



Prairie Pod Transcript

Season 6, Episode 52: A Monarch packs a lunch – monarch migration and their grand trek from Minnesota to Mexico

Hosts: Megan Benage, Regional Ecologist; Mike Worland, Nongame Wildlife Biologist

Guests: Dr. Karen Oberhauser and Dr. Ray Moranz

Podcast audio can be found online at mndnr.gov/prairiepod

Transcript:

((sounds of birds chirping and wind blowing))

Megan Benage: Hey Prairie Pod listeners, I'm Megan Benage, regional ecologist with the Minnesota Department of Natural Resources.

Marissa Ahlering: And I'm Dr. Marissa Ahlering, lead scientist with the Nature Conservancy in Minnesota, North Dakota and South Dakota.

Sara Vacek: I'm Sara Vacek, wildlife biologist with the U.S. Fish Wildlife Service, based out of the Morris Wetland Management District.

Mike Worland: And I'm Mike Worland. I'm a wildlife biologist with the Minnesota DNR Nongame Wildlife Program.

Megan: We are part of the Minnesota Prairie Conservation Partnership and we're here to help you discover the prairie.

Marissa: Discover the prairie.

Sara: Discover the prairie.

Mike: Discover the prairie.

((music playing and sounds of birds chirping))

Megan: Hey welcome back to the Prairie Pod. Mike, we're podcasting!

Mike: Yay, Megan! (Laughs.) How are you?

Megan: I am great. I'm even better because we're doing a wildlife episode today.

Mike: Well, I wasn't going to bring it up, but yeah, absolutely. Those are the best episodes, no, I don't mean that.

Megan: (Laughing.)

Mike: They're all good. They're all great.

Megan: At first I was confused and I thought you were just saying like you weren't going to bring up that we were talking about wildlife and I was like I wonder how he's going to pull that off for a whole episode about wildlife.

Mike: Well, thank you for, thank you for doing that. The other ones are important too because wildlife need plants to live in, so therefore, you know, they're all, they're all important.

Megan: To live in and consume. Right?

Mike: And consume, good point.

Megan: It's the web of life.

Mike: Okay.

Megan: Okay, we'll limit the singing for the podcast.

Mike: Please yeah.

Megan: Even though there is excitement. Well, I gotta tell you we're going to start this episode with a quote from one of our beloved podcast guests, Henry Panowitsch, he - -

Mike: Nice.

Megan: - - once said to us, "If you look across the Minnesota landscape, a monarch would have to pack a lunch to make the trip." And that really resonated with us because what he's talking about there is that we used to have this land of 18 million acres of prairie, right? It was lush with flowers, also known as food in the form of nectar for the monarch, as well as grasses, trees, and shrubs that provide shelter, and now we all know that landscape is deeply fragmented and so Mike and I work in our daily jobs to try to connect that landscape so it can be more resilient. It can house more biodiversity and we know that those two key words are things that we all need to survive and thrive, and also, if we connect the landscape it benefits not just monarchs but many living creatures including us. It's about balance. - -

Mike: Is that it?

Megan: - - Balance of resource use and conservation.

Mike: Very nice. I, I really appreciate, the quote resonates with me because I, I'm always worried about food and packing a lunch is, it's great advice. Thanks, Henry. Yeah.

Megan: Yeah, it's a good quote and I think it takes us right into the meat of our topic today. We're going to talk about the majestic monarch, how some or maybe all, spoiler alert, have an incredible migrating lifecycle, and how as my mom, Norma Benage would say, we can all be part of the solution and not part of the problem, which was her constant phrase as she was disciplining me as a child. (Laughter) Just in case anybody's looking for some tips and tricks.

Mike: I find it hard to believe that you needed discipline. I mean, yeah. (Laughter)

Megan: It's shocking, I know.

Mike: Yeah, yeah.

Megan: Well, without further ado, we are joined by two fantastic monarch guests today who know all things about monarchs. Well, we won't say all things, but many, many, many, many things.

Mike: If anybody knows what they do, that's right.

Megan: Yeah. That's what it is. Karen, we'll start with you. You want to introduce yourself?

Karen: Sure. Thanks a lot. I'm Karen Oberhauser, I'm the director of the UW Madison Arboretum, and have been studying monarchs in many different aspects of their ecology and biology and conservation starting in 1985. So, I go back a long time with monarchs. And I'm just going to say really quick I'm really happy that you said this is a podcast about wildlife because a lot of people don't consider insects wildlife. When a lot of people think of wildlife, they think of mammals and maybe a few think of birds. So yay, kudos to you, Megan and Mike, for calling monarchs wildlife. I really appreciate that.

Megan: Oh, thank you so much. I mean, what does everything else eat? Last time I checked, I think insects are sort of supporting the wildlife world, insects and plants.

Karen: Yeah, insects and plants. That's where it's at.

(Laughter)

Megan: Ray, how about you? You want to introduce yourself?

Ray: Sure. I'm Ray Moranz. I have long titles. I'm, I'm the grazing lands pollinator ecologist for the Xerxes Society for invertebrate conservation, and I'm located in northern Oklahoma, Stillwater, but I also am a partner biologist for the US Department of Agriculture's NRCS, Natural Resources Conservation Service. I'm not a federal employee, I'm a Xerxes Society employee, but they pay me to hang out with people at USDA and help them with pollinator conservation in the entire central US, believe it or not. From Texas to North Dakota to Michigan to Louisiana.

Mike: Great, Ray. Hey, is it okay if we ask a question right away. I think the listeners would really appreciate it if we have each guest tell one of their favorite stories or experiences with monarchs? Karen, would you, would you give us your favorite experience you had with monarchs?

Karen: Sure. I've had so many experiences with monarchs. I mean, really, monarchs have been the focus of my research in a lot of my life. They kind of took over. But probably the, the experience that I remember the most that just stands out is the first time I went to the monarch overwintering sites in Mexico, and that was in February of 1997, and I came from Minnesota, which is elevation about 900 feet above sea level, so I got to Mexico and climbed up to these mountaintops, which are about 10,000 feet, much, much higher than that in elevation, and walked and walked and walked and walked for a long, long time, and was a little out of breath by the time I got up there where the monarchs were, and I was walking with several colleagues from Mexico and got up to the top of that mountain and just, so I, I just remember so much my feeling of, of fatigue, even though I was in really good shape in those days, ran six miles most days, and but going up that mountain was really hard for me. And got to the top and my colleague Eduardo Renton said OKAY, here we are. And I looked around and just saw all of the monarchs and heard them and smelled them and felt them and just burst into tears because the combination of being so happy seeing them in Mexico and also I think that fatigue was, was a big part of my emotions at that time. So that's hands down what I remember the most for me and monarchs.

Mike: Nice, Karen. How about you, Ray. What was your favorite experience?

Ray: Well, I've got to say it's, it's going to those same sites. I've been only been once in March 2019, and what made it super special for me besides seeing millions of monarchs for the first time on a beautiful sunny day, and lots of flowers, and it was just glorious. That, of course, is the best part, but, but matching that is the, I was on the trail with Karen and with Alfonso Alonso, another great monarch expert like Karen, and with Wendy Carlson, the director of Monarch Watch, not Monarch Watch, Monarch Joint Venture, excuse me, which Karen helped to found, helped to create that organization, and Karen knows Wendy extremely well. So being on those trails with three of the planet's greatest experts on monarchs was, was like a dream come true because they could explain everything to me, and it was, Alfonso actually did his PhD research at these sites in the '90s, so having him explain, tell me what the flowers were, and why the monarchs were nectaring there, that was pretty spectacular.

Megan: It sounds spectacular. Mike, I think that's our next vacation, that they've - -

Mike: I was just going to say that. I wanted to ask, I wanted to ask, though, does it get hit hard by, you know, like ecotourism, or is that a concern for that site? Either of you guys?

Karen: Sure, I'll take that and yeah, the answer is, the answer is it's complicated. I'll probably say that to a lot of your questions today, but it's great that tourists go there. It really makes the local people understand that this is a worldwide treasure that people really love and care about. But there are a lot of people. So, the difference between what those mountains look like from 1997 when I first went there in 1987 when Alfonso,

who Ray was just talking about first went there, it's, it's a big change, and a lot of that is due to all of the people coming. So, I think it's really important that we think of how to minimize the impacts of tourists, but, you know, it's, its people bring money to the local economy, so that's a good thing about it, and but, you know, this similar things happening up here. We don't want to love them to death.

Mike: Sure.

