reputations. We, Bat Conservation International, has an excellent reputation with mining companies across the country and they've been some of our best allies working out West here. They worked with us. Freeport-McMoRan worked with us to get Eagle Creek Cave gated.

**Janet Tyburec** [00:55:35] And, they have a lot of big heavy equipment. And so they can donate equipment to bring steel and concrete up to some of these remote locations so that we can get these gates built. There are people whose entire life is building bat gates and coming up with new ways to be least restrictive to the bats moving in and out of the gates and being most restrictive to keeping people out.

**Janet Tyburec** [00:56:03] And, as a result, we've been able to reestablish populations of hundreds of thousands of bats in old hard-rock mines that have never had bats before. So combining the entrance modifications and creating these stable cold temperatures that bats need for hibernation, with these protective efforts like making these special bat gates, has really been a big boon for bat conservation across the United States.

**Janet Tyburec** [00:56:30] And, it's something that we could never do if it was just Bat Conservation International, a non-profit organization. But because we can leverage the cooperation that we have from these big mining industries, who maybe the cost of building a gate, you know, \$10,000, \$20,000, that's just a fraction of a percentage of their annual incomes, their annual revenues. So they're more than happy to do something like that because it's just a small portion. But if BCI had to raise that money, it would be a lot harder to do it.

**David Todd** [00:57:03] Hmm. Well, so you told us about some of these mines that have become roost sites for bats, some of these hard-rock mines in particular.

**David Todd** [00:57:19] And, I was wondering if you could talk a little bit about some of the roost sites that have become important, or maybe have long been important, in Texas, and how BCI became involved in protecting them. I think you mentioned the issue with the Congress Avenue Bridge, I think now called the Ann Richards Bridge. Maybe you could talk a little bit about the, about Bracken Cave and how it was secured so that it can remain a colony for many years in the future.

**Janet Tyburec** [00:58:00] Right. Bracken Cave has been, had been on private property for years and years. It was just a central Texas ranch where they had cattle, and cattle, and it was in the middle of the ranch property. And there might have been two or three ranchers that all shared, you know, borders along the area. And the access was controlled, you know. It was a gated, just a regular old ranch gate that was locked.

**Janet Tyburec** [00:58:32] And, when I first came to BCI, the director of science, Gary Graham, took me to see the bats at Bracken Cave, and we drove down this Texas limestone, dirt road and twisted through the juniper and arrived at the cave. And we're sitting there waiting for the bats to come out. And I guess he had forgotten to mention to the landowner that he was coming out, because it was courtesy to let them know if we're going to be there or not. And she showed up with her shotgun wanting to know who was there at the bat cave.

**Janet Tyburec** [00:59:06] So, that was a very, very interesting reception that I received before I started working for BCI.

**Janet Tyburec** [00:59:13] But, part of the things that were going on at BCI when I first started working there was acquiring not only the access to the cave, but also the land around the cave.

**Janet Tyburec** [00:59:23] And, you know, central Texas is nowhere near as lush as some of the other areas where you can successfully raise cattle. And the ranching industry was on the decline. A lot of the young kids didn't want to take over the ranch from the parents. And so, eventually, they were amenable to selling the property that the cave was under, and the access to it, and BCI was able to purchase it.

**Janet Tyburec** [00:59:53] And, the original intent was to develop it as a world-class destination for tourists and for researchers to study Mexican free-tailed bats. And elaborate plans were drawn up for a visitor center and all of this.

**Janet Tyburec** [01:00:09] But, this was right around the same time that David Bamberger was working on his ranch out near Johnson City and pulling out a lot of the cedar and reestablishing a lot of the springs and of course, building his fantastic chiroptorium, his very own bat cave on the ranch.

**Janet Tyburec** [01:00:29] And, his way of interpreting and protecting the bats was a lot more low-key and a lot more low-impact. And it was not just to interpret the bats, but also the whole central Texas grassland ecosystem, oak woodland ecosystem, and trying to reestablish some of the native plants and habitat compositions prior to running a bunch of cattle on these lands. And he was super successful at that.

**Janet Tyburec** [01:01:07] And so, there was a bit of a shift in the plan for Bracken. And Bracken is very much like that now, where the traditional guano-mining buildings are interpreted as part of the history of the site. And there's a lot of effort to remove invasives. And the site is open, sort of, to the public with reservations so that you make a reservation through BCI to visit the the place. And you can have more of a low-impact visit to the cave.

**Janet Tyburec** [01:01:46] And, because we were kind of successful in doing this without a lot of fancy fanfare, other sites in Texas were protected as well similarly, like the Eckert James River Bat Cave that the Nature Conservancy owns and manages, and the Fredericksburg Railroad Tunnel that Texas Parks and Wildlife owns and manages, we've been able to look at the impact of popularizing these sites as watchable wildlife facilities.

**Janet Tyburec** [01:02:24] And, one of the things we did out at Eckert James River, was we looked at the impact of visitation on the bat emergence, and we had an intern there one year who would provide educational information about the bats and then let people sit back and watch the emergence. And she would count how many people attended each emergence, and then when the bats came out that night. And she found out that for every person that was in attendance, the bats came out 2 to 5 minutes later. And if you've got 20 people in attendance, then all of a sudden the bats are coming out an hour later.

**Janet Tyburec** [01:03:05] Because the bats can hear people, they can hear your shoes as you're crunching through the gravel or through dried leaves. They could hear your voices as you're whispering, especially if you're, if you're whispering - you're making a lot of more high frequency sound. The clothes you wear, if you're wearing nylon or synthetic clothes, like a rain jacket or rain pants, much different than the noise you make when you're wearing cotton or or wool or natural materials.



**Janet Tyburec** [01:03:35] And, bats are pretty intelligent, and they are very, very savvy about the risk of predation at their entrances. So, if they hear a lot of stuff going on outside their entrance, they're going to be a little more wary about leaving.

**Janet Tyburec** [01:03:51] So, now we know that our public viewing sites for some of these places have to be well away from where the entrance is. A lot of these caves are sinkhole entrances, so that's not really a problem. But for some roosts like the Fredericksburg Railroad Tunnel, you could get pretty close to the entrance. So keeping people away from the entrance became really important when it came time to interpreting these sites.

**Janet Tyburec** [01:04:19] And, that's something that Carlsbad Caverns does at the National Park there. They have a huge auditorium, but they restrict talking and flash photography for the people that are watching. So we want people to be able to enjoy these sites. But, we also don't want to let the bats suffer at all or impact them negatively at all just by our presence.

**Janet Tyburec** [01:04:47] So, a lot of what BCI learned with Bracken Cave has been able to be applied to a lot of these other roosts across the country, really to good effect.

**David Todd** [01:04:57] That's fascinating.

**David Todd** [01:04:58] Well, you know, you've told us about two really large-scale kinds of roosts - these big abandoned mines and then these natural, I guess, they're caves of different sorts. Maybe you can talk about the bat houses, these small roost sites that people can build and hang on their own property and how BCI's, I guess, development of that helped spread awareness of bats and their need for protection.

**Janet Tyburec** [01:05:41] The Bat House Project was another project that was in its infancy when I started working at BCI. And for years and years and years, every backyard little nature shop had bird boxes and bat houses, bat boxes. And some of these bat boxes were just these little tiny shoebox-sized things.

**Janet Tyburec** [01:06:06] And, I think Merlin was getting frustrated to see that these nature companies were making money off of these bat houses that he didn't think had any chance of being occupied. And so he wanted to solve this once and for all. And he was, he had a science person on staff whose job it was to figure out where bats were occupying bat houses across the country and where they were not. And what were the commonalities about the houses that people were building for bats or buying for bats that were occupied versus not?

