

Dr. Danielle Ulrich:

In addition to the Clark's nutcracker, whitebark pine seeds are a good nutrition source for the grizzly bear, for the red squirrel, and for other animals in the Greater Yellowstone Ecosystem. And so the loss of whitebark pine and the decline of whitebark pine as we're seeing would be detrimental to all of these species.

Kristin Oxford, Host

Hello there and welcome back to the Voices of Greater Yellowstone podcast. I'm your host, Kristin Oxford. If you've ever spent time in the high wild reaches of greater Yellowstone up near the tree line, you may have come across a silvery gnarled pine tree. If you've seen it, chances are you've encountered a whitebark pine. These remarkable trees can live upwards of a thousand years and are often the highest elevation pines you'll find in Greater Yellowstone. And not only that, but they are important to the overall health of the ecosystem in some surprising ways. On today's episode, we sit down with Dr. Danielle Ulrich, a plant physiologist and assistant professor in Montana State University's Department of Ecology. Dr. Ulrich runs a lab conducting research to better understand how high elevation pines respond to a variety of environmental stressors. Among her research subjects is the vitally important keystone species, the whitebark pine.

These trees are a key food source for wildlife such as the Clark's nutcracker and the iconic Yellowstone grizzly bear. But their impacts don't stop at wildlife, as you're about to learn they also have a vital role to play in protecting the ecosystem and its inhabitants from drought and other impacts of climate change. But as important as they are, the future of the whitebark pine is uncertain. Pine beetles, blister rust and overcrowding from other trees, thanks to decades of fire suppression are among the many forces threatening the survival of this amazing species. In fact, you may have heard about the whitebark pine's recent designation as a threatened species under the Endangered Species Act, which means the species receives federal protections to aid in its recovery.

So join us for a chat with Dr. Ulrich, where we will learn a lot more about what makes the whitebark pines so special, go into detail about Dr. Ulrich's fascinating research, and learn what you can do to help conserve this amazing species and all the wildlife that depend on it.

Dr. Danielle Ulrich:

My name is Danielle Ulrich. I'm an assistant professor and plant physiologist at Montana State University in Bozeman. The overarching goal of my research is to understand, mitigate and predict plant responses to environmental stress, particularly climate change type stress, so drought and heat waves.

Kristin Oxford, Host:

And so you run a lab, correct?

Dr. Danielle Ulrich:

Yes.

Kristin Oxford, Host:

Awesome. So can you tell us a little bit about your lab and just dig into your research a little bit more?

Dr. Danielle Ulrich:

Yeah. So I guess I'll start with why plants are important. So I love plants and as we all know, plants and forests, they're important for providing food, clean air and water, healthy ecosystems, carbon storage, carbon sequestration, beautiful places to recreate as we know in Bozeman here. They form the backbone of our world. Yet with climate change, we know that we're losing plant species, plants and forests are dying. We have increased forest mortality rates, which is leading to changes in where certain plant species are found, where forests are found, and also their function so their ability to store carbon is also changing as these forests shift. And so because of these threats and these shifting plant functions, these increased forest mortality, our lab seeks to understand and try to mitigate the effects of climate change on forest function.

Kristin Oxford, Host:

Okay. Okay. Yeah. So what are some of the kinds of questions that you're hoping to answer with your research?

Dr. Danielle Ulrich:

Yeah. So I guess I like to start with just as we humans go to the doctor and get vital signs measured, our blood pressure, I don't know, our heart rate, whatever vision, hearing. As a plant physiologist, I measure various vital signs in plants such as photosynthesis, so how plants are using carbon and water and light to make their own food, or their sugars through this process of photosynthesis. And then also their stress tolerances, so things like drought tolerance, heat tolerance, cold tolerance. And we're particularly interested in how their vital signs, their plant vital signs are affected by climate change type stressors.