Megan: Absolutely. We hear that a lot from our partners in Parks & Trails where these places are parks because they're absolutely amazing, and we want every Minnesotan to experience that and cherish these places, but then there's also a cost to that recreation, so there's always that balance, man, going right back to the beginning there. Balance and tradeoffs. Well, I like how Mike wrote this question and I'm going to, I'm going to direct it to you, Karen. So, he describes monarchs as one of the most recognized and beloved insects. One of the ultimate flagship species. I think what Mike means by that is I can remember growing up in the '80s and my first sort of, I don't know if it's my first memory ever, but one of the pivotal memories that sticks in my brain is of looking at monarchs in an aquarium in the classroom and watching them form a chrysalis and then emerge from the chrysalis, and then releasing them back outside. And so, it's sort of stamped in me that they're a gateway into wildlife conservation and the natural world and how we experience the joy of the natural world and discovery. So why do you think, Karen, that they became one of these recognized and beloved insects?

Karen: Yeah, that is so true that they are, and I often think that if you ask a crowd of people what insect they know to species, for a lot of people in the room, it's often going to be the monarch, and that's the only one. I mean, certainly people in Minnesota and Wisconsin and throughout the Upper Midwest know mosquitoes, but there are lots of kinds of mosquitoes, lots of kinds of bees, even lots of kinds of bumblebees. So, people recognize monarchs not only as adults, but they recognize them as caterpillars and chrysalids and even a lot of people recognize them as eggs. So that's pretty amazing. And they love them. You know, you, there are very few people who don't love monarchs, and I think there are probably lots and lots of explanations for why people recognize and care about monarchs so much. And I think a lot of them boil down to kind of four things. One is they're familiar. So, we have seen monarchs. I mean, not only in aquariums in classrooms, but out in our backyards, and as we're driving along the highway. We see monarchs, so there's something that we have this connection to often from childhood. People, so many people remember experiences with monarchs, and some really amazing experiences that people have had with monarchs. So, I think familiarity is one thing. Another thing is we as people like beautiful things, and monarchs, I might be a little biased here, but monarchs are beautiful, and they're not only beautiful as these big, flashy adult butterflies, but they're really beautiful in the larva stage. The caterpillars are really pretty with those cool stripes and those kind of, you know, little tentacles on tops of their heads, so the chrysalid people are familiar with those, there they look like jade with gold dots on them, so they're beautiful, we love lovely things, they're really impressive, so they're, you know, they have this incredible migration that they can fly thousands of miles. It's like, you know, we love people who are fast or who run far, jump high, play football well, so that's another thing is that just they have these amazing athletic feats. Their migration is just unbelievable almost that

they can actually do this. And finally, I think they're super interesting, and I think that is what kind of pulled the scientific community into really caring a lot about monarchs. In the beginning, people were interested in the fact that they migrate and they get to these same overwintering sites, winter after winter they have these incredibly interesting interactions with milkweed, their host plants, and the predators, and parasites, they have what I first started studying about monarchs is their mating system. They have a really, really interesting mating system. So, there's so many things about monarchs that are super interesting. So, I think all of this together kind of adds up to this kind of a love affair between people and monarchs, and it, it is a pretty intense relationship that we have with them.

Mike: That was a great summary. I really like that athleticism point that I never really thought about before, but you're right. What they do is so impressive, and.

Karen: Yeah, unbelievable.

Mike: Maybe, maybe that's a good segue to, to Ray. Would you tell us more about that migration and, and more specifics about what they do there and why it's so amazing?

Ray: Sure. I will start with, you know, where, where are the monarchs right now. Here it is, February, early February, and there are millions, perhaps tens of millions of monarchs at the overwintering colonies in Mexico. Staying warm but, you know, staying cool really more than anything. They're not too cold, it's not too warm, they're staying fairly constantly cool, staying alive, really, staying alive, just hanging out this winter. They've been there for how long. Well, for a few months because they got down there in, in, in early November. So come around early March, mid-March, they're going to start heading north. Now, before they do, a lot of them will mate. The females will be ready to lay eggs once they get further north and find milkweeds. But, but yeah, early March, mid-March, they're heading north, where do they go? They go north. North Mexico, Texas, Louisiana, eventually few weeks later some of them make it to where I live here in northern Oklahoma. The males are nectaring and probably looking for females to try to mate again. The females are into laying eggs. They might do some nectaring, but they're really heavily focused on laying eggs. Luckily, in most years, we have a decent number of milkweeds down here. Very different milkweeds from what y'all have in Minnesota. Very different. Very different species. Those eggs get laid, eventually they metamorphose into larvae, chrysalids, adults, and then those butterflies are referred to as the first generation, and they head north. Karen, do some of those get all the way to Minnesota? I believe they do, right?

Karen: Yeah. Our butterflies come in, so we get the first generation pretty much throughout the northern breeding range. They can go a long ways, yeah.

Ray: Yeah. So, so on their way up, they're laying eggs as they go, the females are, and, and some of them, you know, go from Texas and Oklahoma to Kansas and Missouri and lay eggs and, and maybe get eaten by a bird, or, or get hit by a car or die of natural causes. So, of them make it all the way to Minnesota and North Dakota, southern Canada, etcetera, etcetera. Once they're up there, of course, lots of breeding, lots of laying eggs on milkweeds, and you have multiple generations produced in the northern

states like Minnesota. Eventually, in fall, I believe it's August, Karen, is August when they start getting in the mood to head south?

Karen: Yeah.

Ray: In August, they are triggered I believe by the, by the decreasing day length and the change in the sun angle, and triggered to head south, and as they head south, as they do this, they are for the most part no longer in a reproductive state. They're, they're really intent on flying south and feeding while they go. So that, they'll have plenty of fat reserves. They're, they're eating lots of sugar in the form of nectar, and by eating all that sugar, they're packing on the pounds, loading up on fat, and that fat helps them survive the winter. As they fly south, of course, many of them once from Minnesota go through Oklahoma and a few of them make it to my farm where I provided lots of flowers for them, and they fatten up. They do even more fattening up in Texas and north Mexico, and then arriving at those overwintering colonies around November 1st, around the Day of the Dead, so that, that's pretty much it. But the amazing thing to think about, there are many amazing things to think about with monarch migration, but the ones that are up in Minnesota in the middle of summer, they only live for a few weeks or a month or two, each individual. The ones that leave Minnesota in August and early September and make it down to Mexico, they live for seven, eight, nine months. Pretty, pretty amazing that they could live so long and fly so far.

Megan: Is it true that the migrators are bigger than our summer monarchs, or is that a myth?

Karen: Well, they are slightly bigger, but there's a huge range of size, so if any individual, you know, the monarch expert looks at a monarch, they can't tell unless they cut it open and figure out if it's reproductive or not, so we, we would rather not do that.

Megan: Absolutely.

Karen: So, on average, that generation eats more as larvae so that they can become bigger, but that's not a, not a good way to tell them apart. And I think it's really interesting, I loved what you said, Ray, about packing on the pounds. I've never really heard it described that way. I guess I'd say probably packing on the milligrams instead of packing on the pounds. A monarch, it is true and, and super interesting that monarchs on average weigh about half a gram, which is 500 milligrams, and as they're migrating south, and we've done this where if you weigh like hundreds of monarchs up when they start that migration, and then weigh them again in Texas, and in Mexico, they are getting heavier. So that nectar along the way is really important to them because they get to those overwintering sites in Mexico, and there's not a lot to eat there. So basically, the stuff they store up as they're migrating south and what they ate as caterpillars is it, and they're just full of fat at that point, and the ones that have the most fat are the most likely to survive the winter, so I'm going to think of that now. Packing on the pounds as they migrate south.

Megan: This is a species that I can get behind. Right. And half a gram, for those folks who are wondering is 0.0011 pounds, so, so yeah, it's just if you're curious what that conversion is. Now, one last question, well, not last question, I have many questions to

ask you, but on this point, do all monarchs migrate, or are there some that we think don't?

Ray: Well, there are some monarchs in Hawaii, they got there fairly recently in historical time, they don't migrate to my knowledge. Here in the US, there are some in South Florida, which seemingly don't migrate much. There are, if you were to go to Miami, I went to a tropical milkweed patch in Miami. Of course, tropical milkweed isn't supposed to be here, it's not native, went to one of those patches about 1994, and that, that patch has monarchs all year round. Now, do a few monarchs show up in the fall that have come from the north? I think one study says yes, but I don't think there's good evidence, not clear evidence that then some fly back north in the spring. It'd be a really interesting point of research, but to our knowledge, the great majority of the monarchs in eastern North America in August and September head to Mexico, and the ones west of the Rocky Mountains, the great majority head to California.

Karen: Yeah. And that population in the eastern United States is the vast majority of monarchs in the world, so most monarchs, if we say monarch populations, probably you look at every single individual population in the world, probably most of them don't migrate, but like Ray said, they're in Hawaii, Australia, New Zealand, many, many islands throughout the Pacific, there's a fairly consistent population in southern Portugal, in southern Spain. Every once in a while, they show up in England. We don't know how all those monarchs got spread around the world, but, but I think it's pretty cool about all those populations is we can take monarchs from, you know, probably they all came from North America and we plopped them down in Hawaii, and somehow they kind of start doing the right thing for Hawaii, which is don't migrate because you're just going to go over the ocean and end up in the water somewhere, so it really is a good, good example of how adaptive they are, adaptable.