**Janet Tyburec** [01:06:47] And, that became the BCI Bat House Project. And it was, the culmination of that was a Bat House Builders handbook. And instead of debunking the idea about bat houses, BCI became one of the leading organizations that would certify a bat house as being bat-friendly and found out that if you had a house that was tall, at least two feet tall and wide, at least 18 inches wide, that had crevices that were between three quarters of an inch and an inch in width, that you were more likely to have bats in your bat house, than if you had something smaller or something with bigger crevices.

**Janet Tyburec** [01:07:38] And, the idea was to use bat houses as an alternate roost for bats that had traditionally been roosting in big old-growth hollow trees. But as our forests got logged so that we could build our houses, as we started homesteading the country, a lot of these bats lost their big old-growth, hollow trees, but they moved into the attics or to the barns that we used the trees to build. But then people decided, I don't want to live with bats in

my attic, or, oh, you know, my son is a teenager now. He needs more space. We're going to build out the attic. We don't want him living with a bunch of bat, so let's get rid of the bats.

**Janet Tyburec** [01:08:24] But, also realizing that, yeah, bats eat a lot of insects all summer long. Can we keep them close? Can we build them a special house that will attract them?

**Janet Tyburec** [01:08:33] Well, if you just put a bat house up in your backyard and you've got bats in your attic, they're not going to voluntarily move out of your attic to live in a bat house any more than if somebody parked an Airstream trailer in your driveway, you wouldn't move out of your 3000 square foot house to go live in the Airstream.

**Janet Tyburec** [01:08:52] So, the bats are the same way. They know the house is there. They're very curious. They're checking out crevices all the time, but they're not going to move in. But in the wintertime, when the bats go to hibernate, if you seal up the attic and you build it out and it becomes your son's new little special personal man cave. Then when the bats come back in the spring, they can't find the way into the attic anymore. But they remember there was this bat house on this pole nearby. So they're going to go move into that. Or they're going to move into your neighbor's attic. It just depends.

**Janet Tyburec** [01:09:24] But, eventually, people started getting a lot of success with attracting bats to bat houses that had been excluded from other roosts that they were using.

**Janet Tyburec** [01:09:34] And, we saw that there were certain commonalities amongst these bat houses. They were either on buildings, like on the side of the house where the attic entrance was, or on the side of a barn nearby, or on a pole free-standing.

**Janet Tyburec** [01:09:48] But, they weren't on a tree. The bats didn't like the houses that were on trees. So check that off. If you want to attract bats to a bat house, put it either on an existing structure or on a free-standing pole.

**Janet Tyburec** [01:10:00] And then, did they have southern exposure, northern exposure? Were they painted or were they unpainted? And we found out that bats are kind of like us. They don't like drafty houses any more than we do. So having them well-sealed so that there wasn't any air leaks around the top, that turned out to be very important. And the painting really helped to seal the houses as well, because it filled in some of those little micro credits that might be in the wood.

**Janet Tyburec** [01:10:25] And then, roughening up the landing pad. Some people who were observing their bats and their bat houses noticed that it was sometimes kind of hard for them to get into these houses. So they thought, "Well, why don't I just put a landing pad on there? It extends about four feet down from the back of the house, and it's rough enough so the bats can land on there and then turn upside down and creep up into the house."

**Janet Tyburec** [01:10:42] And so, we learned a lot from this bat house building project and that bat houses really do work. And where they work the best is where we're kicking bats out of a roost that they're currently living in.

**Janet Tyburec** [01:10:56] Where they also work well, is where they're roost-limited either because of development, loss of forest resources, disease like white nose. A lot of times we had big maternity colonies of little brown myotis - 10,000, 20,000 bats. But after white nose came through, we only had a couple hundred bats left from these colonies that seemed to be

immune or seemed to still be surviving. So they can't heat a big, drafty attic that could accommodate 10,000 bats, if there's just 100 of them. So they can't reproduce very well.

**Janet Tyburec** [01:11:36] But, they could move into a smaller bat house and they could live there, and they could heat that up, and they could reproduce very well, and then slowly recover from population declines. And so the bat houses are a really nice stop-gap measure for keeping bats on the landscape, until traditional roosts can come back online, until our forest management practices start preserving more and more old-growth trees that have the kind of crevices that bats can form colonies in, or where we can do these set-asides where we can protect old historic buildings that have bat roosts in them.

**Janet Tyburec** [01:12:15] We can create larger bat houses. Once our small bat houses fill up, then we can make double-wides and triple-wides, and we can make big bat condos that are four foot square or eight foot square.

**Janet Tyburec** [01:12:28] Any time we provide artificial roosts for bats or provide any kind of artificial management, man-made, man-controlled, water for wildlife, anything like that, there's a certain amount of maintenance that has to go on so that you don't create some sort of a population sink at that location. So having a diversity of bat houses available for bats turns out to be really important if they're going to be used to accommodate backyard bats or to be used as part of a large-scale insect control effort, you know, natural insect control effort.

**Janet Tyburec** [01:13:04] So, it's been something that's been really super successful and it's been something that has been spreading throughout the globe. There are people in lots of foreign countries that are successful in attracting their bat species to special bat houses.

**Janet Tyburec** [01:13:19] So, but, without Merlin's early suspicion about should these things really even be promoted or not, we wouldn't know very much about what it takes to attract bats to manmade roosts. But now we know what it takes, and we also know where it can be most successful.

**David Todd** [01:13:38] Well, this is great.

**David Todd** [01:13:39] You've told us about, you know, this big variety of roosts that are possible, you know, from mines to caves to these artificial bat houses. And I loved the way you explain how they work and how these partnerships and research efforts developed.

**David Todd** [01:14:04] And, I was hoping that you might be able to talk about how you have managed to write about bats for the general public, and maybe for folks that aren't really familiar and comfortable yet with a technical, complicated topic. You know, how do you, how do you introduce, and translate, in a sense, so that folks can understand, you know, what you're trying to explain to them?

**Janet Tyburec** [01:14:35] Well, I think that writing goes hand in hand with reading. And you can't be a voracious reader without also being a voracious writer. And I've always loved to write and people have always told me that I love to write too much. I will try to use every word I know whenever I write.

**Janet Tyburec** [01:14:54] And Merlin was a fantastic editor, a brutal editor, but a fantastic editor. There is not a single sentence that I could ever write that he couldn't cut the number of

words in about half. And so he taught me a lot about knowing my audience and then expressing my topic as efficiently as possible.

**Janet Tyburec** [01:15:19] But then I also like a lot of creative writers, I really love people who use metaphor and simile to explain complex scientific topics and make them easy for a layperson to understand. And when I come across really clever turns of phrase, I jot them down in a book. I have several notebooks that are just called, "Quotes". I have notes on my computer and on my phone that are called, "Quotes". When I hear something that is just really well-said, I like to capture it somehow because I really am so thankful for when I don't understand something and somebody can say, well, it's electrical engineering, it's complex, but if they can say, think about it this way, you know, and then you have that aha moment and any time you can give somebody an "Aha" moment, then it means so much to them.

**Janet Tyburec** [01:16:26] And, you know, everybody learns differently and everybody responds differently. And so if you can weave a variety of these little "economy of phrase", "knowing your audience", and then "creating those 'Aha' moments", that's something that I've always found to be very, very rewarding.

**Janet Tyburec** [01:16:47] I think all of us like to be understood. And when somebody can say to me, "Oh, that makes a lot of sense. Thank you so much for explaining it to me."

**Janet Tyburec** [01:16:55] And, I've been really fortunate to be involved in some, some great projects. I've done a couple book chapters on bats, one for a small publisher about the Chiricahua wilderness and Cave Creek Canyon in southeastern Arizona. This is a place where I've had the great fortune to be able to work for the past 32 consecutive years. And it's a neat little place, too. It's in the middle of nowhere - southeastern Arizona. There are a couple of little towns nearby, ranch families and a lot of retired naturalists who just love wildlife. And they live in this area rather rustically, you know, there's no Wal Mart nearby. There's not even a gas station nearby. But these people are just super passionate about the flora and fauna of the Chiricahuas.