And so the overarching question or goal of my lab group is how do high elevation pine species, especially whitebark pine, respond to environmental stress, particularly climate change like drought and heat waves. And so we want to know more specifically, how will drought and heat waves affect these pine's survival and their mortality, what are the physiological mechanisms that underpin whether an individual tree will survive or die, how do droughts and heat waves affect these pine's functions, so their functions like how they do photosynthesis, how they're using water or taking up water, how are they storing their carbon or their carbohydrates or those products of photosynthesis.

Kristin Oxford, Host:

Okay. Interesting. So what does that research look like in practice? What kinds of things are you up to when you're in the field versus when you're in the lab?

Dr. Danielle Ulrich:

Most of our research right now occurs in controlled settings in the greenhouse. And so we mostly focus on smaller trees or saplings or seedlings, so all kind of individuals that we can grow in pots in the greenhouse under controlled conditions. And will impose various environmental stress treatments, so we'll impose a drought treatment or a heat wave treatment or a cold treatment, and then we'll measure their different vital signs or their different functions before, during, and after those environmental stress treatments are imposed. And we say we're plant torturers.

Kristin Oxford, Host:

I was going to make the joke. I'm glad you did it first.

Dr. Danielle Ulrich:

And that we're good at killing plants because that is what we do. But of course, there's more to it than that. We also want to know how these pines will respond to these stressors, so those vital signs or those functions I mentioned, and how these stressors will affect those vital signs like photosynthesis, how they use carbon and water and light and their stress tolerances, their drought tolerances. And so this will help us understand what our forests will look like under future climates, and how we might mitigate the effects of climate stress on them.

Kristin Oxford, Host:

Okay. Wow. So interesting. So this sounds like a pretty niche thing to do with your life. So tell us a little bit about your journey. How did you find yourself researching plant physiological ecology in the greater Yellowstone ecosystem?

Dr. Danielle Ulrich:

Yeah. So I fell in love with the outdoors and outdoor recreation around the same time that I fell in love with plant physiology, and this all occurred during my undergrad time, during my bachelor's at Bowdoin College in Maine. It's a small liberal arts school. I majored in biology and minored in chemistry. And neither of my parents went to college, and so when I started at Bowdoin I didn't know that being a plant physiologist was a career option or something that you could do. I actually started at Bowdoin wanting to go to medical school and be a doctor for humans, but didn't know that being a plant doctor was an option at the time. And so during my junior year, I was more than halfway done with my degree, and during my junior year at Bowdoin I took a plant physiology class with Dr. Barry Logan. And loved the class.

There are six of us in the class, so maybe that also contributed to a great experience too. But yeah, fell in love with plant physiology, the course. Barry ended up being my undergrad research advisor, I did an honors project with him some summer, undergrad research with him. And he really mentored and supported me throughout my research, throughout I think fostering my love for plant physiology too. So I attribute a lot of my inspiration for plant physiology stemmed from that class, from his mentorship, from my time in Bowdoin. Yeah. And then from there, I learned from my mentor Barry learning about how to apply to grad school, how to apply to fellowships and get funding. And then I did my master's and PhD at Oregon State University in plant physiology. And then the rest is history.

Kristin Oxford, Host:

Okay. So how did you find yourself in Montana?

Dr. Danielle Ulrich:

So after I finished my PhD at Oregon State University and then did a postdoc, a postdoc research position in Los Alamos, New Mexico, Northern New Mexico, just outside of Santa Fe at the Los Alamos National Lab. And was there for two and a half years. And then ended up getting a position in the ecology department at MSU, and so that's what brought me and my family to Bozeman.

Kristin Oxford, Host:

Right on. So when you're not working, how do you enjoy spending your time?

Dr. Danielle Ulrich:

When I'm not working, I like being outside. I like recreating outside. Like I was saying, during my undergrad time is when I fell in love with outdoor recreation, so we started hiking and backpacking to now my favorite outdoor recreation activities or sports are mountain biking, I like to telemark ski, trail running with my dog and my partner in... Bozeman's been a great home for us for that reason.