Mike: Karen, along those lines, we talked, we kind of touched on this a little bit like how they do it, you know, the potentially bigger animals and how they, make the, they make the big trip from Minnesota down to Mexico, and how packing on the pounds. What kind of other physiological mechanisms allow this, allow these little, tiny little insects to make this huge journey?

Karen: Yeah, and they are tiny. I mean, they're big compared to most insects and another way to think of besides all those zeroes you talked about for how much a gram is, Megan, it would take five monarchs to equal the weight of a penny. That's how light they are. So, you can imagine something like that getting buffeted about by the wind as it's migrating, and, you know, having to just to flap those little wings so many times to get to Mexico, but they are super clever about it. So, if you look at a monarch during the fall migration, it's, it's really adjusting its elevation how far it's flying above the ground based on the wind. So, if there's a south wind, either they'll hunker down and not migrate or they'll stay pretty close to the ground so they're not having to deal with the wind. If there's a north wind, they'll find where it's best and they actually don't use powered flight that much, they soar. They soar on their wings like birds do. So, they're, they're saving energy all the way and they also take advantage of thermals. So, when there's air going up above next to a mountain or above a black parking lot or anywhere where hot air is rising, the monarchs all just get higher and higher in those thermals,

and then they'll glide down, so they, they are really, really smart about saving energy while they're migrating. So, it's, it's pretty amazing to watch them. It's, it's hard for us to study because they're so little and we can't track individuals very easily, but there was a guy named David Gibo, who studied migration, and he was also a hang glider pilot. And he saw monarchs over a kilometer up in the sky, you know, none of us could see them if we're standing on the ground, you can't see something that size up a kilometer, but he saw them. So, they're probably using air currents in ways that we don't even understand.

Mike: That's amazing. I didn't know. So really, they're like, they're behaving like raptor, like a vulture and some of our hawks.

Karen: Yeah, and some - - I've definitely seen this in Texas where, you know, where you go and see kittling by birds of prey by hawks. Often, we get data about monarchs from these hawk migration spots where people are watching them because the monarchs are right there doing the same thing with the birds of prey. Yeah, it's amazing.

Megan: Yeah, that is amazing. And kittling is just taking advantage of those thermal wind air currents so that you can sort of save energy, maximize your energy during flight.

Karen: Yeah.

Megan: One thing I was thinking about when you're saying that, Karen, is monarchs are what we think of as cold blooded, right? So they can't regulate their own body temperature. So just thinking about them flying so high where most of the time it's colder. Like is there a limit to how high they could fly where it would be too cold then and they wouldn't be able to go any further?

Karen: Yeah, and definitely they're adjusting there too. So, monarchs will only fly usually if it's above about 60 degrees Fahrenheit. They can, if you think of a monarch body, it's black, its, its thorax where its wing muscles are is black, so it can actually thermoregulate, so you'll see them kind of moving around their bodies so it's pointed toward the sun and they can heat up those muscles enough to fly, so it's really sunny. They can fly up, it's 50 degrees. But yeah, so again, it's really hard to study that flight, and I'm not sure anybody has ever looked at the temperature at different levels and seeing how they're adjusting there. That's a super great question and I don't know the answer to it. Do you, Ray?

Ray: I do not. That, that is a wonderful question. I do know just ignoring the aspect of flight, but think about overwintering monarchs, a study got, was performed by Jim Anderson, one of Lincoln Broward's students I believe in the '80s, in the Mexican overwintering colonies, and show that they're, they're surprisingly tough. When hanging out on the trees, they can withstand subfreezing temperatures, and actually a fair amount survive temperatures below 20 degrees Fahrenheit. Now, you had a fair amount of mortality at that point too. But just, just to give you that, you know, just to let you know that they are, they can handle temperatures below freezing. Once it gets down to the, say, the teens, they're in deep trouble. So, if they, if they make it up to Minnesota a little

early some year and you have a bizarre cold snap, they're, they're probably going to survive it unless it gets really cold down, down below 20 degrees.

Megan: This is super interesting. I just, it just brings home to me how you can take one thing in nature, one species, and you can have thousands and thousands of questions about that one piece of the ecosystem and how it's working and functioning and how it connects to everything else and how it's living its life doing what it's doing, and that's what I love about ecology, that's what I love about prairies. It's just fantastic. We're going to shift gears a little bit, talk a little bit about how monarchs are doing. So, Ray, let's start by setting the stage, how do scientists measure their population trend and, and what do we know, how has it changed through time?

Ray: Sure. First, I'll talk about the western population of monarchs because it's easiest to understand in a way how they, how they do that. As I mentioned earlier, the monarchs from west of the Rocky Mountains in late summer and fall, the great majority of them head to the California coast, and they overwinter in forests along the California coast that are quite moderate in temperature, very, very, never hot, never freezing, cool, so they can stay consistently cool, similar to the sites in Mexico. There are few enough of those sites and few enough monarchs that with a huge number of volunteers, we are able to actually census, census, excuse me, census them, count them, just like we do for humans, we try to get a complete count of all the people in the US, we can do that with western monarchs. We don't get it exactly right, and when I say we, I, I'm talking about the organization I work for, the Xerxes Society for Invertebrate Conservation has been monitoring western monarchs for decades with the help of an enormous army of volunteers, and for instance, this past winter, past Thanksgiving really and, and early December, they visited about 272 sites. So, when you get to a site, maybe there's 10 monarchs or 100 or 1,000 or 5,000. Even if there's 5,000 or 10,000, with a little bit of effort, you can count them. Now let's switch completely over to the monarchs east of the Rocky Mountains, the monarchs from Minnesota and other eastern places that go down to Mexico. There are so many millions of monarchs, even still, even still there are millions of monarchs down there, some of them are exceedingly high in the trees and some of them are piled one on top of each other on tree trunks. You count, you can't count them all, there's no way to count them all. So instead, we monitor the acreage of forest that's covered with monarchs or more technically, using the metric system, the number of hectares of forests that are covered with monarchs. And there is a conversion factor and I can remember this testing it on the trail with Karen because I'm sure Karen probably knows the conversion factor of how many monarchs on average fit on a, on a hectare of forest in Mexico. But, but the big picture is when these, when, when the monitoring began in the early, early '90s, mid-'90s, there used to be a lot more hectares covered with monarchs than there are now, and, and the winter of I believe 2013-2014, that was the winter when there were just a, gosh, a hectare, two hectares covered with monarchs. In other words, the area covered with monarchs had gone down about 95% from what it had been in the '90s, and that really got the alarm bells ringing. So that's what happens. I believe it's the World Wildlife Fund of Mexico, that organization is in charge of, of assessing monarch population, but they're not in Mexico, but they're not counting them, they're measuring the area covered with monarchs. And they have yet, they're probably doing that right now or have been doing that for the last

few weeks or maybe next week, I don't know, but they haven't released the numbers yet for this winter, so every year about this time, or March, we get very anxious as we wait to hear how many hectares in Mexico have monarchs.

Mike: Ray, did you say, so get the listeners a clear idea of what the trend is like, at one point the area they cover was down 95% is that - -

Ray: Yes, yes. Winter of 2013-2014 I believe, it's gone up since then, but it's been bouncing up and down at a low level, a level, you know, it changes every year from winter to winter, it changes, some winters up a little bit, some winters down a little bit, but it's hovering around a much lower average than it, than it was in the '90s, and I think, go ahead.

Megan: Oh, is it fair to say it's a pretty significant decline? I mean, so even if it's not 95%, it's gone down quite a bit from where it was.

Ray: I think it's like 80%, 80% to 90% down. There's some, one monarch biologist who Karen knows well, Dr. Chip Taylor, is predicting really low numbers of monarchs in Mexico for this winter, so he's, he's pretty darn good predictor, he's a real smart guy, so we'll, we'll see what he finds. But yes, the numbers are I think, I think about 80%, 90% down from what they were. Karen, do you agree with that ballpark?

Karen: Yeah. It's, it's really hard to know. I, I prefer kind of to think of decade averages. So, if you think, I mean, if you take the high, so the first year I went there, it was 18 hectares, there were 18 hectares of ground covered with trees covered with monarchs, and the lowest number as down to 0.67, so that is a huge, huge drop from 18 to 0.67. But if we look at the last decade, the average number of hectares covered was about a little over 2, 2.1 hectares, so it bounces up and down, like Ray said, but it, it's kind of hovering around that number of about 2. We look at the previous decade, so the first decade of the 2000s, the, the numbers were hovering a little under 6, so, you know, going again going up and down from year to year, but that the average of that decade was about 6, and the average of the decade before that was almost 9. So, you know, depending on how you want to do it, we can go that decade average when we first started measuring around 9 down to 2, so that's, that's where we, so kind of a conservative loss is around kind of around 80%, but if you go from the high to the low, it's well over 90% loss.