**Janet Tyburec** [01:17:56] And, this book project united all of the people who had studied wildlife in the area and people who had studied the history in the area. And each one of us were responsible for a chapter. And of course, I did the chapter on bats. But we had chapters on jaguars and we had chapters on birds and we had chapters on the geology. And it was just such a fantastic collaborative effort. And it was a lot of other people who just really enjoy teaching people.

**Janet Tyburec** [01:18:24] And then, I had a more serious book chapter on bats in a Arizona Sonora Desert Museum publication about the natural history of the Sonoran Desert. And because, as a child, I was so enamored with this new desert I had moved to, that was a really nice project to be involved in as well.

**Janet Tyburec** [01:18:43] But again, an educational project, a place where you can take a certain skill set that you have and help somebody else understand not only what it's about, but why it is so important to you and why it's so fascinating to you and why it's so helpful to the, the world as a whole. Because really, we are a global community and everybody is interconnected. And the extent to which we have a better understanding of what's right outside our front door, we can all get along a little bit better.

**David Todd** [01:19:19] Well, and I gather that one of the ways you have been connecting with, you know, a larger community is not just through the printed word, although that's certainly a really effective way to do it. But, you've also, I gather, put together over what is it - over 200 bat research training sessions and bringing folks both to lecture halls but also to field sites. And I was hoping you could talk a little bit about how you've sort of developed your skills there and how you managed to connect with students that you work with in that kind of context.

**Janet Tyburec** [01:20:00] One of the best things about my life is my job teaching other people about bats, whether I am in a classroom and I'm talking to a bunch of teachers or to their students, or whether I am in the middle of nowhere in Nevada, at Great Basin National Park with a bunch of adults who want to learn more about how to capture and handle and record the echolocation calls of bats.

**Janet Tyburec** [01:20:27] It is so neat to get a group of people and provide them with information and see those little "Aha moments" happen. And it's super fulfilling for me as well to be able to change these people's lives and give them something that they're going to be able to take back and run with. And I've always had really good teachers, but I think the kind of teaching that I do is the best because I get these people for an hour, or I get these people for a day, or I might get them for eight consecutive days, but then I can send them off into the world. Like, they graduate and they're gone. And then I get a fresh group of people back in again.

**Janet Tyburec** [01:21:14] So, it's never boring. And I never think, "Oh, man, if it only weren't for this one student who does nothing but ask me questions." You can indulge anybody for eight days, but it's so much harder to indulge them for an entire semester or an entire school year. My sister is a teacher for the public school system here in Tucson, and her experience and my experience are very similar. But I think I have an easier job because I have a lot of people who come to my classes who want to learn these skills, who are there because they are interested in the subject I'm teaching.

**Janet Tyburec** [01:21:54] She has people in her classrooms who have to be there because the state says they do or their parents say they do. So it's, it's a little bit different.

**Janet Tyburec** [01:22:03] And, I feel fortunate that I'm able to do this for a living, because it's really ... nothing is more gratifying, I think, than being a teacher. Even if you're not a teacher, the ability to teach, like when my dad would be able to teach me how to use power tools, or my son can teach me how to work on my car. You know, it is so rare to have somebody who is not only very well-versed in a subject, but to have somebody who can also explain that subject to somebody who's not well-versed is really special.

**Janet Tyburec** [01:22:49] And, I tell all of my students in all of the classes that I teach, whether it's a day-long class or an eight day long class that you've put your entire life on hold to be here with me for this period of time. There is nothing that is a stupid question. There is nothing that you have to feel afraid to ask. And don't feel shy at all. If you know, I've explained this before, but you didn't hear it the first time or you didn't understand it the first time. I say, "I'll answer the same question until you're satisfied that you understand the answer", because I really want these folks to go away feeling like they got their money's worth out of the experience: that they were able to receive something in-kind for putting their life on hold to be with me.

**Janet Tyburec** [01:23:45] And, that's the type of personality that I bring to the classes that I teach. And I think it's because the people that I teach with also have that very altruistic attitude towards being there. The people like Joe Szewczak from Humboldt State University, who's the developer of a very sophisticated piece of software that analyzes about echolocation calls. He is every bit as altruistic about giving information to the students who really need the information to understand his software that I am when I do my classes, too.

**Janet Tyburec** [01:24:30] And, I really look up to people who have that skill set and I try to emulate them. And I think that's where my attitude towards teaching comes from, is because I want people to learn.

**David Todd** [01:24:44] And, I gather that what you're hoping that they will learn about are some of these methods that you've developed and learned yourself about bat inventory and monitoring. And as I see it from the outside, it looks like a very challenging kind of field of study and especially compared to terrestrial animals that might be active during the day.

**David Todd** [01:25:14] And, can you help us understand what some of these sort of major obstacles are to understanding more about the bat world?

**Janet Tyburec** [01:25:25] Well, bats are, of course, very difficult to study because they are active at night, because they fly, and because they're essentially silent to our ears. So, compared to rodents or birds or plants that have just, are going to stay put, they are very, very challenging.

**Janet Tyburec** [01:25:44] So, we have to capture them. We catch them with nets that are very fine. They're kind of like stringing a volleyball net between two poles, but much larger and much finer. They're called mist nets, kind of like the mist that arises off of a warm pool in the wintertime.

**Janet Tyburec** [01:26:03] We also use traps, but they're not little steel Sherman traps like you have for a rodent. These are big eight-foot tall by six-foot wide frames that have wires strung between them like a harp. And the bats detect the first line of wires and twist themselves sideways and hit the second line of wires and then fall down into a little canvas bag.

**Janet Tyburec** [01:26:30] We also use microphones to record their echolocation, but it's not like the microphone that you use on your phone to record somebody's conversation. We have ultrasonic microphones because they have to listen to the echolocation calls of the bats and record them. And so they have to sample sounds at rates that are 10 to 100 times that of what we have to sample for human voices.

**Janet Tyburec** [01:26:59] And, all of this technology is very niche, and it's not something that you can buy at the at Sportsman's Warehouse or a Cabela's. It's something that you have to order from special wildlife manufacturers. And they come with instruction books: "well, this is how you put a mist net up between two poles". But you can put a mist net up between two poles and still not catch anything, because you have to be savvy about how these bats are traveling through the habitat.

**Janet Tyburec** [01:27:30] Same with harp traps, and the same with these ultrasonic microphones that we use. We want to have the best chance of catching or recording our animals, and that's something that you only do out of practice.

**Janet Tyburec** [01:27:44] It's kind of like riding a horse. You can give somebody a horse and a bridle and a saddle and say, "Okay, go ahead, ride a horse". But you have to learn a lot more about the details of being successful at deploying these traps.

**Janet Tyburec** [01:28:00] And then, of course, you have to know how to handle the animal correctly. You have to know how to identify the animal correctly.

**Janet Tyburec** [01:28:08] And, it's, again, not something that every wildlife biologist leaves school having learned, because you have to do this out in nature. You have to travel to an area where you have a good chance of catching a lot of different species of bats if you want to teach species identification. You have to go to a place where it's not going to rain for weeks at a time so that you can use these high-frequency microphones to record the bats as they're flying through the air.

**Janet Tyburec** [01:28:33] So, we bring people out into the field and we acquaint them with the equipment and the concepts during the day in classroom settings and in laboratory settings. And then we take them out into the field at night and we practice these things and we'll do this for up to seven consecutive nights. And in eight days, people can get about as much instruction as you might get in half a semester of a college course.

**Janet Tyburec** [01:29:02] So, it's really, it's very challenging. But once people leave after seven days, they are so far up that learning curve that they have a chance of being successful when they go back on their own. If they would have just read a bunch of dry texts and looked at a bunch of illustrations, they still would have made a lot of mistakes.

