Josh Lawler: I don't think we're doing enough in terms of integrating climate change into all of the conservation we do and all of the management we do. But in the picture of who's listening and who isn't and who's responding to climate change and who isn't, the conservation world is doing a pretty good job if you compare it to the political world or other spheres where folks aren't listening as much as they need to be.

Priya Shelly: Welcome to From the Field, a podcast logging real life scientists and their efforts to improve the world, one study at a time. I'm Priya Shelly. In this episode, I speak with Josh Lawler. Josh is an ecologist and professor at the school of Environmental and Forest Sciences at the University of Washington.

Do you ever notice in the movies when a catastrophic even is about to occur, the animals can sense it and flee before the humans? Even though that's an exaggeration, plants and animals do respond to the impacts of stressful events, like climate change and migrate to cooler climates.

Josh researches how climate change can alter the migration paths of animals and plants and how those shifts impact both the species and the ecosystem. But first, Josh went through several realizations to get to that point, starting with a bug collection.

JL: as a kid, my parents were pretty good at getting us outside we spent a lot of time going to nature centers, going on hikes and walks,-my mom had a bug collection that she made with me when I was little. Oh, just, I still remember vividly.

Part of my interest, at least in nature and ecology came pretty early on. and then in college I had the chance to take lots of ecology classes. And at the same time I was taking a bunch of an environmental philosophy classes, uh, which got me interested in conservation. And then there were a couple events, that really made me decide I need to be a conservation biologist.

JL 00:01:49: And one of those was hiking, the Appalachian trail, the trail drops down to valleys and then goes back up and you walk on a Ridge along way and then you drop down into a valley, cross the road or a river and then you go back over a ridge. And so I, I was passing through one valley and about to go up the next ridge and there was a sign that said for the next three miles, five miles, whatever it was, don't stop, don't touch anything, don't eat and don't drink. Uh, and then it went on to explain that this ridge was a downwind of a zinc smelter that had operated for a, for a number of years. Uh, and sure enough, when I got up on the ridge, it was, it looked like Mars.

There was, very little alive. And what was alive was, was in pretty rough shape. And it just struck me that this whole ridge had just been devastated by something going on in the valley right next door. It was the first time I'd really seen firsthand that of environmental damage. it made me realize how important it was, to do something about it.

~~PS:~~ Josh had been witness to the effects of the Palmerton Zinc Pile in Palmerton, PA where a zinc smelting operation deposited a large smelting residue pile called the Cinder Bank. For nearly 70 years, it emitted heavy metals through the Appalachian Trail valley. It left nearly 2000 acres void of trees. Listed as a Super Fund site, it has since been cleaned up after massive restoration efforts but at the time, it was and example of how landscapes were treated. It was shocking enough to sway Josh to gear his career path towards conservation.

JL: From there I went to Grad School, and I studied, landscape ecology. I've always been interested in sort of larger scale patterns and questions about why, why are these trees here and those trees over there, how might animals move through this landscape, what kind of animals might we expect to find in that stand to forest versus the standard for it. so a lot of the questions I was interested in had to do with how the patterns on the landscape affected ecological processes. and from a conservation standpoint, I was interested in what we do to the landscape and how that affects plants and animals.

I was studying cavity nesting birds in the winter mountains in Utah. Uh, and I was looking at, um, and how they selected habitat and why the birds were nesting, where they were. Were they keying in on landscape patterns? so that was, that was my graduate work. after that I wanted to go on to do something that had a little more conservation relevance and was more directly related to conservation. so I ended up doing a, a number of postdocs~~.~~

For a while I did a postdoc with the environmental protection agency. I then went on to do a, um, David H. Smith, a postdoctoral fellowship at the University of Oregon. that's when I started to look at climate change in particular and, how climate change might affect, uh, plants and animals in the future and what that means for the conservation planning process and, um, and how we address it.

PS:~~-~~In the early 2000's around the time of Josh's post doctoral fellowship, conservation and landscape planning wasn't yet equipped to account for the effects of climate change, leaving room for Josh and his colleagues to come to an important realization. It was time to look to the future.