Mike: And just in the wildlife world, I mean, that sounds like a very steep decline, you know - -

Karen: It is, it's a steep decline.

Mike: For birds, we quite often find like a, a few percentages, percentage points per year, and, and when we see that, like alarm bells start going off, like 3% or 4% per year, and we'd have to do the math to figure out what it is exactly for monarchs, but it sounds quite a bit more than that, and, and so that's, that is very significant, yeah.

Karen: Yeah. Alarm bells are definitely going off, so we, in about 2000, I can't remember what year we published it, but we did what's called a population viability analysis, which is sort of a best estimate of how low the population can get before it'll have trouble

recovering, and we know that it didn't spiral out into extinction when it got down to 0.67, so we know it's somewhere below 0.67 it'll kind of be a point of no return, but in order to avoid getting to a point of no return, we estimated that we should, we should be hovering kind of a 6-hectare level. That should be the average from year to year. Some years will go below it, some years will go above it, but we haven't hit 6 hectares for a long time.

Megan: Yeah. It'd be interesting to see, you know, the declines that you're describing mirror somewhat the declines in the prairie world and prairie landscape, right? Obviously, there's all different kinds of prairie and because monarchs are moving across the United States and are connected across multiple states, those numbers range depending if you're talking about shortgrass, tallgrass, all these sorts of things. But what, it would be interesting to see if there's any influence as we restore prairie corridors and connect the dots if there is a correlation between monarch migration success and my hypothesis would be yes, I hope so because we, I mean, that's sort of the point, right, of a lot of the work that we're doing is that we are trying to reclaim some of that balance back into the system, and it is really important to have connectivity if you're going to have resilient habitats. And I know that prairie isn't the only habitat that necessarily monarchs are utilizing as they're making their travels, but it's certainly that's where we most often find milkweed and that's where we find a lot of, you know, forbs that they like to nectar on, so I'm just, I guess I'm as an ecologist, I'm interested in how this all connects in the big picture of the prairie world.

Ray: It'll, it'll connect but we got a lot of work to do. We've got a lot of work to do to make up for what we lost.

Megan: Well, that could be the bumper sticker for all of our careers.

Karen: I really liked the, I hadn't quite understood the title for this podcast before you explained it at the beginning, Mike. I really, really like that analogy or metaphor, however we want to say that, monarch packs a lunch, because it's not just packing a lunch, it's, you know, it's got to fly long distances to find food, but it's got to fly long distances to find plants to lay eggs on, and you know, used to be that the whole world was monarch habitat, so I think what you were saying, Megan, earlier just now about what's the difference in all of the work we're doing to restore prairies and connect these dots and make corridors. Unfortunately, right now, I think we're, well, not necessarily unfortunately, I think we're holding our own, so if we look at that last 10 years, it hasn't gone down anymore. So, in some ways, that's good. We know there's still habitat being lost, and right now we're kind of holding our own. We, we aren't going back to what we were. The amount of habitat available to monarchs in the summertime kind of sets an upper limit to the population, that's how many, that's how many monarchs we can produce and send down to Mexico. And then weather and other things are going to determine whether we reach that maximum that's allowed by the habitat that's available. So, what we're doing I think is kind of letting us stay in one place. We're, we're making up for the continuing loss and by adding more habitats but like Ray just said, we lost a lot. There used to be a lot of milkweed in agricultural fields, corn and soybean fields, and then as farmers could use plant genetically modified crops that allowed them to spray pesticides and herbicides on these crops after the crops grew up, then that milkweed

disappeared, so, you know, monarchs for a long time were kind of lucky because they could survive, they, they had resources in agricultural fields. So right now, because there's no longer either it's very little milkweed left in agricultural fields, that's what we kind of have to make up for at this point.

Mike: Thank you, Karen knows that helps me understand a lot what's going on and, and how these things interact. So yeah, we've kind of said that the lack of connection between fragments of habitat is a factor, milkweed, and then recent developments in, in, in crops that allow us to spray pesticides to kill milkweeds, that's a factor. Ray, what else can we add on, on threats and why these monarchs are declining?

Ray: Well, there's some folks that speculate there's also been a large decrease in the abundance of nectar plants, especially as monarchs head from Minnesota to Mexico. I don't think we have strong data showing that yet. I don't think it's been looked at fully yet. I do know somebody at the NRCS who has a dataset that he's working on analyzing, but to, to look at that, but yeah, loss of nectar plants, you can, you know, if they don't, if they don't have enough flowers to, to fatten up on, then they're, they're not going to survive the winter. They might not make it Mexico or maybe more likely they'll make but they can't survive the whole winter.

Mike: Just to review for the listeners, I mean, I think we've said this, but they, they require milkweed for their larva, correct? And so most flower species can be used for nectar for the adults or?

Ray: That's, that's a big focus of mine. Quite, quite a many species, not any flower, there are a lot of flowers that they'll almost never go to for some reason, the flower structure is not appropriate or there are of course, wildflowers that are wind-pollinated and don't have, don't have delicious nectar, but, but many of the, many of the wildflowers that people associate with Minnesota prairies like sunflowers and blazing stars are, are quite good for monarchs. Of course, milkweeds also produce nectar for monarchs but, but yes, they, the monarchs need a variety of nectar plants and an abundance of nectar plants in the spring, in the summer, but especially in the fall as they're heading back south to Mexico.

Megan: Which is our same goal when we're trying to do a prairie reconstruction or restore prairie or work on our management of prairies is that we want to make sure we have flowers that are blooming all season long.

Ray: Thank you. That's wonderful. That's what, yeah, that is essential.

Karen: Yeah. I think another thing to kind of put in there with what we should plant is we often when we think of milkweed, we just think of common milkweed *Asclepias syriaca*, and that's by far the most common milkweed, that's why it got its name, common, but there are over 100 milkweed species that grow in North America, and I should say that milkweed, common milkweed is not that common down where Ray is or further south, so they have a lot of diverse milkweed species that monarchs will eat as caterpillars, but up here we, actually have some pretty cool milkweed diversity as well, and including a diversity of milkweed in prairie mixes is great because that means in a dry year, some of them will do better, in the wet year, others will do better, in one wet corner of your

prairie restoration, one species might do better up on a hill, another one might do better so, and one will look better in the fall and another will look better in the spring, so planting a diversity of milkweed species as well as nectar plants is a great idea too. And then you had asked about some other threats. You know, weather is a big driver of monarch numbers, probably one of the biggest drivers right now is, is habitat isn't changing so much anymore, so weather. A hot, dry summer is bad for monarchs, cold wet summer is bad for monarchs. They're kind of like the happy medium, the goldilocks summer of not too hot and not too dry, not too wet, and not too cold either. So, so weather is an important driver, there are a lot of insecticides, most insecticides that people use are general, so they'll kill all kinds of insects, not just the insects that are the target of them, so a lot of monarchs get killed by insecticides, and there are also some really interesting natural enemies. You know, that's kind of part of their natural cycle. Only 2% to 5% of monarchs survive. Lay 100 eggs, if a female lays 100 eggs, she might get, she's lucky to get five adult offspring out of those 100 eggs, and most of those are killed by natural predators that occur in the environment, but there are actually a few introduced species that people brought in to control, especially one that was brought in to control gypsy moth, it's a, it's a parasite called the tachinid fly, doesn't have a common name, but it's called *Compsilura concinnata* is its scientific name, and that was introduced on purpose by people, and it kills a lot of monarchs in some parts of the country, so it's a generalist parasitoid, so, you know, in some ways it's kind of death by a thousand cuts. A lot of things are hurting monarchs, but, you know, if we provide enough habitat for them, then they can find the places, you know, in, in the summer where we have a really hot and dry summer. There are some places that won't be hot and dry. We have a lot of habitat, they're more likely to find some habitat in the good places, so in a lot of cases providing that habitat is really key.

Megan: Providing the essence or you're talking about the essence of resiliency there, Karen. Basically, that's the, you have to have lots of different pieces and parts so that when you face these climatic extremes, or even just climatic variations, you can have species that respond to that ebb and flow of change that we're always going to get. Speaking of change, what about climate change? What can we expect with respect to monarch?