**Janet Tyburec** [01:29:26] And, the neat thing about the people I work with, the people that I have to help me instruct, is that we've all made a lot of mistakes. And so we can teach people from the mistakes that we've made so that they don't have to go through that same frustration again. And that's one of the things that I like to see the most, is you give somebody who's never played with a bat detector before, or who's never looked at what an echolocation call looks like that's been digitized and then translated into a spectrogram, and you can tell them how to use the bat detector, how to analyze the echolocation call.

**Janet Tyburec** [01:30:05] And, after just four or five days, then all of a sudden they're having their "Aha moments", and they're saying, "I can see the difference between a Mexican free-tailed bat and a hoary bat. I know look what they look like in the hand. I know what their echolocation calls look like on the screen. I feel so much more competent now to take this technology back and apply it to my own job."

**David Todd** [01:30:31] That's nice that you teach these students and then they become teachers in their own right.

**David Todd** [01:30:40] So, you mentioned a little bit about mist nets and these harp traps and the, some of the sound recording. Something else that I think you've told me about in the past involved banding and using radio tags. Could you tell us a little bit about those methods?

**Janet Tyburec** [01:31:04] Right. Bats, again, are difficult, more difficult than other animals. You know, we banded birds a lot. We stick little bands on their legs. And then when we see them with our binoculars in a tree, we can say, oh, look, that's crow number 26 or that's

Mexican jay with the red right foot or the yellow left foot. And then we can write this down on a piece of paper and say, "Yeah, we've, we've observed our target animals again".

**Janet Tyburec** [01:31:37] With bats, it's not easy to see their bands. We don't put them on their legs, we put them on their forearms, and they're much tinier because they are much tinier. And the only time we can see them with binoculars is when they might be hibernating in a cave. And then, of course, we need supplemental light, and we might need to take a picture so that we can figure out what the band number is.

**Janet Tyburec** [01:32:02] And, of course, if we're in a cave with hibernating bats, we're disturbing them. So that's not a really good way to observe bats.

**Janet Tyburec** [01:32:11] But we can catch a bat and band it, and then release it and hope that we catch it again. But unlike some animals like rodents, where they can become trap-happy, of course, because we're baiting their traps with peanut butter on a Ritz cracker or something, with bats, we're not baiting them at all. In fact, we're catching them out of the mid-air in a mist net, which is kind of like when a, when a motorcycle cop catches you speeding and gives you a ticket, you know, you don't really feel like going anywhere near motorcycle cops again after that happens.

**Janet Tyburec** [01:32:45] And so, the bats don't often get recaptured. So, our recapture rates with banding are really, really low.

**Janet Tyburec** [01:32:52] And because banding can be so disruptive to so many species of bats, especially if you're banding them in a hibernation site, the U.S. Fish and Wildlife Service doesn't even authorize band numbers for bats anymore, and they haven't since the seventies.

**Janet Tyburec** [01:33:05] So, they are only really useful for very small, isolated surveys of bats that have very small home ranges. It's not anything that we could ever band all the bats in Bracken Cave and figure out where they show back up on the landscape.

**Janet Tyburec** [01:33:22] So, we will also radio-tag bats just like you can radio-tag a mountain sheep or a black bear. But we don't put collars on them. We glue little, tiny, battery-operated antennas to the middle of their back where they can't reach it and groom it off, and then we let them go.

**Janet Tyburec** [01:33:43] Unfortunately, bats are very small. Most of our North American bats weigh about 6 to 10 grams, which is, a gram is about as, as heavy as a single peanut or a single plain M&M. And you can imagine a handful of M&M is not very much. And that's what most of our bats are.

**Janet Tyburec** [01:34:03] And so, we can't put heavy tags on them. We can only put a tag on them that is 5% of their body weight if we're trying to get foraging studies and only about 10% of the body weight if we're trying to get roost studies. So we're pretty limited on what we can do.

**Janet Tyburec** [01:34:18] And so, our radio-tag batteries only last for about ten days to two weeks. We can only get a very small snapshot of what that bat is doing throughout its entire life.



**Janet Tyburec** [01:34:30] But, we've learned a lot about many of our bat species that are more over-dispersed in a habitat where they form much smaller colonies and they move their colonies from roost to roost to roost throughout the season, depending on where the water is, where the insects are, what their thermodynamic needs are as they emerge from hibernation in the spring, form maternity colonies in the summer, and then go back into hibernation in the fall.

**Janet Tyburec** [01:35:01] So, if we tag bats in sequence throughout the season from a single colony, we can learn a little bit more about what that population does.

**Janet Tyburec** [01:35:10] But, it's still very, very challenging, because with a black bear, you know, you've got a couple of years to follow that animal and you can check in on him, you know, every Monday morning and see where he is. But with a bat, you have to follow that bat day and night until that battery dies. Otherwise you're losing data.

**Janet Tyburec** [01:35:30] So, it's very, very challenging. It takes a lot of people with a lot of antennas and a lot of vehicles to go moving across the countryside to try to catch up with bats.

**Janet Tyburec** [01:35:41] But, it can be done. And some really fascinating studies have come out of radio-tagging bats. And the technology gets smaller and smaller every year. The batteries get better and better every year. Some of these tags have GPS locators on them so we can track them across the landscape with big net towers, big meteorological towers. And GPS antennas, marine radar, that kind of thing.

**Janet Tyburec** [01:36:08] So, eventually, our technology will become even more advanced, and our abilities to, to keep up with these bats are going to become better and better. But it's still super challenging.

**David Todd** [01:36:21] You know, two of the ways that I think you have monitored bats are really intriguing to me. One would be thermal imaging video and then the last would be something that I hope we can spend a little bit more time talking about. And that's this monitoring their calls and their echolocation sounds. Can you talk a bit about those, those two ways to track bats?

**Janet Tyburec** [01:36:52] The thermal imaging video studies - again, it's a very new technology, but they're ideal for bats because bats are mammals, so they're warm-blooded and they are active at night and they're flighted, which is very energetically expensive. Nighttime is cooler. The expense of flight makes the bats heat up. So there's a really great difference between a bat flying against the cold night sky. So they're very easy to see with thermal scopes.

**Janet Tyburec** [01:37:28] Unfortunately, the thermal cameras aren't as, the resolution isn't as precise. So we can't often see what species we have. And then, of course, the bats are super fast too, when they're flying.

**Janet Tyburec** [01:37:44] But, we can tell that we have a bat versus a bird, depending on where the heat signature is in the body of the bat. Most bat wings are very cool and their bodies are very hot, whereas a lot of bird wings, you see a radiating heat signature throughout the wings. So they have been very useful in looking at the differences between bird activity and bat activity at night.

**Janet Tyburec** [01:38:08] And, counting bats as they emerge from a roost, as long as the roost is up against a dark sky, as opposed to maybe a warm building or a slightly warmer line of trees. So that's where thermal imaging is, is very helpful for bats.

**Janet Tyburec** [01:38:28] Not very helpful for hibernating bats, because when a bat hibernates, it drops its temperature down to the temperature of its surroundings. So, there's very little temperature difference in a hibernating bat.

**Janet Tyburec** [01:38:43] The other technique that we use for surveying for bats is more of a hands-off technique, and that is recording their echolocation calls. And the premise with that is that bats will produce species-specific echolocation calls, much like birds will produce species-specific bird calls.

**Janet Tyburec** [01:39:08] But, unfortunately, when a bat echolocates, it's not vocalizing to announce its species to another bat, it's vocalizing to solve a navigational problem. And as a bat's navigational problems become similar, like approaching a tree line, or getting a drink out of a pool, then their echolocation signatures become similar and they become less species-specific.

**Janet Tyburec** [01:39:38] So, what we've tried to do is we've tried to record the entire acoustic repertoire of known species of bats as we catch them, as we identify them, as we release them, as we release them maybe with a light tag on them, or tether them to a little zip line so that they stay in the area. We've been able to build a whole library of the vocal repertoire of these bats, and then see where the species-specific call types are. And then we train our computers to identify that.

**Janet Tyburec** [01:40:11] One of the ways that bat detectors are used are in an active manner, where you can record the bat call as you're watching the bat travel through an area, and then you can either listen to the converted sound output as it gets lowered in frequency so that we can hear it.