Kristin Oxford, Host:

Is it hard when you're outside recreating, are you paying attention to the plants constantly or do you manage to put blinders on and just bike?

Dr. Danielle Ulrich:

It depends. Maybe it depends on the trail and it depends [inaudible 00:10:26] activity. But oh yeah, a lot of the activities I like to do definitely take me to high elevation locations, and there are five needle pines everywhere, especially around Bozeman and I'm always taking pictures of them.

Kristin Oxford, Host:

Nice. Well, that's a perfect segue because for this conversation we really are going to focus on the whitebark pine. So for folks who aren't familiar with the species, could you describe the whitebark pine for us? What do they look like? What's their range? What kind of habitat can they be found in? Just give us a crash course in this particular plant.

Dr. Danielle Ulrich:

Yeah. So whitebark pine, it's a conifer, it's a conifer tree and a pine tree. It's needles are in bundles which are called vesicles, in vesicles of five needles, so it's in this group of five needle pine species. It's also found at high elevation, so they combine the names. It's a high elevation, five needle pine. It's also part of another group called the White Pine species, so it's high elevation, five needle white pine species.

Kristin Oxford, Host:

It's quite the resume.

Dr. Danielle Ulrich:

Yeah, it is. And so whitebark pine is found in high elevation mountain ranges throughout the Western US and also up north to Canada. whitebark pine are very slow growing trees. I think they're beautiful, they're majestic looking. If you see them in the Bridgers or South of Bozeman, they're just beautiful. And they produce these dark purple cones that make them easier to identify, in addition to having those bundles or those vesicles of five needles. You can go up to a tree and count how many needles are in there, and if there are five, it's either whitebark or Limber Pine if you're around in the Bozeman area. And then if they have these dark purple cones, then you know that it's whitebark and not Limber Pine.

Kristin Oxford, Host:

Okay. Okay. Limber pines are the ones that are bendy too. Do whitebark bend the same way?

Dr. Danielle Ulrich:

Yeah. Oftentimes they... So both species are very similar, their morphology is very similar and really hard to distinguish the two species unless they have those cones. So it can be really tricky.

Kristin Oxford, Host:

So why are whitebark pine trees so essential to places like the Greater Yellowstone Ecosystem?

Dr. Danielle Ulrich:

Yeah, good question. So the whitebark pine is found at some of the highest elevations for any tree species, and they like to establish in bright sunny environments. These environments at high elevations are also windy, very exposed, they can be cold. whitebark pine likes to establish on high draining and very nutrient poor soil. And so these conditions altogether mean that few other tree species or plant species will establish there. So they're some of the only species that can establish in these really harsh high elevation conditions. And because of that, they're considered pioneer species, meaning that they're usually the first to establish after a disturbance. A disturbance could be something like wildfire.

Kristin Oxford, Host:

Okay.

Dr. Danielle Ulrich:

So they're really important to the greater Yellowstone ecosystem because of this ability to establish in these locations where other plant species can't establish. We say that because of this role, they're what we call foundation species, meaning that they create or build a foundation for other species to inhabit. So they can create habitat for other plant species or animal species, including providing shelter from the wind. Their roots will help stabilize the soil and help prevent soil erosion. Whitebark pine can also help to stabilize snow pack and help delay snow melt by keeping the snow pack shaded longer and prolonging stream flow longer into the summer, which is beneficial for downstream ecosystems that rely on that snow melt.

Kristin Oxford, Host:

I would imagine that's becoming increasingly important with the way that climate change is affecting our region, where we're going to see big changes in precipitation and our snow pack as well. So that's really interesting to know.

Dr. Danielle Ulrich:

Yeah, definitely. I'll also add there, in addition to creating this foundation for other species, they're also often referred to as keystone species, meaning that even though they're... They can be viewed as relatively rare in abundance, they have a large ecological impact on the ecosystem in which they're found.