Ray: I see the impacts of climate change. My understanding is that the greatest threat is what could happen to the overwintering colonies in Mexico and the overwintering colonies in California for that matter. If those areas become warmer, they'll no longer be cool enough to keep monarchs in a, in a, in a steady state during the winter. With higher temperatures, the monarchs might get kicked into reproductive behavior again, in which I don't understand it, hopefully Karen does, but what I think it is, is that the reproductive hormones cause them to die quicker of old age. That's, I've never done any research, but that's, that's, that's what I've taken from it, that when they're in a reproductive state and they have their, their reproductive hormones going, they don't last as long. With global, with, with warming of the overwintering colonies, that's likely going to be a big, big problem. Of course, climate change can be a, a big problem in Oklahoma and Minnesota as well. Karen, am I interpreting that right, that, that, that's what, that's the main thing that would be happening to monarchs if it warm, if overwintering colonies warm up?

Karen: Well, certainly climate change, I mean, they, they're going to a very narrow climate envelope when they go to these overwintering sites in Mexico, so you're right. If it's too hot, it's not just that they become reproductive, but their whole metabolism speeds up. So basically, I think a nice analogy for thinking about what is happening to monarchs is when they're migrating south, they're in this arrested state of development, and here's a great new word for all of the listeners today. It's diapause, d-i-a-p-a-u-s-e, diapause. And they're in this reproductive state that they're just kind of stopping developing. So, they look like a normal adult on the outside, but it's kind of like they're arrested in a juvenile state like a 12-year-old kid kind of. You know, they might look a little bit like an adult, but they're not reproductively mature yet. And they go to Mexico and it would be like we could take a 12-year-old kid and put them in a refrigerator for a couple of years and just kind of stop their development just like put them on hold and say okay, kid, it's like go down, go down and we're just going to stop you for a while, and that's what happens to monarchs when they're in Mexico. Their, their whole body just slows down and stops developing. And then like Ray said, both day length and warm temperatures can trigger a switch so it's like you pull them out of that refrigerator, they stop developing, or they start developing again, and at that point it's just like a, you know, you snap your fingers and they all of a sudden start aging again. So, you know, those monarchs that are always reproductive, the ones we have up here in the summer that don't migrate only live two to four weeks, that's because they don't get stuck in that refrigerator to slow down. So, when it gets too warm in Mexico, their metabolism speeds up, they become reproduction, reproductive, and their biological clock just starts ticking away again. So, you pull them out of that refrigerator. But climate change up here can be important. We know that we've done a lot of modeling now, so we have enough years of data so while what happens in Mexico is important, also what happens up here during the summer breeding is important, so if we, if it's really hot and dry, probably that has an impact on nectar availability and the quality of the milkweed, so we don't get as many monarchs. If it's cold during the summer, the monarchs don't develop as quickly because they're coldblooded, so they everything just slows down, they don't get as many generations, so and then as they're migrating south, if it's really hot and dry, they're not going to get enough nectar down there, so climate affects them throughout the whole year. So yeah, it's, you know, creating habitat, that's a big thing we can do to help monarchs, but trying to do what we can to mitigate climate change is also really important.

Mike: Yeah, Karen. Earlier you mentioned the, the goldilocks effect, you know, having the just right kind of weather conditions, which is, that's just exactly what we're supposed to get less of now with climate change, right? And it's helped me understand how the climate change is affecting these guys up here.

Karen: Yeah, exactly. It's, you know, we get on average maybe temperatures a going up a little on average, but the variation and, you know, those long periods of hot and dry weather are becoming more common.

Megan: I was really feeling a kinship with monarchs for, you know, they're packing on milligrams in the winter, they're, they like only these right conditions in the summertime, then now we're learning that there might not be those just right conditions or as much of them, so I'm getting a little sad, but let's jump to what is happening with their federal

listing. I know this is something that we field a lot of questions about because it is complicated how the listing process works, and so there was a period of time where we were receiving a lot of emails from concerned folks in the Minnesota who are saying now what, now that the monarch's listed, and so if you could walk us through that a little bit because, of course, they're not listed on the endangered species list yet, so it'd be good to clear that up.

Karen: Yeah, sure. So, in 2014, the Xerxes Society, Lincoln Brower, and what was it, the Center for Food.

Ray: Center for Food Safety.

Karen: Food Safety, yeah.

Ray: And CBD, I believe. Center for Biological Diversity.

Karen: And, right, petitioned the US Fish and Wildlife Service to list officially list monarchs under the Endangered Species Act with the status of threatened. So, when a species is listed, they basically get official protection from the federal government, which sort of sets a lot of wheels in motion. That, that kind of protection is really important, and I just want to put in a little plug that we know that the Endangered Species Act works, that when species get listed, they're less likely to go extinct and it, it benefits species. I think the Endangered Species Act is a really, really important piece of legislation that protects species and habitats. So, what happened is the Fish and Wildlife Service collected lots and lots of data, pulled together a lot of groups of scientists, and assessed whether monarchs actually met the criteria. They have very specific criteria for what it means to be threatened or endangered. And their determination at the end of that process was that monarchs fit the criteria for being listed as a threatened species, but there are so many species that are worse off, you know, that, that are in worse conditions, that monarchs are, that monarchs were precluded from being listed just because it, it takes so much work once a species is listed, it just, it just you can't, the federal government, and I'm not being critical of them because they do a great job, but they just don't have the resources, nobody would have the resources to deal with all of the species that meet the criteria for being threatened. So, what that means is the Fish and Wildlife Service will continue to reevaluate them, so they're continuing to collect the data to see what happens as we're putting all this work into action that you talked about, Megan. You know, all of our work to restore prairies and do what we can to help monarchs. Will that be enough? So, we're continuing to support them and help them, but the Fish and Wildlife Service is just going to keep evaluating them. And then a lot of people are getting a little mixed up with there was the federal, the United States government considered the status of monarchs. There are several states that have considered and are continuing to consider the monarchs. So, in California, monarchs do receive a lot of protection from the state government, and then there are other countries. So, Canada is considering putting monarchs on their species at risk list, so they actually have listed them with a certain degree of protection. In Mexico, they have a certain degree of protection. So, the United States is just one of the federal government of the United States is just one of many entities that works on legal protection for monarchs. And then there was a recent listing last summer that got a lot of publicity, and that was the International Union for the Conservation of Nature, or

IUCN. So, this is an international body that is trying to assess the status of the world's biodiversity, and there are no legal ramifications. So, if the IUCN lists a species as threatened or endangered, it, it doesn't mean that they get any special protection from any government, it, it has no legal teeth. It's just a way of assessing how we're doing to protect biodiversity in the world. They've assessed over 160,000 species, it's, it's a huge, huge process and, you know, when people said to me well, why did they, why did they do this assessment of monarchs now? In some ways, it's kind of surprising that they never did it before because of all the insects out there, we have a lot of data on monarchs. So that group using very specific criteria for what it means to be endangered determined that monarchs were endangered, kind of like you said before, Mike, their numbers are declining, and if we were looking at a bird that declined at that rate, we would be really, really concerned. So, the IUCN listed monarchs as endangered, but again, that has no legal ramifications at all. It doesn't mean we, we have to do anything, we just learned that monarchs fit their criteria for being endangered, whereas the Endangered Species Act has legal teeth.

Megan: And hopefully, it sparks us to action. One thing I want to repeat that you said there that I think is particularly important is that Endangered Species Act, you know, benefits these species, it does work, and it also benefits the habitats that they reside in, and the key link, if I can build upon what you said, is that it also benefits people because biodiversity is the number one indicator of health in any system - in any system, so what that means is just what we talked about earlier, you need all of these different parts and pieces that are working together in complex ways that we still don't fully understand, and by having all of them, it means they can better respond to this ebb and flow of change that we talked about earlier. So that inherently then benefits people as well because we rely on healthy environments to survive. We are breathing that air, we are drinking that water, we are living on that land. So just to make sure that sometimes we sort of lose that and we, we might love these species and think wow, those are great things because I love monarchs, but it's also a great thing for the environment as a whole, so I just want to make sure that we bring that connection point home.

Mike: It is, and, and thinking about the old canary in the coal mine concept like even if you, even if you don't care about monarchs and I don't know who that is, but, but what that, what their, what their decline means is alarming, should be alarming to everybody. Yeah, so I think Karen has touched on some potential solutions to this. I'd like to focus more on solutions. Ray, what can you offer as far as how we can, what else we need to do here for monarchs.

Ray: Well, you know, the obvious one that a lot of people know about, fortunately, is, is planting more milkweeds. This is more of an issue up where you are and where I am, it's, we're not certain of that, but, but.

Mike: Ray, Ray, say where you are again, please, for the listeners.

Ray: Oh, yes. I'm in Oklahoma. I live in Oklahoma, and we have very different milkweeds down here than you have in Minnesota.

Megan: You have some of the same, but I'll just say that you have a lot more than we do in Minnesota.

Ray: We have a lot more milkweed species than Minnesota.

Megan: A lot more species, which is true because you're a southern state as well.