**Janet Tyburec** [01:40:30] Or, you can look at the spectrogram of the bat call on a computer screen and you can see what the bat is doing as it's moving past your bat detector. And you can use your eyes to see is it moving fast? Is it moving slow? Does it have stubby wings? Does it have long, narrow wings?

**Janet Tyburec** [01:40:50] The other way we can use bat detectors is by putting our microphones on a stick out in the woods and let it record all night long. Let it record for a week. Let it record for a month. Let it record for an entire year. And then download the data periodically and see how the bat activity changes over time, how the species activity changes over time, and when certain species are in an area versus not in an area if they happen to be migrating through an area.

**Janet Tyburec** [01:41:28] So you can get a lot of sort of passive information from these bat detector studies, as long as you have something that will keep running all night long, all week long, all month long, all year long. And you have the ability to analyze the data because you collect a lot of data. And so we have to have some computerized way of winnowing through that data to spit out the confident data, and to ignore some of the junk data.

**Janet Tyburec** [01:42:00] Because anytime you have just a microphone sitting on a stick, it's just like having a trail camera out there. Sometimes you get that perfect picture of that jaguar

that has just the right exposure where you can tell which individual it is because of the spot pattern on it. Other times all you get is a blur as it's going through your camera field of view too quickly. Or you just get like the tail end of the back of the jaguar and you have no idea which one it is. That happens a lot with some of our echolocation calls as well.

**Janet Tyburec** [01:42:30] But, it has been a fantastic way to cover a large area, or a long period of time, without having somebody to have to be there, mist-netting, or harp-trapping the bats, or catching them some other way. So that is one way that we've really been able to advance what we know about what these bats are doing over the season and sometimes, you know, over their lives.

**Janet Tyburec** [01:42:58] There are large clearinghouses that store acoustic data and summaries of acoustic data. The North American Bat Monitoring Program, NABAT, and the BATAMP, which is the Bat Acoustic Monitoring Program with a databasing group, they're able to, for the first time have longitudinal survey data on bat activity and occurrence across the entire continent. So it's really exciting that we have this.

**David Todd** [01:43:31] You know, it's, it's nice that there's this network of folks, the North American Bat Monitoring Program and the Bat Acoustic Monitoring Portal that seem to be giving you this sort of robustness that, you know, you're probably looking for in a kind of study field that is just so hard. I mean, I think about, you know, working at night with something that is moving, and moving fast even.

**David Todd** [01:44:04] And I was wondering if you could talk about some of the, the difficulties and challenges that you hit between, you know, false negatives and false positives and trying to distinguish bats that are, I gather, sorting themselves by gender and, you know, different seasons of the year, you may see them in different states or even in different countries. Can you give us some sense of the, the mystery of this, this kind of study that you've taken on?

**Janet Tyburec** [01:44:44] Oh, there is so much mystery involved in bats. And every time I give one of these interviews, I think if a bat could listen to me trying to explain what he's doing with his echolocation, he would just laugh at me because my knowledge of his abilities is so pedantic. There's not a year that goes by that we haven't been like slapped in the face by these bats, figuratively, of course, where we think we know what's going on, we think we know what's happening, and then all of a sudden they do something that throws us for a loop.

**Janet Tyburec** [01:45:15] But that's, that's kind of like science, too, because what is science, but, but looking at systems and making predictions, and testing hypotheses, and seeing if you're right, and then doing it all over again. And that's one of the things that we do with these bats, because everything we know about their echolocation repertoires is based on a finite set of data. And there's going to be a time when a bat is going to do something that is going to be not fitting nicely in that data space that we thought we had for him, you know. But that's all part of the learning process.

**Janet Tyburec** [01:45:48] And, it's part of the excitement, too, because it's never going to get dull. It's never going to be boring. You know, it's not like the rules of physics that haven't changed for years and years and years. So I think it is definitely challenging and there's always a chance that we're going to be wrong. But if we stick with it, there are so many times when we can have those "Aha moments" as scientists and as researchers and as experienced people that are going to be real game changers for us.

**David Todd** [01:46:19] Well, and I gather that part of the way you're learning about bats is by working with different kinds of partners. And there are two that come to mind right now, and I'm sure there are others, but I was interested to learn that through this, I think it's called the Sikes Act, some of these Department of Defense tracts of land have had to be managed for the natural resources that are found there. And then secondly, I guess some of your more recent collaborations have been with pecan auctions, many of which are in Texas, of course. And maybe you can talk about those two places and groups of people that you've been working with.

**Janet Tyburec** [01:47:08] Since I started doing these training workshops, I had no idea how often I would be working with wildlife biologists that are Department of Defense employees. And, I had no idea how much buffer land most of these military installations have. And because of the Sikes Act of 1960, the U.S. government has said that these buffer lands need to be managed for the fish and wildlife and plants that are on these areas. And some of this buffer land is some of the most protected natural habitat that we still have in in North America.

**Janet Tyburec** [01:47:54] And, just like we have a military mission to train our people to fly jets and to fly drones and to do cyber intelligence, we also have wildlife biologists that protect the buffers on the lands where these people work. And they need to learn survey techniques, too. And a lot of them work hand-in-hand with the military mission to make sure that these bases are safe for the military operations, but then also safe for the wildlife that wanders near the military operations.

**Janet Tyburec** [01:48:38] So, it's been it's been really neat. I've worked at the Picatinny Arsenal in New Jersey and the wildlife biologist there has done some great work with bat houses, and with managing building roosts for bats, and keeping bats out of buildings where they don't want them to be in there. And it's just, it's so nice to see an organization that you think would not really care that much at all about native wildlife that has this mission. And it's part of their part of their marching orders. And we've made some really great collaborations with these folks, and that's been great to work with.

**Janet Tyburec** [01:49:20] But, you're right, the pecan work that I've been doing this year has been really rewarding for me. And again, it's an example of one of those things that happen to you that you don't really spend a lot of time thinking about, but then all of a sudden you have this "Aha moment". And this is something that Merlin Tuttle got me involved with during the pandemic. He had met a pecan grower, Troy Swift, from Swift River Pecans out near San Marcos. And he said, "Oh, Troy's a fascinating guy. He's all about restorative agriculture. We're trying to get bat houses on his property. We need to know what kind of bats are flying over his property."

**Janet Tyburec** [01:50:12] And, that's just a perfect, perfect plan for me to use my capture techniques and my acoustic survey methods to investigate an area that we didn't have very much information about. And I was really excited to be a part of it. And so I said, "Yeah, I'll help you out for whatever you need". And I visited the orchard in April to learn about the the landscape and the resources that were there, and to perform the first bat survey.

**Janet Tyburec** [01:50:52] We did four nights of capture using mist nets and harp traps, and we did, during those four nights, we had six consecutive nights of acoustic surveys that were passive, where we had a bat detector out recording all night long at five different locations.

We were in the commercial orchard on both of his properties and we were in the native pecan forest. And then we were also near the bat house installations that he had begun to put up.

**Janet Tyburec** [01:51:27] And, we were looking at the bats that we recorded versus the bats that we captured. When we capture a bat, it's a unique individual and we can tell if it's male or female. We can tell if it's reproductive. We can weigh it. We can see how healthy it is.

**Janet Tyburec** [01:51:44] If we record a bat, we have no idea if when we record 300 Mexican free-tailed bats, if it's 300 different Mexican free-tail bats, or just one Mexican free-tail bat flying past our microphone 300 times.

**Janet Tyburec** [01:51:57] So, by combining the capture and the acoustic records, we can look at the relative species composition that we catch, versus that which we record. And we can get a much better picture of the type of species that are flying over the orchards. And if there's a difference in the species that are flying over the commercial orchards, versus the native pecan forest, and we can then design bat houses that we have known from our previous research are going to accommodate those particular species.