JL: At that point, most conservation planning involved identifying where the conservation targets you wanted to protect were on the landscape, and then selecting places to protect them. so that meant looking at current distributions of plants and animals, current maps of, eco regions or a vegetation types and at its best also incorporating land costs and maybe some of the threats of land use change and things like that into an algorithm that you then run to identify where the places, if you had a certain budget, how many of these places could you pick? And you were only allowed to pick a certain number, which places would you pick to protect the most biodiversity? That's how conservation planning was done at the time.~~So~~ studies were finding, butterflies and birds shifting poleward and finding mammals moving upward in elevation plants moving upward and elevation. And so with these movements, everybody realized, well if we planned for where the species are today and we don't take into account where they might be in the future, we might be putting these protected areas in the wrong place or investing in restoration or other conservation actions, in the wrong places.

PS: From there, Josh accepted an assistant professor position and the University of Washington and began building a lab. The Landscape Ecology and Conservation lab, is dedicated to studies about climate change, conservation planning, land use change, and how human activities across the US play a roll in migration.

It's where Josh began to formulate one of his bigger questions: how do you account for climate change in the migration of plants and animals and how do you show that? His results were astonishing.

JL: Most of the work that I've done on climate change, climate impact on plants and animals and on conservation planning has been done a while I've been at the University of Washington. One of the things that we needed to do to figure out, um, how to change the conservation planning process to, to address climate change was first to understand how plants and animals might move as the climate changes. And, uh, so we went about building a set of models that would project, um, potential future distributions of plants and animals in the face of climate change. And so one of the first things I did was, um, built models for 3000 different vertebrate species, birds and mammals and amphibians and projected where those species might be in north and South America in the future, given 30 different potential future climates, where are those climatic conditions that the species exist in now? Where do those conditions end up on the landscape? And make the assumption that that may be where the species need to be in the future. That was the very first step. And looking at, um, how we incorporate climate change into conservation planning was to try to figure out how species, where they were going to go and if they needed to move, um, where they might move to.

PS: Some animals travel seasonally, in search of a more hospitable climate, by using well known migratory patterns passed down from generation to generation. Like when some birds in the US flock to the south during the winter season. And that's normal. But account for the desire to migrate due to climate change and many animals suffer.

JL: We looked at 3000 different species and across, the, the western hemisphere, and we asked, well, in any given place, how much change you expect in the species that are there today. we found that on average you'd see about 35% change in any given place. And so that's, and some places were projected to change by 90%. that would be a wholesale change in the mammals, birds and amphibians that you find in a particular place.

JL: It was fairly shocking that we might expect that much change. then took those models and, I've had a number of students since the reviews, those models developed similar models and started asking other questions. I had a student, Carrie Schloss, who asked whether the mammals in our data set would actually be able to keep up with the shifting climate. She went about trying to figure out how, how fast 500 mammals could move across the landscape, how far they could get in a hundred years. She looked at where they would potentially need to be in a hundred years and said, can they keep up? Can they make it? Um, and she found that on average, about 8% of the mammals, ~~we~~ wouldn't be able to keep up with climate change. And that in some places up to 40% of the mammals wouldn't be able to move fast enough to track shifting climates. it was a sobering number.

PS: This is the part where we should be worried. What would that mean for our natural landscape? The results were even a shock for Josh and his team.

JL: I've been asked when I've given talks, how I can do it and, how one doesn't get too depressed. ~~I~~ would say that as the pressure to do something mounts and as our time runs out to deal with climate change, I do question whether this research is the most important research. I say that I'm fully believing we need to the natural world and we need to understand how it will respond. But, um, but the most important thing we need to do at the moment is to slow down the change and to reduce emissions and to sequester carbon and to eventually stop climate change. And so that being the most important thing I do question sometimes is, is the research I'm doing the best way to contribute to that.

PS: Despite his lingering doubts, Josh and his team knew they needed to solve this problem. They started figuring out the best possible paths for these plants and animals to follow.

JL: so that led to,~~-~~research, on connectivity. And so for a long time, conservation biologists have been, concerned about how fragmented habitats have become an as people have expanded across the planet. And as we farm it and as we build out our cities and suburban areas, uh, the amount of natural land shrinks and often becomes fragmented, broken into different patches and pieces. But that fragmentation has impact on wildlife populations, on the genetics of isolated populations and on the viability of populations, how long they'll last.