Ray: And our dominant milkweeds are really, really toxic, and they live in, we, we still have a lot of prairie left, we don't have enough, we lost a lot, but we have a lot more than Minnesota does, and in that prairie, we have a lot of really toxic milkweeds, and we have cattle, and the cattle don't eat those toxic milkweeds, so, so we don't find a big, a huge need to plant milkweeds down here, actually. The NRCS, who I assist, that is their policy call. They don't, they don't make a big effort to encourage farmers to plant milkweeds down here. More milkweeds would be better, but it's a lot more important to add more milkweeds in Minnesota and Iowa and other, other North Central states.

Megan: And Ray, real quick, when you say they're toxic, when you say they're toxic, can you explain a little bit about what you mean so that people aren't concerned about walking through an Oklahoma prairie and - - (laughs).

Ray: Toxic if you eat them. So, if you come to Oklahoma or Texas and you go to a cattle ranch and you see some milkweeds, do not eat them. They will likely be very, very toxic. The only, they're loaded with chemicals called cardiac glycosides, and they would make you first feel ill, feel nausea, and if you ate more of them, they will make you vomit, and if you continue to eat more despite the vomiting, you'd have cardiac arrest or something like that. So, it'd be very silly thing to do. Yeah. In your area, milkweeds, adding milkweeds is super important I think later Karen will talk about a cool study she worked on that gives people an idea of where to plant milkweeds, but also throughout the range we need more nectar plants, and the nectar plants we want ideally native nectar plants, native wildflowers, and huge part of my job is to create lists of what nectar plants people should be planting, where they are, whether you're in South Carolina or Texas or Minnesota or Wisconsin, so the Xerxes Society, we produce lists like that. So certainly, hit our website and search monarch nectar plants, and you'd come up a list for wherever you are, whatever state you are in, you could come up with a list of what nectar plants you should have. But other things we should do, we need to be more careful where possible with, with use of insecticides. We understand that many farm operations, you know, feel the need to use insecticides to, to run their agribusiness. If one can mitigate there, there are things that one can do to, to spray at a certain time of day where it's less windy and the insecticide is less likely to, to fly offsite. Of course, if you can use less insecticides, that would be advantageous to, to monarchs and, and other pollinators. But again, there are other things one can do to mitigate the impacts of insecticides. As far as herbicides go, similar issues. And let me confess I use herbicides on our farm. In my case, I'm using herbicides, and this is something I'd like more people to do, whether it's herbicides or some other means, control the exotic plants that are ruining monarch habitat. In Oklahoma, Texas, all the way up to Nebraska, maybe even South Dakota, we have a huge green menace, and that is the spread of junipers and eastern red cedars. They're native to this region, but they have greatly, greatly multiplied. And so much of our prairie, again, we still have millions of acres of prairie, but much of it is getting converted to cedar forest, which once the cedar forest, there's not enough light for the milkweeds and wildflowers. So, on our farm, I'm looking out the window now, where I'm looking out the window, we used to have a lot of cedar trees, we

chopped them down so that the wildflowers would, would get sun and would come back up. In Minnesota, I don't think you have a big cedar problem. Karen, what would it be up there maybe, buckthorn?

Megan: We sure have cedars. We sure do. Yes, we share in that problem with you. (Laughter.)

Ray: We need, we need to fight woody plant encroachment into our prairies if we, if we do. We are going to, if we win that war, we're going to restore a lot of habitat grass because most of our milkweeds don't do very well in dense, under dense canopy at all.

Megan: Karen, I want to ask you this because I think, I like talking about solutions because I think it helps people know what they can do and maybe it would tell sort of a, a hard to hear story, right? Like we've had these big declines, we're seeing those, you know, in the prairie itself, and then we see those declines echoed in the monarch, and of course, other species that live there. And that is hard to hear, especially for such an iconic species. But what, if you were giving advice to a prairie manager, so somebody who is working with, could be public lands, it could be tribal lands, but they're working with larger pieces of prairie, if you will, so bigger than five acres in size, what would you say is an important thing for them to consider or do as they work to conserve the prairie landscape?

Karen: Well, first of all, I want to say thanks to them for working to preserve the prairie landscape. That's really important. Like Ray said, creating habitat is really important, but creating it smartly just because as you know, we have limited resources, so we should do what we can to make sure we put this habitat in the right places. So, in some ways, monarchs will find your habitat wherever it is. They're really good at scanning over the landscape and, and finding habitat, even if it's pretty isolated. But we started to do some work looking at what are the characteristics of a site that will produce a lot of monarchs, and kind of a no-brainer answer to that is the higher the density of milkweed, the more milkweed that's on a site, the better. So, you know, increase, and, and even, you know, Ray, you talked about in Oklahoma you don't really need to put milkweed in the seed mixes because it's in a lot of these habitats already. In some cases, that's true, so my lab when I was at the University of Minnesota did a study and we found that in CRP mixes, milkweed came up even if, if milkweed seeds were not included in the mix, there was enough out there. Now, that was a while ago, there's a little less milkweed on the landscape now, so not 100% sure if that would still be true. But including some of these other species besides common milkweed is important. So, making sure there's milkweed in the landscape no matter how, how you get it there is important, and then including a lot of nectar plants. We found that even a small site will attract monarchs, so they'll find a small site. So don't be discouraged. Bigger is better, it's going to produce more monarchs, but if you only have a little site, don't, don't think that it's not going to make a difference. So, I think that's, that's important too. Even some people think well, it wouldn't really matter because the habitat around me is so bad, you know, if you got this little island in a sea of corn and soybeans, they, they will find your little island, so don't be discouraged that the surrounding habitat isn't very high quality, because putting, putting something there so that the monarch doesn't have to pack such a big lunch as it flies across the landscape is important. So, you know, a lot of milkweed, a lot

of nectar plants is good, and, and, you know, whatever you can do in size and location. The other thing I would say, I would encourage land managers and anyone to do is monitor the success of what they're doing. We have a lot of programs out there, there's something that the Monarch Joint Venture if is running called the Integrated Monarch Monitoring Project or IMMP, so that's a really great opportunity to get a, a great picture of how your efforts are making a difference. There are other monitoring programs, the Monarch Larva Monitoring Project that we run out of the University of Wisconsin Arboretum jointly with the Monarch Joint Venture. Monitoring how the milkweed is doing, that's part of the IMMP protocol, so monitoring is really important. We're not going to know the success of what we're doing unless we monitor. And in a lot of cases, monitoring can help land managers spread the word because they can engage other people. So, if somebody is working for a federal agency or a nonprofit organization, state agency, a county, a city, and is doing habitat restoration, spreading the word about what you're doing will magnify the impacts of it because you'll encourage other people to do more as well. So, you know, there's a lot you can do at that site once you get the habitat in, and then continuing to maintain it and making sure that, you know, whatever you did to make that habitat better doesn't get wasted. I think sometimes we put a lot of effort into the initial restoration and forget about I know that Megan and Mike, you and Ray, that this is your life, you can't just throw those seeds in and then walk away and wash your hands of it, you got to keep, keep, keep at it. So, you don't want to waste those resources that you put it into, but keep managing it, keep monitoring it, keep learning from it, make other people learn from it, and that will increase the impact of what we all do.

Mike: Karen, you made about 17 really good points there, like release that as its own podcast episode, like yeah, really great points. I like kudos to you for mentioning monitoring and its importance and, and, and also this, yeah, we habitat work, it's not a one-time thing, it's an ongoing love and struggle to continue working on that habitat forever basically.

Megan: Mike, we, we treat prairies and prairie restorations sometimes like the seeds are magic beans that you can just put in the old science, we can just put them out there and because they're native, they're just going to do their thing and it's all going to work without even considering how far we may have come or how many the history of that land and the choices that were made before that. We have to make sure that we're still stewarding and caring for those prairie lands and reintroducing the things that they absolutely need, like fire and grazing onto the landscape because we're not.

Karen: It's all hard work. You know, we don't, it's, it's hard work and it costs a lot of money, so we don't want any of that hard work or hard, or hard-earned money to go to waste.

Megan: Right. So, step one really is conserve the habitat you have because it's built perfect the first time, so step two is restore it after we might have made a choice that we need to correct later, which is infinitely harder than conserving what you already have.

Mike: Ray, anything that add to that the public land managers, prairie managers what they can do?