**Janet Tyburec** [01:52:34] And, we repeated the same survey in September to see if there were any seasonal differences in the relative bat compositions there. And we were able to document seven different species of bats acoustically. And of those seven, we were able to capture four of them physically.

**Janet Tyburec** [01:52:53] And, our most common bat that we captured was the Eastern red bat, which doesn't use bat houses at all. It roosts out among the foliage of trees, and the native pecan trees would provide perfect roosts for these bats.

**Janet Tyburec** [01:53:07] And, the bat that we recorded most often was the Mexican free-tailed bat, which we never captured.

**Janet Tyburec** [01:53:16] And then, we also captured or we recorded some additional bat species in the area, too, that we didn't capture.

**Janet Tyburec** [01:53:25] But, it gave us a much better, more complete picture of the total species diversity in the area. And then we could look at the relative species presence by looking at the relative numbers of bat calls we got acoustically from these different species.

**Janet Tyburec** [01:53:44] And, even though the Mexican free-tailed bat was the most common bat to record, it was certainly not the most common bat that we captured. And that's because all of these survey techniques have certain biases. But if we just were to use one technique, then we would have just a snapshot, we wouldn't have a complete picture.

**Janet Tyburec** [01:54:04] And the capture techniques were really challenging in this area because we rely on capturing in places where bats are funneling together and the pecan forest was a very diffuse type of habitat. The bats can fly just about anywhere they wanted.

**Janet Tyburec** [01:54:20] So, I think we put up between 1000 and 2000 linear feet of net during each of the surveys, which is a huge amount of netting. It's a huge effort to capture these bats. And then we also recorded between 7000 and 12,000 unique bat passes. That's every time a bat passed the microphone during each of the surveys.

**Janet Tyburec** [01:54:49] So, it's an enormous amount of data, but we learned a lot about what kind of bats were in the area and what kind of bats to expect in the bat houses.

**Janet Tyburec** [01:54:59] And then, also, as a side, I got to learn a lot about what it takes to grow a commercial nut, a pecan. And it's the only native commercial nut in North America. And I had no idea about that. And just how extensive the pecan growing is in the southern United States, and the different measures that the pecan growers in the area around San Marcos are doing in order to practice this restorative agriculture, in order to balance the need for an economically successful crop and an ecologically successful growing area.

**Janet Tyburec** [01:55:43] And, it was just a part of the grocery store items that I buy that I never really thought about how they get there. And then to be in a native pecan forest, I had no idea these places existed either. Even though I spent a long time of my professional life in central Texas.

**Janet Tyburec** [01:56:05] So, it was a really special, synergistic opportunity to not only learn about the bats in the area and teach the pecan growers what kind of bats were in the area and how to manage for them, but also for myself to learn about a habitat that I had never really given much thought to.

**David Todd** [01:56:28] Well, it's great to hear about your experience there. And I was wondering from your time being in the pecan orchards, what you might have learned about why somebody like Troy Swift, a pecan grower, might want to learn about bats. You know,, what use would that be to him besides, you know, his curiosity about how the natural world works. But, as a pecan grower what was it that he was trying to gain from what you were practicing and teaching there?

**Janet Tyburec** [01:57:10] Well, bats, just like the birds that live in the pecan orchards and the forest, and the other insects that live there, everybody's got to eat. And they all eat something. And some of them eat pecans. Some of them eat leaves. Some of them eat insects. And a lot of the bats apparently eat some pretty significant pecan pests. And they're hoping that by installing these bat houses along the perimeters of the cultivated groves, they can attract a hungry population of bats that will consume enough of the insect pests that they're not going to have to use any kind of chemicals to spray their crops, or any kind of other mechanical means to control the insects that are on the crops.

**Janet Tyburec** [01:58:06] And, that by having wildflowers and understory plants and bat houses and bluebird boxes and turkeys, somebody is going to be eating something at some part of the year that's going to just make the entire ecosystem a little bit healthier and a little bit easier to manage, especially in uncertain times of excess rain, excess drought, excess heat, excess cold. It all becomes part of the balance of nature.

**Janet Tyburec** [01:58:38] And, it was so neat to be around Troy because he's interested in absolutely everything. You know, he's, of course, interested in making money off of his pecans, but he's also interested in being successful at attracting bats, in lowering the chemicals that he has to spray for insects or for fungicides or for herbicides, and just being part of nature, as opposed to trying to control nature to his own needs.

**Janet Tyburec** [01:59:12] And, I think that's a great place that we can all move. And bats are just a tiny little piece of that. But if we can showcase what Troy's doing with the pecans and the bats and the butterflies and the bees and all the other critters that he has over there, then I

think it can really open people's eyes about, "Yeah, we are all so connected on this planet, and if I do something over here that's thoughtless, then something else is going to happen over there that's not going to be so nice."

**David Todd** [01:59:49] So, you know, earlier you talked about the opportunity that a place like Bracken Cave provides for folks who want to come and see bats and appreciate them and learn about them.

**David Todd** [02:00:06] And, I was wondering about some of these caves that have been turned into show caves - Inner Space Cavern, Longhorn Cavern, Natural Bridge, Caverns of Sonora - you know, big, very beautiful caves that I imagine, some of them, were at one time roosts for bats. And I was curious if you have some insights about how they might be restored to be bat colony sites.

**Janet Tyburec** [02:00:40] That would be, that would be a lot more challenging. They may never be restored to be bat colony sites. A place like Natural Bridge Caverns or Carlsbad Caverns - they serve such an educational benefit that if we can provide them with the facts about bats and they can reach a million people a year, like Carlsbad Caverns could do, or several hundred thousand people a year, like Natural Bridge Caverns probably can, then that's much more impact than what I can do with my training workshops or with my bat surveys where I impact maybe 100 people a year and all of their contacts.

**Janet Tyburec** [02:01:32] But, most of those people are already kind of drinking the wildlife conservation Kool-Aid. I think a lot of the people who go to Carlsbad and to Natural Bridge, they are people from all walks of life. And if you can inspire just one kid from New Jersey or from Fargo, North Dakota, who says, "Oh, my gosh, this bat stuff is fascinating. I want to study bats in high school, in college. I want to become somebody who studies bats." You know, then we can have a huge impact in an arena that we don't currently work in.

**Janet Tyburec** [02:02:12] So, reestablishing the population at those places, those show caves, may never be really super high on the priority list, but providing them with examples of bat conservation at like these hard-rock mines that are just really helping these populations that have suffered enormous population declines is really important and just providing that information is going to have a big impact rather than trying to stifle their show cave economy so that we can promote that conservation.

**David Todd** [02:02:55] I see. So these show caves give you a wonderful audience to try to teach about bats, especially for folks who may not have been exposed to bats or have been thinking about them in the past.

**Janet Tyburec** [02:03:09] Or, who may never think that that's something that they want to pick up. They may not have ever thought about bats, but then when they go to the show cave because they really love caves, then they'll say, "Oh, yeah, there's this bat thing going on. That's, that's interesting."

**David Todd** [02:03:26] Well, you know, one thing that has been interesting to me and tragic as well is this phenomenon, the white nose syndrome that has really devastated so many bats, not Mexican free-tails that we've been talking a good deal about but others. And I was wondering if you could talk about, you know, what white nose syndrome is. And then since you're such an expert in monitoring, what some of the issues are, almost ethical issues, that

arise when surveys are attempted for these bats and, you know, where you may be actually at sort of counter, cross-purposes with protecting the bats.

**Janet Tyburec** [02:04:10] White nose syndrome is definitely a tragic situation that emerged in the United States in the winter of 2006-2007. It is a introduced fungal pathogen, probably from Europe, probably introduced by humans, possibly cavers, who had dirty gear that brought it into a cave. And when bats are hibernating, they reduce their body temperature to that of their surroundings. And the bats that hibernate up in the Northeast pack in cheek-by-jowl in big populations of thousands to ten thousands to hundreds of thousands.

