Kristen Finch: If you're an amazing tree in the forest and you don't have any senses really but if there are other trees being cut down around you, there has been some evidence that your chemical defenses might actually be turned on because the tree that's being cut down next to you is going to release a lot of chemicals into the air and you have the same machinery if you're the same species as that tree to receive those chemicals. So your defenses may actually be heightened. So even though you're a tree and you're not responding in any kind of physical way to what a human might perceive as danger, you might actually have some kind of hormonal response for that danger or that wounding that might happen. So maybe if you're a tree, you're a little bit freaked out or your machinery is kind of pumping.

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 Kristen Finch

KF: OK - I'm a Ph.D candidate in botany and plant pathology at Oregon State University, my focus for my dissertation is population genetics and my interest is the applications of population genetics and other technologies for timber classification.

PS: As Kristen explained, trees can chemically alert neighboring trees of the same species when they are in danger. But it isn't enough to prevent the trees from being chopped down by humans. And that's where Kristen comes in. Kristen and her team have developed a way to use the chemical fingerprint of wood samples to identify what forest the wood came from. This could combat illegal logging and timber theft, an on going epidemic that's been depleting a number of trees and forests at an alarming rate.

KF: Timber theft is very lucrative, they have estimated between 30 and 100 billion dollars annually are lost because of illegally harvested and traded timber and those are, those stats cover around, 15-30 % of the wood is traded illegally in the world. Some recent estimates say that that is actually more than the amount lost from other wildlife crimes, such as ivory trade.

PS: Aware of the devastating impacts of illegal logging, Kristen geared her career path towards timber forensics as a way to contribute to conservation.

KF: So I after college, I got internship at Fairchild tropical botanic garden, this was the year before I started graduate school and while I was working at Fairchild, I was visiting graduate schools and trying to decide where I was going to go and I had visited OSU. And after talking to the professor that I wanted to work with, they actually offered me a role in this project to develop genetic screening tools for wood from a mahogany tree or a wood relative called Spanish cedar. So while I was at my internship at Fairchild, I got to do my own project and I started developing a protocol from extracting a dna from mahogany woods, but I was initially attracted to this type of project with timber forensics because I saw a direct application for the conservation of tree species. And I thought that by discouraging harvest and trade of protected timber, this would impact the conservation of biodiversity on the global level.

PS: Kristen's academic career began to flourish. She found herself actively involved with the US Fish and Wildlife Service Forensics Lab in Oregon– the only lab in the world that is dedicated to solving crimes against wildlife and timber. Sounds, pretty cool.

KF: I am a student worker or volunteer at the US Fish and Wildlife service forensics lab and I work there sometimes during the summers and my first summer working there was in 2015 and I collected wood samples from ~~uh~~ different places around Oregon. I brought them into this forensics lab, which does handle case evidence and I got to do a chemical analysis project there, and this lab, the cool thing about it is, there the lab in the US that really handles wildlife crime. So they process all the evidence, timber cases as well as wildlife, elephants, mammals, other mammals,

PS: Kristen tells us that when the forensic scientists collect samples for wildlife crimes, it's pretty serious.

KF: Well, I'm actually not a forensic scientist by training so I've never been to a crime scene, but I did go to a forensic science meeting for the society of wildlife forensic science, and I was at a workshop, and they described what it's like to be at a wildlife crime scene. And it is really a lot like a crime scene that you would see on tv, you have to be very careful and document everything that you see, take a lot of notes and pictures and you have to make sure that people that are coming into the crime scene have all been documented and that they're not trying to hide any evidence so the handling of evidence is very important for these types of cases because that is all that the judge and the jury in some cases have to go on to be able to find the responsible parties for any wildlife crimes.