Ray: Well, yes, yeah. You know, Karen brought up the land management. Fortunately, monarch populations can, can do well, will thrive under a variety of land management practices and regimes. One of the most important ones in prairie country is prescribed burning, and we do, I've been doing that on my, on my farm. People prescribe, do their prescribed burns in winter. When you do a prescribed burn, you're going to kill something, you know, there's, there's always some insect, there's a diversity of insects out there. You're going to hurt something. We do it because it's the right thing overall. We may be hurting a few species, but we're helping the majority. If you burn in the winter in Minnesota, you're not hurting monarchs at all because they're in Mexico, so prescribed burning is a pretty easy, pretty, pretty easy one with regards to monarchs. Now, if you choose to burn in summer or early fall up in Minnesota, there could be reasons to do that to help plant diversity, monarchs might be vulnerable to that, to, to that, would be vulnerable to that, but there'd still be, again, could be reasons to do that. You might decide to, to manage your grassland when mowing with haying, monarchs can be vulnerable to that, yeah, you, you could, you could chop up a whole bunch of monarch caterpillars that were on milkweeds if you, if you mow the prairie in July, yet as Karen notes, some studies have been published showing that the mowing stimulates the milkweeds to regrow and the new, new sprouts that come up are, are more nutritious. So, one big lesson from this is heterogeneity, have a variety of management practices. Don't treat your whole area the whole, the same way if, if you manage a thousand-acre prairie, don't burn the whole thing in midsummer because you could really, you could, you could wipe out a local population of maybe monarchs or more likely some other, some other pollinator species. It's good, it's good to, to split things up so that you're not managing everything the same way.

Megan: You mentioned Jessica Peterson, who is a former host on this podcast, one of her favorite words, heterogeneity.

Ray: Absolutely.

Megan: So, good, it's a good one. Karen, absolutely, she's fantastic. Karen, tell me a little bit about let's go down to like a micro scale. And you mentioned this earlier when you were talking, when you said that people shouldn't be discouraged if they have a smaller piece of land and there isn't a lot of habitat connections around them because they can still make a difference, which I love because sometimes we feel like the choices we make don't matter and the reality is, is they do matter, and even I'm surprised even at my own house the amount of wildlife that I attract in town in a city that is visiting my flowers and I'm constantly wondering where, how are they finding it, but they do. So, if you can expand on that a little bit about maybe some of the things that a person who's interested in a pollinator garden or has a pollinator garden or just a native garden in this backyard that they can do. And if you could also talk a little bit about hand rearing, because that's something that we hear about when we start thinking about things that we can do to benefit monarchs, and I'm curious about your thoughts on that.

Karen: Sure, thanks. I'll start with a, the small garden, and I think that it's really important to, to feel like you can make a difference no matter where you are. When I lived in Minnesota, I, I had a big, pretty big sunny yard, and I made the whole yard into a prairie and got a ton of monarchs there and a ton of other pollinator species, and it was,

it was gorgeous. Then I moved to Wisconsin near the arboretum where my yard has like three square meters of sun, and so I'm kind of learning how to garden in the shade, but my three square meters have a lot of milkweed plants and a lot of nectar plants, and then I'm putting other stuff in the shady areas, so monarchs still find my yard, so yeah, you can make a difference wherever you are and you're going to get a lot of cool pollinators coming and, and they're going to find you, and we were talking before about connectivity that if we have this, you know, this kind of patchwork of habitat for monarchs, we can really make a difference, so I'm going to probably beat a dead horse here, but this analogy of packing a lunch if, if your yard provides a little snack along the way for butterflies and other species, that's really valuable, so yeah, great to do that. And you'll learn and you'll, your yard will be pretty, and you'll be teaching other people, they're going to ask you what's going on, so you're making a difference in so many ways, and you can monitor it, you can join the Monarch Larva Monitoring Project then, keep track of what's going on in your yard. So rearing monarchs. If you have milkweed in your yard and you keep track of what's going on with the monarchs, you'll learn pretty quickly that most of those eggs don't turn into adult butterflies. So that concerns a lot of people and they think they're going to save the population by bringing all the eggs and caterpillars they, they see inside and raising them. There are states where that's not legal, you actually cannot do that in California, you need a permit to collect monarchs, that's not the case in Minnesota or Wisconsin, so there is a spectrum of opinions on rearing monarchs, and, you know, really smart people are on all sides of this issue. I personally do bring some monarchs into my house, I put them by a window so as much as possible they're exposed to outside conditions, I'll maybe rear five or six or ten every summer. I do that because I'm interested in parasitoids, I'm interested in, in survival, and I can't keep careful track of them when they're outside, so I contribute all of my data from every single caterpillar I, I raise to a citizen science project, so if you are raising them, the benefits of that are you personally will learn more about them, become connected to monarchs, and you can share what you're learning with other people. If you contribute your data to a citizen science project like the Monarch Larva Monitoring Project, you're helping us understand more about monarchs in general. You should not rear monarchs if your goal is to save the population. And here's why. So like Ray said before, there are millions of monarchs, and you, you said that when you were talking about that Ray, you said Karen will know what the number is. It's about 20 million on a hectare of land, give or take a few. There's no way humans are going to take monarchs into their kitchens and make a difference in the numbers of monarchs. The only way we can make a difference is to create enough habitat. If you're raising monarchs and there's not habitat for them, in the end it really won't make a difference, you're just going to let them out into a world that they won't be able to survive well in. So, your goal should not be helping the population. You, you are probably, if you find an egg outside and bring it into your house, from the point of view of that individual monarch, you're probably saving its life, you know, it's, it's got a 2% to 5% chance of surviving while it's out there. But from a population perspective, that one monarch is not going to make a difference. So, you, you know, think about your motivation for doing it and I'm just going to tell you it's not going to make a big difference in the big picture if you're raising them to help them. Another issue is under some rearing conditions, you're actually hurting the monarchs. If you rear monarchs under really crowded conditions, it's really easy for

pathogens to spread from one monarch to another, so unless you're keeping them in individual containers, there's a likelihood that they might get sick from each other, you know, it's like when your kid goes back to school in the fall or late early September and picks up all those colds that every other kid has, you're putting them in this, you know, big group of kids where they've been used to playing outside with just a few friends all summer long. Same thing with monarchs. They're used to being under conditions where they're not very crowded. So, rearing has the runs the risk of, of spreading pathogens from one individual to another. And there's some really interesting, very recent research only in the last couple of years that the conditions under which they're reared, forget about pathogen spreading, but they're not, when they're not exposed to those outside conditions, so if, if you bring them into your house and they're exposed to unnatural day length, unnatural light, they, when you release them outside, they'll just be really mixed up and they might not be able, they might not know that it's time to migrate. They might just be really confused. So that, that research is still ongoing, there's a lot more that we can learn from that, that research, but there's a chance that you're, the conditions in your house are going to confuse them to the point that they won't be able to migrate well. So, lots of concerns and, and this only the rearing of, you know, small numbers of monarchs that you brought in from outside. There are concerns, some people sell monarchs, so you can buy monarchs from, from big organizations that are, you know, raising lots of them and releasing them, and one of the things that this recent research showed is that it doesn't take many generations of captive breeding. So, they're basically being selected for really different conditions when they're being raised under captive conditions, and their genetics change. So, when you look at, when you do genetic studies of these monarchs that have gone through multiple generations of rearing, they're, they're so messed up that they're, they're missing a lot of the genes that, or they're, they've, they're genetically different from the wild populations. That's not an issue if you're just bringing an egg in from outside, raising it on your kitchen table, and letting it go. You're not going to change its genetics. So that's not an issue. It's only with these captive rearing that goes on generation after generation after generation. So, you know, I think every individual has to make their own decision, but just, you know, telling you that you, you should do it because you're interested, you, you're contributing data to science, but not because you want to save the monarch population. It won't make a big difference.

Mike: It's very helpful, Karen, yeah.

Megan: Karen, is it true that there has never been a captive bred monarch that has been found in Mexico, is that true, like a tagged monarch that none, we, we don't have any evidence yet of a captive bred monarch actually making it on its migration journey?

Ray: Totally false.

Karen: Yeah, actually, there have been some that have been reared in captivity that have been found in Mexico. So yeah, they, and right, so the Monarch Watch program that Ray talked about before, which is a program that tags monarchs, has some pretty interesting data on that. We don't know the percentage of monarchs that get tagged make it, but there have been some recovered, so some make it. It's just that there's the, the rear, and again, we don't have the data on the conditions under which they were

reared, so yeah, the probably the ones that make it have been exposed to natural light conditions as much as possible, so yeah, some are making it.

Megan: So, some make it but most don't, is that fair to say? Or we still don't know. Up for debate in science.

Karen: Yeah. Probably the, the rearing conditions really matter.

Ray: I, I need to share that. I used to rear monarchs, usually 5 or 10 or 20 a year, and one year, a local professor named Dr. Kristen Baum, needed caterpillars for her research. So, I had 200 caterpillars outside on my milkweeds, so she took them and reared them out I think near a light and a whole bunch of, I say a whole bunch, about four or five of those were recovered in Mexico. She, she reared them to adulthood, tagged them, and released them, so by, by no means do they never make it, but I've been convinced, convinced by the concerns that Karen brought up, the concerns that my coworkers at Xerxes Society have, and I, I no longer rear them. I, I would feel fine about rearing five or ten, but, but yeah, I, I, I've been convinced that there are too, too many, too many cons, but it, it is fun, isn't it, Karen? You're still doing it. It's, it's so much, it's so much fun and so fascinating to see these guys develop right before your eyes.