So for example, they have a mutually beneficial relationship with the bird, the Clark's Nutcracker, where the Nutcracker can use their strong beak to access the seeds in the whitebark pine cones, and will eat those seeds and then we'll cash them, bury them in the ground somewhere and cash them, hide them to access them later. And to whitebark pine's benefit, some of those seeds will germinate. And so the Clark's Nutcracker serves as a way for whitebark pine to disperse its seed. While the whitebark pine seed serves as a high calorie nutritional food source for the Clark's Nutcracker. In addition to the Clark's Nutcracker, whitebark pine seeds are a good nutrition source for the grizzly bear, for the red squirrel, and for other animals in the greater Yellowstone ecosystem. And so the loss of whitebark pine and the decline of whitebark pine as we're seeing would be detrimental to all of these species.

Kristin Oxford, Host:

So speaking of the decline of the species, let's talk a little bit about some of the threats to whitebark pine. Often when we hear the name whitebark pine, the words immediately following it are things like blister rust and pine needles and climate change. So it seems like they're up against some pretty significant challenges. What can you tell us about these threats?

Dr. Danielle Ulrich:

Yes. Whitebark pine faces a suite of threats, like you mentioned white pine blister rust is the primary main threat to whitebark pine that's leading to the widespread decline that we're seeing, especially in the GYE and the greater Yellowstone ecosystem. In addition to white pine blister rust, also mountain pine beetle is also a major biotic agent that threatens whitebark pine as well, leading to a lot of whitebark pine mortality. In addition to white pine blister rust and mountain pine beetle, an abiotic factor that is also threatening whitebark pine is climate change. So warmer, drier conditions can stress trees out and can make them more susceptible and less able to defend themselves against these biotic agents like white pine blister rust, like mountain pine beetle. That if they weren't stressed due to drought or heat waves, would have normally been able to defend themselves against such agents. So it's this perfect storm of being stressed by drought and warming temperatures, and then also these biotic agents, the beetle, the rust.

And then finally I'll say another threat to whitebark pine is competition with other more shade-tolerant conifer species, so Subalpine Fir, Engelman Spruce are just more shade-tolerant, whereas whitebark pine is very light loving, it's very high light tolerant. But this Engelman Spruce and Subalpine Fir can actually shade out whitebark pine, making it harder for whitebark pine to establish. That has happened because Subalpine Fir and Engelman Spruce are increasing in prevalence. Those Subalpine Fir and Engelman Spruce forests are becoming more crowded, and that's because of a history of fire suppression caused by humans. And that we're suppressing fire, and that fire would create space for whitebark pine to establish. But with a history of fire suppression, there's been an overcrowding and an increase in the growth of these shade-tolerant conifers that makes it hard for White Bark to establish or regenerate.

Kristin Oxford, Host:

So they're getting it from all angles right now so to say. So I think I have an inkling of how you're going to answer this because you talked about some of the species that are dependent on the whitebark pine for nutrients, but what would a place like the greater Yellowstone ecosystem look like without whitebark pine? What are some of the impacts of losing them?

Dr. Danielle Ulrich:

Yeah. Some initial things that come to mind are maybe earlier snow melts, earlier summer drought, if we don't have whitebark pine protecting snow pack at those higher elevations, an increase in Subalpine Fir Engelman Spruce. We might see a migration or a decline in some of the animal species that depend on whitebark pine seeds as a nutritional source. Maybe denser forest. Maybe an increase in wildfire. To investigate this further, this question further, I have a grad student who's using field measurements and some climate modeling, some water balance modeling of stream and snow hydrology to understand the effect of whitebark pine mortality on snow pack and on stream flow. So a research project getting at this question of what would the GYE look like without whitebark pine. So we're trying to quantify with some modeling, with some field observations, what are those downstream impacts of losing whitebark pine.

Can we quantify them? And then maybe next time I come on the podcast, I can answer it more definitively.