**Janet Tyburec** [02:04:58] And so, this cool bat body provided just a perfect media, like a petri dish almost, for this white nose fungus to grow on the skin and the membranes of the bats. And then it's a very rare fungus in that it's a cold-loving fungus. So it grows optimally around ten degrees C. So, conditions were just perfect for this thing to spread out of control.

**Janet Tyburec** [02:05:23] And, it's led to the death of at least 6 million, probably 10 million, bats in the northeastern United States alone. It's probably led to the extirpation of several species like little brown myotis, Northern long-eared myotis. It has threatened the recovery of the Indiana myotis, the endangered Indiana bat, and it's caused a lot of, just loss, of bat life in this area.

**Janet Tyburec** [02:06:02] In the fall, August, September, we used to be able to go to any cave entrance, any cliff crevice entrance, even a place that was not a hibernation site, and at around midnight, one in the morning, there'd be this huge, just big bat party, a swarm of bats, a huge vortex of bats that were just swarming around the entrance here. And this was part of the way that these different species would meet up once a year to find each other and to mate.

**Janet Tyburec** [02:06:34] And, that just doesn't happen anymore. You can go out to these places and it's just crickets in front of here. So it's been really devastating.

**Janet Tyburec** [02:06:43] A lot of people haven't noticed this because not a lot of people spend time in front of a hibernation site at midnight in August. But for bat biologists, it's been, it's been absolutely devastating.

**Janet Tyburec** [02:06:54] And, one of the things that's the most frustrating is that humans have this presumption that we can control Mother Nature. And we really can't. But we think we can. We think if we impose restrictions on handling bats, on kind of clean-room techniques that we have to practice in the field if we want to handle bats - suiting up in Tyvek so that we don't spread germs or fungus from bat to bat, not thinking about just the amount of disturbance that we cause when we go into these caves in the wintertime to monitor these populations that are still hanging on.

**Janet Tyburec** [02:07:42] It's really a delicate balancing act that we have to walk in getting information about these animals in order to save them, versus is it really possible to save them from this thing that they are so much better at transmitting to each other than we can ever control?

**Janet Tyburec** [02:08:07] So, it's definitely a dilemma.

**Janet Tyburec** [02:08:12] I think the best we can hope for is to understand as much as we can about the growth of the fungus and how easy it is to transmit the fungus on different media



and through different means, and then protect the sites that still have populations that are hanging on, protect them, summer and winter, and the habitats in between them, to create these living corridors that the bats can use to travel to. And then doing some of this restorative agriculture and restorative management so that we don't just do the single-species conservation and management, but we manage these systems that all these species need, because we're never going to be able to do everything possible for a single species when other species have disparate needs.

**Janet Tyburec** [02:09:09] So, if we just provide a diversity of habitat resources, a diversity of resources, a diversity of food resources, a diversity of healthy habitats. Controlling invasives. Minimizing disturbance. Then we're just going to let nature take its course, as opposed to presuming that we can control it. Because I think that puts us into a lot of trouble.

**David Todd** [02:09:38] So, one of the other things that I think has happened in recent decades, or at least it's become more and more clear in recent years, is climate change. And I am curious what sort of impacts you see on Mexican free-tailed bats and maybe other bats due to the changing climate system.

**Janet Tyburec** [02:10:07] It's really hard to say. I think, especially with bats, we don't have enough data on most of them at the population level to see just how flexible they are, where and when they occur in an area from year to year. We've seen this with some of the bats that have been on the endangered species list. I'm thinking specifically of the lesser long-nosed bat, and it was listed back in the eighties when we visited a bunch of its caves and noted that it wasn't there, and we had thought populations had declined terribly. And so it got listed and then we started studying it for decades.

**Janet Tyburec** [02:10:53] Until recently, we realized that it had a very unexpected, very lengthy migratory behavior, and it would move in and out of areas that had been monitored throughout the year, and it wouldn't always use the same caves from year to year. But we were able to identify the entire mosaic of roosts that it used. And by simultaneously monitoring these roosts and counting the bats as they were in there, we saw that the population was actually very stable, but it wasn't very consistent.

**Janet Tyburec** [02:11:28] And, I think with climate change, there again, our biggest unknown about how it's affecting bats is how flexible are these individual species and populations as a whole able to be from year to year in the roost selections that they use? Are they ... We know they're very curious and that they're seeking out roosts during a large portion of their year, both summer and winter, and they'll check out things that they have no desire to ever roost in. But it's almost like because they're such a long lived mammal, they're creating a genetic memory in the population, so that if you have an unusually hot year, an unusually cold year, an unusually wet year, the bats can pick one of these alternate roosts to move to.

**Janet Tyburec** [02:12:15] And, there may be a limit to the amount of alternate roosts bats will have, especially to hibernate in, in a warming climate. But, they're probably, more than many animals, more able to find alternate roosts.

**Janet Tyburec** [02:12:37] When we talk about the effect of climate change on something like a pika, a little alpine rodent that has a very limited distribution elevationally, and it doesn't have very long legs. It can't move from mountain range to mountain range to mountain range to get to a colder and colder climate in a warming world.

**Janet Tyburec** [02:12:56] But, bats that can fly long distances both across the country and elevationally, may be able to do that. And because they've been on the planet for 50 million years, largely unchanged, they must have a pretty good genetic memory of areas that are suitable for them in different changing climates during ice ages, during, you know, glacial and interglacial times.

**Janet Tyburec** [02:13:26] I don't know. I'm more hopeful for bats than I am for other animals in a warming climate.

**Janet Tyburec** [02:13:30] Like once, all of the shorelines kind of become covered in water and once people do themselves in, I think we're still going to have bats on the planet.

**David Todd** [02:13:45] It's a mixed bag. Maybe good for the bats, not so good for people and their houses and their, their civilization.

**Janet Tyburec** [02:13:55] So, something else that I have heard folks express concern about, in terms of bats and their conservation, is the proliferation of wind turbines. And I was curious if you could talk a little bit about your view of the development of wind energy and, you know, the effect on bats of all kinds, but of course, Mexican free-tails in particular, since that's something that we're sort of focused on here.

**Janet Tyburec** [02:14:32] Yes, the proliferation of wind energy across the continent has really been a surprise for us, bat-mortality wise. We'd known for decades that raptors were impacting turbines and dying. But it's only been very recently that we realized that bats were too. Because you think about these bats - they've got this sophisticated echolocation. They should be able to detect a wind turbine, and they should be able to avoid it.

**Janet Tyburec** [02:14:59] But, apparently, a lot of our tree-roosting bats, like the red bats and the silver-haired bats and the hoary bats, they have this behavior where they seek out these tall, emergent structures on the landscape during the fall when they're mating. And because their echolocation is like a strobe, it's not a continuous sort of visual stimuli like sight is. They're just sending out a pulse of energy. They're not noticing that those turbine blades are spinning with tip speeds of up to 200 miles an hour. They're just getting a picture of that in a stationary position. And they may be impacting the blades because of that, because they're looking for these tall, sticky-up things in the landscape.

**Janet Tyburec** [02:15:49] And so, we have seen enormous mortality among our tree-roosting bat species in North America.

**Janet Tyburec** [02:15:58] We do know, though, that bats do not impact turbines that are not spinning and we don't ever find dead bats beneath those turbines. So, by stopping the turbines from spinning, especially during fall migration, when the impact is the deadliest for these bats, we can curtail a lot of this mortality.

**Janet Tyburec** [02:16:21] And, many of the wind facilities are doing this as a part of their mitigation process. And so that offers hope.

**Janet Tyburec** [02:16:28] But then, we have these wind energy facilities that are moving further south and further west, and they're going to be impacting more and more species that we just don't know how they react or why they're in the path of these spinning blades - things like Mexican free-tailed bats and like our nectar bats.