PS: In the history of Earth, plants and animals either migrated due to changing climactic conditions, adapted to their environment or became extinct. Though migration may not have been easy, it was still possible because of connected terrain. One distinguishable difference between then and now is the presence of man made infrastructure.

JL: In the face of climate change, it may become even more important that the landscape is connected to allow species to move. Because in the past when the climate has changed and species have moved around~~,~~ which has happened a number of times in the Earth's history, many times, plants and animals have moved. And there's evidence in the fossil record, um, that, plants and animals have moved as the climate changed. But today there's the landscape, as I mentioned,~~-~~is quite fragmented and large portions of continents are covered with agriculture. ~~And~~ so it's going to be harder for plants and animals to move to the places they may need to go as the climate changes. connecting these fragmented bits of natural landscape become important. so we've had a number of studies in the lab where we've tried to develop approaches or we have developed approaches that, um, plan for connectivity that would allow species to move to where they need to go in the face of climate change.

PS: Josh uses data layers on top of his base map findings, so he can pinpoint areas on the landscape that need to be optimized for future migrations.

JL: So, so I'll give you two or three different approaches that we've, um, we've used and built different maps with. So one uses those same models I talked about before. We use those models and we said, well, we know where they are today and we know where they might need to be in the future. How would they get there? and how can we map of the routes that they might take to get there.

And so we did that. We looked at what's on the landscape today and um, generated what in connectivity modeling, we call a resistance layer. It's a layer of data that provides information on how much resistance, any part of the landscape, poses to the movement of, an organism or a particular species. we used a layer that was based on all sorts of human impact on the landscape, whether it's the land use that's there or the population density, nighttime light, uh, information on roads, where roads are. And we use that layer that ~~sort of~~ shows how impacted the landscape is~~-~~we tried to map routes through that, that avoided the heaviest human impact, from areas where the species are today to where these models project they might need to be in the future.

It turned out to be more like 2,500 species and we mapped those routes and, um, and then we sort of overlaid them for all the individual species and we asked where on the landscape would we likely see the most movement. So looking across all these species, across different climate models and across the whole range of the species. And so we came up with this map of north and South America that showed these, these routes started to appear where species might be moving in the route, they generally flowed to areas where, the climate is suitable. So that tended to be northward in the northern hemisphere and it tended to be southward and the Southern Hemisphere, but mountain ranges played a large role too. And so route showed up, um, that moved up through the Appalachians in the eastern us and, um, down through the Andes in South America and through the Rockies and some of the other mountain ranges in the western us.

PS: The data visualization is shown on a map of North and South America, by way of multicolored wiggling arrows, flocking northward or southward depending on the origin of the species. It's as if the entire map is covered in traveling impulses of a human nervous system. It makes you realize how serious the need for connectivity is. Josh didn't stop at mapping the routes. He and his students did what they do best - they went back to the lab to conduct more studies.

JL: another approach we took was to try to project how the climate to themselves might move and particularly climates that, um, that might be disappearing or B shrinking. You can imagine that, that today there are lots of different climatic conditions, on the continent. And so there are places where taught dry in places where it's a generally cooler and wetter, like the Pacific northwest. Um, and there are all sorts of combinations. Well, those different combinations as the climate changes, some of them might become more common in some of them might become rarer. I have a Postdoc, a researcher working with me, Julia Maholick, who went about trying to model how the climate's might change, identify the shrinking climatic types and figure out where they're shrinking too.

And then one of my students, Caitlin Littlefield said, well, let's see if we can map the routes from where those climates are now to where the shrinking climates will be in the future. we called these, these climate Refugia where they ended up. Uh, and, uh, Caitlin mapped routes through a human dominated landscape, much like we did in the other study to get to those, um, shrinking climates where they ended up being projected to in the future.