Kristin Oxford, Host:

That is all so interesting because I think it's probably intuitive to imagine that there are animals that depend on a plant like the whitebark pine, but then when you talk about snow pack, that's a whole another level of impact to the ecosystem that I think is really important and certainly not front of mind for most folks. Just think about how a single tree species can actually impact our resilience to climate change and have implications for our water supply. That's pretty significant.

Dr. Danielle Ulrich:

Yeah.

Kristin Oxford, Host:

Yeah. So let's talk a little bit about conservation. What are the conservation implications of your research? How are you contributing to understanding how to better conserve this species?

Dr. Danielle Ulrich:

So a primary restoration strategy for whitebark pine right now by the forest service is to outplant white pine blister rust resistant whitebark pine seedlings. And the forest service does this every year. And so my goal for our research is to improve how we match the seedling's physiology and their physiological profiles, how we match those seedlings with the most appropriate and optimal planting locations. So making sure that we're planting seedlings with certain heat or drought tolerances in locations that will promote or ensure their successful establishment and survival. So using physiology to appropriately match the seedlings with the location to outplant those seedlings.

Kristin Oxford, Host:

So what do you think the future looks like for this species? Is there anything that makes you particularly concerned or even particularly hopeful?

Dr. Danielle Ulrich:

I'll speak to both. Some things that are particularly concerning is whitebark pine's really slow growth rate. So even with outplanting restoration efforts, their mortality outpaces their regeneration or their death rates outpace how fast they can reestablish and regenerate. So their slow growth rates plus that we're seeing warming temperatures and droughts may increase the prevalence of white pine blister rust, may increase the susceptibility of whitebark pine to these biotic agents as I mentioned before. So their slow growth rates plus climate change may be exacerbating their biotic agents and biotic stressors, makes me particularly concerned.

Kristin Oxford, Host:

Yeah, fair enough.

Dr. Danielle Ulrich:

But what makes me particularly hopeful is that there are lots of people interested and invested in protecting and conserving and restoring whitebark pine. It's incredible how many people and how many

groups and organizations are on board with doing everything we can to protect and conserve high elevation pines, to conserve whitebark pine, especially to conserve high elevation ecosystems in general. It's inspiring to have so many people care and be aware and be educated about these issues and doing what we all can and working together towards that same goal. And so only time will tell how much we can accomplish together.

Kristin Oxford, Host:

Yeah, for sure. Newsworthy recent thing that happened was of course that whitebark pine were listed for additional protections under the Endangered Species Act. Of course, that's not a silver bullet. That is one tool in the toolbox as far as conservation is concerned, but how do you feel about that designation for the species?

Dr. Danielle Ulrich:

I think whitebark pine has been a candidate species to be listed officially under the Endangered Species Act for a while. So I think it's great to see it finally being considered an officially threatened species, and getting that official designation when it's been on that candidate list for so long. We've seen these mortality rates for so long. So seeing some validation at a federal level is a good thing.

Kristin Oxford, Host:

Yeah, absolutely. Is there anything that regular folks can do to help protect and conserve the species?

Dr. Danielle Ulrich:

Yeah. I think there are lots of things that regular folks can do to conserve the species. One being you can educate yourself about whitebark pine's value, it's ecological functions and it's threats. You could educate yourself so that you can then talk about whitebark pine and whitebark pine conservation with others, with your friends, with someone on the ski lift, someone in the grocery store. If you like recreating and high elevation alpine ecosystems, most people will care about whitebark pine and other high elevations species, and it can help get others on board to care as well if they don't already know.

Kristin Oxford, Host:

When I was poking around on the Wikipedia page, cough, cough, for whitebark pine before chatting with you, I read this thing about how they... And I'm going to totally forget the German word for this, but how they are very malleable, how they grow depending on their environment. So they can either grow really tall and straight if they're in a protected place, or they're one of these species that because they live in this harsh environment can grow low to the ground and all bendy. And I just thought that was really cool. Is there anything particularly special or different or interesting about the species that really resonates with you, where it's a fun fact that you're just like, "Ah, this is such a cool species."