Mike: You know, guys, we, this is, this is a tremendous episode, and we could talk about this for a long time, I'm convinced of it. I would like us to kind of wrap things up, Megan, if that sounds okay to you. Just to get a quick, as quick as reasonable anyway as you can do it, summary of what you think about the future of monarchs. You know, are, have they, how much trouble are they really in, is there hope, those kinds of basic ideas. Ray, you want to start with that question if that's okay?

Ray: Sure, I'd be happy to. I, I think monarchs are in significant trouble, but I'm a pretty optimistic guy, and I work all the time with farmers and ranchers and gardeners who are, who are doing great work, so I think, I think the species is so beloved that it's generating a lot of positive action, and I think we will be able to help keep the monarch population stable and maybe even get it, get it back up. It probably won't ever get back to what it was in the '80s and the '90s, but I am, I am optimistic that with, with hard work, we, we can save the monarch.

Mike: Karen?

Karen: Yeah. I, I would agree with Ray. I won't repeat because I, I think that so many people care about monarchs and are doing so much to help them, it makes me very hopeful. And I just want to add that I, I'm a conservation biologist, and at its essence, conservation biology is in my opinion really the science of hope. We wouldn't be doing what we were doing if we didn't have hope that it would make a difference. So yeah, I, I just think that I, I am doing this because I do have hope, and I think that I thank everyone out there who's what they can to preserve habitat. It's not just monarchs you're helping, it's so many species and like Megan said in the beginning, or earlier, that this is, this is benefitting us as well, so yeah. I, I do have hope.

Mike: Awesome, thank you.

Megan: I feel like I'm getting choked up a little bit over here. I mean that, I'm saying this sort of facetiously but I'm meaning it really, I'm deflecting my emotions like a good Midwesterner. No, but I really am getting choked up a little bit because it is hard to be a conservation biologist because we so often talk about threats and challenges and difficulties, and I have never thought about our field being the science of hope, and I just love that because you're not wrong. That is why we do this, that is what our work is rooted in.

Mike: Yeah, why, why do it otherwise, right? Yeah.

Megan: Right, we are hopeful, even on the toughest days, we're still hopeful that we're going to, we're going to pull out a win. We'll win for the world. So, I just, well, we could talk about monarchs all day long, we're not quite done. We're going to move on to our next section.

(Music playing)

LET'S SCIENCE: To the Literature!

Science!

Megan: This is the part of the podcast where we recommend a book, a blog, or a paper, and why we like those choices. And Karen, we're going to start with you.

Karen: Thanks, Megan. I'm going to talk about some recent research that we did in collaboration with partners in the US Fish and Wildlife Service up in St. Croix County, and at the University of Wisconsin, my graduate student Skye Bruce, and other collaborators worked on a project to assess the impacts of habitat characteristics on monarch use of a site, and the landscape level features. So, what we found is what I talked about before that monarchs will find pretty isolated sites and also that they'll find small sites just as readily as large sites, and that the more milkweed that's in a site, the better for attracting monarchs and producing monarchs.

Mike: Ray, how about you?

Ray: Well, it's a very recently published paper titled Cattle Graze Central US milkweeds at Least as Much as Grasses. And it's by Tim Dickson, Brittany Poyner, and Chris Helzer. And I'm, I'm friends with Tim Dickson, Chris Helzer, and I love this paper. I, I, I've known about it for, for years because they presented it at a meeting. We, you know, have learned many of us have learned that milkweeds are toxics and thus assume that livestock can't eat them, and yet in this study conducted in Nebraska, they found that the cattle were devouring milkweeds like crazy and happily, there seem to be no negative impact to the cattle. So, so this has repercussions to monarch conservation. It implies that perhaps rather than worrying about the effect of milkweeds on the cattle, and again, this is only two species of milkweed, these are the one showy milkweed and common, but this is pointing out that these milkweeds are more, might be more vulnerable to the cattle than the cattle are vulnerable to the milkweeds. And very, very, a very easy read as far as a journal article goes.

Mike: Interesting. Thank you. Hey Megan.

Megan: Yeah Mike?

Mike: Why don't you take a hike?

Megan: Why don't we all hike together, Mike? You know it's more fun when we're together.

Mike: Find some monarchs.

Megan: Find some monarchs, have a good day.

Mike: That's where I go as I biologist like counting. Isn't that, isn't that terrible, like we should go out and enjoy monarchs, not in addition to counting them.

Megan: I mean, these sound like your own math issues that you're struggling with there, buddy.

Mike: Right, math issues, yes.

Megan: Because when I go to the prairie, I don't think about counting stuff, I think how lucky I am to be out there.

Mike: See, you do it right.

Megan: I'm just going to use that as your new ringtone. You do it right, Mike said that to me. Okay. Ray, what is your pick? Where are we hiking today?

Ray: Well, I couldn't pick just one. And to show you folks that I, I have been in Minnesota, my first pick is for the Lake Walk in Duluth. I got to go there in August, and along the Lake Walk is right along Lake Superior, and they have restored a narrow strip of prairie, it's full of wildflowers, and it's going to have some Monarchs various times of the year. So, the Lake Walk in Duluth, Minnesota. But if you're willing to go farther afield, please come on down to the Foothills of Oklahoma and Kansas. We have, believe it or not, millions of acres of prairie, some of it is exceptionally beautiful, and maybe the single spot to recommend to you is the Tallgrass Prairie National Preserve. It's about 7,000 acres of prairie near Strong City, Kansas City. Once again, Tallgrass Prairie National Preserve. You can be on a hilltop surrounded by nothing but prairie and milkweeds and flowers and butterflies. It's pretty heavenly.

Mike: 7,000 acres. That sounds amazing. Karen, how about you?

Karen: Sure. So I spent most of my career in Minnesota, so have hiked a lot in many beautiful prairies in Minnesota, done a lot of research in them, but Wisconsin is not that far from Minnesota and like I said at the beginning, I'm now the director of the UW Madison Arboretum, so I am going to encourage everybody to come on down to Madison and hike at the arboretum. We actually have the distinction of having the first restored prairie in the world, - -

Mike: Wow.

Karen: - - which is Curtis Prairie right outside my window. That was started to be planted in the 1930s, first modern restored prairie in the world. So that's a great place to hike, but where I'm going to recommend that you can go, if you only have a few hours in

Madison is Green Prairie, which is also part of the arboretum. We call it it's south of the beltline, so it's a beautiful prairie that was restored in the 1950s and 1960s, and it's just a pristine wet mesic prairie that has so much diversity in it and so many beautiful plants, it's just a great place to visit at any time of the year and a great place to see butterflies and bees and birds and all sorts of great things, and you're, you're right in the city but you feel like you're way out away from the city.

Megan: Hey Prairie Pod listeners, Megan here with a quick fact check update. We wanted to note that while Curtis Prairie is the first prairie reconstruction in the western context, native people have been here for thousands of years stewarding the land and making choices that enhance prairie habitat, and certainly that would include prairie restoration. All right. Fact check update out.

Megan: These all sound like beautiful places.

Mike: I think your places were all, were, were unprecedented on the Pod, I think.

Megan: I know. Just - -

Mike: All new ones, good job, you guys. Yeah.

Megan: Extra bonus. Well, the phrase that we are going to leave our listeners with is with hard work we can save the monarch. Next week we're going to spend some time in the shade because we're talking about savannahs with Becky Esser with the US Fish and Wildlife Service, Neil Slifka with DNR Parks and Trails, and Dr. Greg Hope with DNR Fish and Wildlife. Savannahs are arguably the unsung hero of the prairie landscape. When you think about prairies, savannahs are just an ecological subset of them, the special class of habitat that includes both prairie vegetation and understory and most often mature towering oaks, or even if you're in southeast Minnesota, some jack pine in the overstory. These transitional communities play an important role connecting Minnesota's prairies and enhancing word of the day, biodiversity. So, you're not going to want to miss a thing. As always, all of the resources that we talked about today can be found on our website at mndnr.gov/prairiepod. This episode was produced by the Minnesota Department of Natural Resources South Region under the Minnesota Prairie Conservation Partnership. It was edited and audio engineered by the fantastic Dan Ruiter. Our web production team is led by Bobby Boos and our social media lead is Kelly Randall. Gosh, what should we say to sign off, Mike?

Mike: Excellent job to our guests. That was an amazing podcast.

Megan: Yeah. Excellent job and let's make it so that monarchs don't have to pack a lunch because it's really hard with their tiny little legs.

Mike: There you go. That's a good way to end.

((sounds of birds chirping and wind blowing)).