The third approach doesn't have, this doesn't involve any climate projections at all. I had a student, Tristian Nuñez who developed this approach, uh, and it involves just looking at what the climatic gradients are today. the approach assumes that you want to connect places that are more natural, so less human-dominated and you want to connect ones that are slightly warmer to ones that are slightly cooler. And that's just in today's climate. He developed these routes from natural patches of vegetation or natural more natural areas that were slightly warmer to ones that were slightly cooler. And she did it by, again, avoiding human land use and human dominated landscapes, but he also did it by avoiding steep changes in come out of gradients. So I'm trying to go down from a cool area down through a warm valley to get to a cooler area, but instead trying to follow the climate gradient to get from cool to cooler.

PS: The maps provide a pretty, but alarming swirling pattern of data but what's being implemented to create areas of connectivity? One physical form of connectivity is green overpasses and underpasses which cross busy highways, but often times improvements to connectivity can appear on the landscape in subtle ways.

JL: So how did those maps end up playing out in the landscape the placement of those overpasses are underpasses. They often come from connectivity modeling. I think most of those that are in place now weren't designed in taking climate change into account. most of the ones were done a while ago. but there are some, that I know of that cross a highways that run east west and those could be considered as allowing movements and the direction you might expect and Climate change. but the other ways that the connectivity modeling might manifest itself on the landscape or are less obvious. So those would be the restoration of a piece of agricultural land or, the purchase of a piece of land that might be developed that would keep a green corridor between two suburban areas or something like that. So those are other ways that you might expect to see these efforts manifested on the landscape.

Some animals are quite willing to move through our suburban areas and even some of our urban areas. There are plenty that, that avoid people. Right. And the ones that avoid people, uh, are going to have the most trouble adjusting to climate change because we're in the way. Um, and so, yeah, so the connectivity modeling is, is mostly for the species that, um, a need to move in the face of climate change and be, um, either don't get along with people are or avoid human influence on the landscape. So, um, there's species that won't move through suburban areas across large highways or, um, or get killed when they cross large highways, or move through, agricultural areas.

Dealing with multiple practices and scenarios is a good thing, especially with the uncertainty of the future and how things will actually pan out here on Earth. It’s something that Josh and other scientists have to deal with on a regular basis.

JL:That, that's a big deal. The uncertainty is a big deal for, um, wildlife managers for conservation planners, for conservation practitioners in general. Um, and there's always uncertainty that we don't know what's going to happen tomorrow. Um, but with climate change, um, I think that the conservation community has to, to a fault keyed in on that uncertainty. Um, because there's uncertainty in the projected changes in climate. All the climate models project that the temperature will increase. They project that increased to different degrees, but they are projected increase. When it comes to precipitation. There's more uncertainty, there's more variability in the predicted changes in climate. We looked across multiple climate change scenarios coming out of the global climate models. And so we didn't just pick one and look at that. And so that's one way is to try to look at a breadth of different projections and then draw conclusions across all of them.~~.~~

JL: ~~A~~nd that's also how, um, it's been recommended that managers and planners look at the problem is to look at multiple scenarios of change and to plan for the potential alternatives that that might happen.

The other thing that's probably more important now than it ever was before is something we call adaptive management. it's often recommended but rarely done in wildlife management and conservation. And that's to treat management activities as if their experiments, uh, and be willing to adapt and change those. With climate change it's more even more important to do that because a, we're not certain how things will respond to climate change and B, we're not exactly certain how the climate will change

It's hard to look as far into the future as we need to when it comes to climate change. And managers often have enough trouble dealing with, um, the population trends they've seen over the last five years and, um, the data they have on current distributions. Um, there are several challenges. I mean, challenges come in with, can they get their hands on good projections of what might happen? Can they take the time and the money to produce those? Uh, and then how do they take that information, which, which might be uncertain, well, which will be uncertain, uh, and incorporated into their planning process. And so I'd say that it's a big challenge to look that far ahead. But I think there's, there are definitely efforts going on to do it. Um, both in the planning process, the conservation planning process, uh, and more generally in terms of restoration and, um, and wildlife management and, um, a landscape management in general.

PS: In an effort to let plants and animals hold their ground, projects have been put into place to increase the chances of adaptability to the inevitable warming of the planet. Because, usually as Ian Malcolm says in Jurassic Park, Life, finds a way.