**Janet Tyburec** [02:16:48] Again, we have been able to work with certain wind energy facilities to minimize impacts. And there's a site in Nevada that is within five miles of a Mexican free-tailed bat roost. And they've put an elaborate beam-break system on the entrance of that cave. So they know when the population in that cave reaches a certain minimum number, they will curtail the blades so that they will not be spinning when the bats are emerging nightly above that site. And they've been able to significantly reduce mortalities at that facility as well.

**Janet Tyburec** [02:17:29] But, not all facilities, you know, have this like known roost that's very close to where the bats are coming from, especially bats like free-tail bats and nectar bats that have very long migration distances and probably very long daily and nightly commutes. So those are going to be a lot more challenging.

**Janet Tyburec** [02:17:51] So, we may have to work with these folks about increasing the cut-in speed because we find that when the blades are spinning slower, there's more mortality.

**Janet Tyburec** [02:18:01] Fortunately, just like with the mining industry and the cave gating, we have been able to identify wind energy facilities that are willing to work with us and have like "bat-safe" wind energy, just like you have dolphin-safe tuna.

**Janet Tyburec** [02:18:18] And again, it's celebrating the successes that we have with these folks and hoping that other folks will come on line and say, we want to be successful as well.

**David Todd** [02:18:28] Thank you. So, the last thing I wanted to touch on, I guess, in terms of current events and bats and people's perceptions of them, is COVID-19. And I think there's been a lot of talk, maybe loose talk, about the role of bats in spreading disease and spreading COVID in particular. And I thought that maybe you can teach us a little bit more about how we ought to look at that whole question.

**Janet Tyburec** [02:19:05] Well, the question of COVID-19 and bats is really a very, very timely question for me in particular, because I just finished reading David Quammen's book, "Breathless". This is a non-fiction account of the emergence of COVID-19 in the world, the studying of the virus, its origins, and the treatment in the development of vaccines. Really, it sounds dry and deep, but David Quammen is a fantastic writer, and he makes a lot of this gene sequencing science very approachable for a layperson like myself.

**Janet Tyburec** [02:19:50] And, before I read this book, I was, I was railing against the restrictions that COVID put on my life because it basically stopped my career. I could no longer touch bats because, out of an abundance of caution, we didn't want people to transmit COVID to bats, that could then become a reservoir in North American populations and reinfect other people. And we'd be in a pandemic for the rest of our lives. And I also couldn't do my in-person training because we couldn't gather in groups of more than ten and we couldn't travel. And the federal government had restrictions on gathering and traveling.

**Janet Tyburec** [02:20:38] And, for two years, I didn't work. I didn't do any of my training. And you cannot teach people online how to capture and handle bats. So I was very, very upset that out of an abundance of caution (this was just like white nose), all bat research had to stop.

**Janet Tyburec** [02:20:56] And meanwhile, people in North America did laboratory studies to see how infectious COVID-19 was for our North American bat populations. And then, if it was

infectious, could these bats spread it to each other, could they spread it, you know, outside of their species? And they found that it was a vanishingly small possibility that these things could happen.

**Janet Tyburec** [02:21:23] And, it, when we put all of this into perspective, COVID-19 has been a pretty small pandemic as far as pandemics go, because it's not really like the Black Death, like the plague back in the 1300s. It's not even like the Spanish flu, as far as the fatality rate goes. Sure, you know, millions of people have died, but it's such a small percentage of our global population.

**Janet Tyburec** [02:21:59] And, really something is going to get each and every one of us. And it may be a spillover virus. It may be a bus that runs us over. It may be a cancer that we get from pesticides on our foods. But something is definitely going to get it. It may even be ourselves because we continue to smoke or not wear a seatbelt.

**Janet Tyburec** [02:22:24] So, there's a diminishing return in the amount of of impact you can have on a global population to restrict their livelihood, versus actually controlling a virus that is going to find a way, because that's what nature does. And so we have to, I think, be a lot more intelligent about how we interpret science and how we use science, because COVID was an example of reality that was moving a lot faster than science could keep up with, even though we knew that something like this was on the horizon because we had the SARS-CoV-1 virus back in the early 2000s, but it just didn't have this wild fire effect where it went nuts.

**Janet Tyburec** [02:23:17] And, it could be very much like white nose. White nose may have been in America much earlier than 2006, but it just didn't have the right conditions in order to go wild.

**Janet Tyburec** [02:23:31] And so, we are always going to be faced with things like this. And I think at first we should do no harm and then we should try to understand the science of it so that we can be as prudent as possible with not re-infecting each other, not infecting wildlife.

**Janet Tyburec** [02:23:54] But, the truth of the matter is, is our population on the planet is huge. It is probably a billion more than this planet can comfortably sustain. And this is just going to continue to happen as our population continues to increase. We're always going to have something over the horizon that is going to be like COVID-19. But nature is going to find a way.

**David Todd** [02:24:21] Yeah, I think you've said once that Mother Nature bats last or something to that effect. It's, it's hard to control the natural world.

**David Todd** [02:24:33] And, well, so, you've touched on so many topics here and I could go on and on and on, learn more and more, but I don't want to take all of your time today. How about if I just ask you sort of a general question? Is there anything that you might like to add that we just haven't treated with the respect it needed in our conversation so far? Is there some other issue about bats and conservation that you'd like to teach us about?

**Janet Tyburec** [02:25:10] I think the biggest thing we have to keep in mind is that when we say, "bats", and bats need this, and bats need that, and in order to save bats, we must do this, is that we have 40-odd different species of bats in the United States. There are 1400 species of bats worldwide. And each one of these animals has been successful on our planet for millions of years, and they have done it in 1400 different ways. And it's not like when the World

Wildlife Fund has an alert about giant pandas and what we have to do to save giant pandas. It's not like when the Center for Biological Diversity has a Mexican gray wolf alert.

**Janet Tyburec** [02:26:02] When we have a bat alert, when there's a bat emergency, it may impact just a single species. Like COVID-19, the only animal capable of transmitting this novel virus to other animals or to people may be this horseshoe bat in China. So we shouldn't demonize all bats because of a fact that we learn about one species. Nor should we be complacent about all bats because we have 100,000 Mexican free-tailed bats in a roost down the street.

**Janet Tyburec** [02:26:45] All of our animals on the planet are precious. All of our biological diversity is precious. We tend to think that we're the most precious one in the food chain, but we're probably not the ones that are going to outlast our impact on the earth. And that's just what I'd like to leave us with, is that we have to be humble when we study bats. And I think we have to be more humble when we decide what to do about them.

**Janet Tyburec** [02:27:20] Yeah. And maybe this gets back to what, you know, you've been trying to share with us before is just how much diversity there is and how early are tools for understanding them are in their development, but lots of good things to come, I'm sure.

**Janet Tyburec** [02:27:41] And, I really want to thank you for taking time to explain some of these things that you are learning about and and teaching others to learn as well. So thanks very much.

**David Todd** [02:27:55] Janet, is there anything you'd like to add before we let you go?

**Janet Tyburec** [02:28:00] Well, I just wanted to thank you for this opportunity as well. I, I absolutely love my job. I love studying bats and I love being surprised by bats, nine times out of ten, because it is very humbling. And I think it's, it's better for us to be a little humble when we're trying to interact with the natural world and maybe even with each other, because we certainly don't know all the answers. We'd like to think that we do. But I think not knowing something is exciting, and then, being challenged about what we know is even more exciting. And that's probably why most people become scientists, I think.

**David Todd** [02:28:43] Well, may every day bring you something new that excites your curiosity. And thanks for teaching us about a lot of this today. I wish you the best; hope our paths cross soon.

**Janet Tyburec** [02:28:59] Well, thank you so much. I've enjoyed it.

**David Todd** [02:29:01] All right. Well, thank you, Janet. Have a good one at the racetrack and otherwise.

**Janet Tyburec** [02:29:09] And, hopefully back in the pecan fields.

**David Todd** [02:29:11] Yeah, that's true. All right, well you take care. Bye now.

**Janet Tyburec** [02:29:16] Bye.