Dr. Danielle Ulrich:

Overall, I just think the species is so cool because of where it lives. I think just it inhabits a place that few other species can live and that in itself is impressive. And I think also what you're referring to is the Krummholz formation, especially under really windy, harsh conditions, the Whitebark pine's crown morphology will take on this bush morphology where it's low to the ground. And in that way, it's again very impressive in that it can adjust to these harsh conditions, change its morphology so that it can survive where not all species can do that. So you're right, and that's really special.



Kristin Oxford, Host:

Yeah, it really seems like it is such a beacon of resilience and adaptation. And it's sad to think about losing a species that can do that for us. I know we've focused on whitebark pine today, but they aren't the only plant you study. So do you have any other favorite or particularly interesting species that you work with that you want to tell us a little bit about today?

Dr. Danielle Ulrich:

Yeah. I think whitebark pine is still my favorite species, but Limber Pine comes in a close second. It's similarly impressive in where it also inhabits high elevations. It looks very similar to whitebark. It's found throughout the Bozeman area. And it's also I think just as beautiful and deserves just as much attention as whitebark does.

Kristin Oxford, Host:

Perfect. You heard it here first. Limber Pine are worth your attention. I like them because I like that they're bendy. I just think it's really fascinating when you can go up to a tree and they have flexible branches. It's not what you expect, and they're really beautiful. You may have touched on this earlier when you were talking about your undergrad mentor, but one thing we really like to ask our guests is if they have a conservation hero. So are there any other people or is there any one person who you can really point to as being your really main motivator in your conservation work?

Dr. Danielle Ulrich:

Rather than a single person, my conservation hero is the Whitebark Pine Ecosystem Foundation. They're a science based non-profit organization that promotes the conservation and restoration of whitebark pine and other high elevation pine species. And the work they do is phenomenal. They have a whole group that organizes annual conferences, webinars, meetings. They helped organize the press release on the Endangered Species Act for whitebark pine. They provide student funding for student research. They also do a program where they will certify ski areas that are whitebark pine friendly. And so the Whitebark Pine Ecosystem Foundation is just great and a leader in conserving whitebark pine. And for that reason, they're my conservation hero, especially in relation to whitebark pine.

Kristin Oxford, Host:

That's a really good answer. We will put a link to their website in the show notes for this episode. If listeners want to learn more about your research, where can they go to find that?

Dr. Danielle Ulrich:

My research website which I can give you, and my email address which I can also give you.

Kristin Oxford, Host:

Perfect. Is there anything else you'd like to share with us today or anything else you'd like people to know either about your research or about whitebark pine?

Dr. Danielle Ulrich:

I guess I would add to my list of things that regular folks can do to help protect and conserve whitebark pine, in addition to educating ourselves and talking about it with others, people can also write to their local politicians to maintain protection and fund conservation efforts. And I'll end with this poor pun

where I'll go out on a limb and say that all whitebark pine researchers, enthusiasts would be happy to hear from you. So don't be afraid to reach out and ask how you can help. So if you know anyone who's in the whitebark pine world management or research, anything, reach out to them and I'm sure they can direct you for more ways for how you can get involved.

Kristin Oxford, Host:

That was beautiful. I feel like I should say nothing after that. The dad joke lover in me is intensely satisfied by this ending. Thank you so much for spending time with us today. It was really lovely to talk to you and to learn more about this really charismatic species and thanks for being here.

Dr. Danielle Ulrich:

Thank you.

Kristin Oxford, Host:

Thank you so much to Dr. Daniel Ulrich for joining us to share more about this amazing species. We loved learning about this rugged pine tree and its importance to the Greater Yellowstone Ecosystem. Listeners, if you'd like to learn more about Dr. Ulrich and her work, we've placed those links in the show notes.

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