JL: There are a number of projects that have been, uh, we call them adaptation projects that had been funded to, to help ecological systems, uh, adapt to climate change. And so those include everything from reintroducing beaver into a system to reengineer the flood plain in such a way that it can absorb more flashier flood year, conditions that we expect with climate change and to store more water, um, which might be needed as the climate changes, um, to doing things like changing the mixture of trees being used in, restoration efforts so that we're picking trees that might be more drought tolerant or species that, um, we know, uh, can exist in warmer climates or drier conditions.

JL: I’ve actually had two students who've explored the potential for using beaver as a climate adaptation strategy, both to store water and potentially to cool water in streams. beaver used to be a much more widespread than they are now, but we're trapped out, of many, if not most places. the idea is that we could reintroduce them to systems and what they do as you know, is they, build dams, they cut down trees and collect wood and build dams, creating ponds. Sometimes they're a little pond, sometimes they're big complexes of ponds. those ponds store water.

~~T~~here's water being stored and not only in those ponds and wetlands ~~or~~, but also underground by raising the water table, adding more water underground. In the Pacific northwest where we expect to see drier summers. it might be good to have some more water stored at higher elevations in those streams that can trickle out over the summer so that there's more water in the streams.

PS: Beavers end up making up for the lack of cool snowpack and glacial melt trickling down into streams over the summer, providing a functioning ecosystem for other animals. Josh and his team are also looking at the potential for beavers to cool the water underground - depending on where you place them, this could provide much needed cool water for neighboring animals.

JL: Um, the other idea that folks had was that, um, there beaver can potentially cool the water down below these ponds. one of them found that beavers are storing a lot of water and that they were, that the water coming out was on the whole cooler than the water that was going into these beaver ponds. The other students found that the water coming out of the beaver ponds downstream at the beaver ponds tended to be warmer so that the beaver were actually, they were storing some water, but they were actually a warming the water as it came out downstream. Not all beaver streams are going to be the same in the face of climate change.

PS: Busy beavers aside, we can also make a contribution to plant and animal refuge and adaptability by starting in our own backyards.

JL: In terms of conservation and biodiversity, providing species with a place to go is one thing that people can do even ~~even~~ on a small scale. So planting native plants, even if we're talking about providing butterflies and, bees and other insects, a place to go and birds, that's still something that can help, um, contributing to local land trusts and, voting for legislation that, promotes land protection or conservation. When it comes to slowing down climate change or even stopping climate change, it's all sorts of personal decisions about transportation and about energy use. So moving to electric power and pushing ones, local utility to move away from fossil fuels to, um, to renewable sources is another thing. food waste is a big contributor to climate change. And then meat consumption, is also a large contributor to climate change. So moving to a more plant based diet, so there are lots of things that one can do that go far beyond, um, changing light bulbs or um, putting solar panels on one's house.

We need nature even more and we need to increase the access we have to nature and we need to potentially preserve what we have so that people can access it. There's also linkages between, um, our care for nature and feelings of stewardship towards nature and, and having had experience in nature. And so, um, so that loss of contact with nature is, is probably detrimental for the protection of nature in the future.

PS: We know without a doubt that the presence of flora and fauna on our wild landscapes will be different due to climate change over the years but does that mean we should lose hope about our natural world? Josh doesn't seem to think so.

JL: There is hope and people should have hope. first of all, I don't actually fear too much for the, um, the natural world period. ~~Um~~, nature will nature in some form. we'll do just fine. Uh, the ecosystems we have now, the sets of species we have now may not. Um, and so we'll see lots of change. I think what we probably have to worry about more is ourselves. We're going to have a harder time dealing with the changes that are coming. Many of our economic systems and social systems and are going to be more fragile than the natural world on the whole is. There's going to be lots of change, but there is hope because nature's fairly resilient and so I do have hope that, that we will act in time to save ourselves and in so doing will act in time to save nature as well. The hope comes in part from the fact that we've been able to address some fairly serious environmental problems before. So the hole in the ozone was a big one. The fact that we had, um, rivers catching fire at one point. Uh, and so we were able to come together to address those problems and granted the scales a bit different. And, the level of difficulty in overcoming them is a bit different. But when we were able to do that. And then if you look back in history, you can see times when people chose to make some pretty decent sacrifices for the greater good so I do have hope that, that we'll be able to go through this transition and that the natural world, uh, at least a good portion of it will come with us.