PS: But timber theft is a little different. It's like committing the perfect crime. In a vast forest, the chances of a person stumbling upon the theft of a tree, is small. So once trees are illegally cut down in a forest, all that remains are the stumps. From there, the cut logs are milled and turned into strips of lumber, making it nearly impossible to tell if they were illegally sourced. So monitoring becomes an issue, even with CITES, or the Convention of International Trade of Endangered Species in wild fauna and flora, which requires exporters to be ready to show their permits for their product. But document forgery makes it difficult to monitor the requirement of even that.

KF: Right it would be pretty difficult to uh, patrol, I mean you're in wilderness areas. You can't even really use a vehicle to patrol our national forests, so I think that it would be very difficult on the national scale to regulate these types of things but if you did have a piece of evidence, that's another thing. If we finally do have apiece of evidence, we need a way to process it and that's where the research and development, the kind of stuff that I'm doing comes into it.

I started a regional project dealing with timber identification using chemistry, wood chemistry.

So trees, they produce chemicals as a constitutive defense system, so they're always ready for an attack from herbivores or plant pathogens. They also have an induced defense system as well, so that when they are wounded or when they are attacked, they can also put out these chemicals and then some of the chemicals are also for growth or growth hormones, so plants are just full of these chemicals that previous research has shown were useful for identifying trees to the species level.

So out of the US Fish and Wildlife Service Forensics lab, there had been publications identifying trees to the species level for many protected trees. But the wood chemistry was very very accurate up to 99% of cases they were getting this species identification correct, using wood chemistry alone.

But, when I started my project, there had been no research to test if you could use wood chemistry to differentiate between two sources of wood for the same species. So, we're good with species ID but we didn't have any evidence to say that wood chem. Could be used for source or geographic origin ID. So, that was where my project came into play

I think I'm either the first or one of the first research groups, to look at that question. If you can tell geographic source.

PS: In order to test her idea, Kristen set out to the Cascade Ranges of Oregon.

KF: I was able to use the same techniques with a native tree called Douglas Fir and collect wood from 2 very prominent, actually they're running parallel to each other in Western Oregon, these two mountain ranges, that have very different climate conditions and see if I could use wood chemistry to differentiate wood that was coming from the coast range of Oregon and the cascades range of Oregon.

The two ranges are very different in size and in climate, so near the pacific coast is the pacific coast range and it's characterized by mountains that are a lot lower elevations so the highest mountain elevation is about 4,000 feet – it's Mary's peak. The climate is basically driven by the pacific ocean, so it's very misty and kind of rainy and comfortable for plants nearly all the time. It doesn't snow there very much. I think it would be kind of the best place to be a tree.

And then the cascades range is completely the opposite. So it is characterized by magnificent volcanic peaks. because of that high elevation and the higher change of snow there, the climate conditions are much more extreme for a tree. So while it would still be nice to live in the cascades range, I would much rather be a tree in the coast range.

And the evidence for these differences is actually visible at face value. When you look at the annual rings or the growth that a tree makes every year, then you can tell that the growth rate in the cascades range is much slower than the growth rate than the coast range and it's probably because they go through a seasonal drought and many hard

conditions during the winter, that they just don't have the resources necessary to grow. Their main priority is survival.

PS: Kristen takes samples of the Douglas Fir and uses DART Mass Spectrometry to identify the chemical compounds of the tree. It turns the liquid elements of the tree into a gas, which is then injected into the Spectrometer.

KF: This is a rather large piece of equipment. It has a helium stream and an intake port. So the helium is heated to 450 degrees Celsius, so very very hot and you put your wood sample into the helium stream and it heats the compounds that are on the surface or within your sample to the point that they volatilize or there are airborne. So they fly off into the receiving end of this mass spectrometer, they go into the machine and then they are measured for their mass. So how much they weigh. So you have an instantaneous measure of all of the molecules that have come off of your sample. So you can find out which growth hormones are in that piece of wood and which chemical defenses are in that piece of wood and stuff like that. So it's really fun to kind of find out what compounds your tree was producing at that time when you took your wood sample.

PS: Identifying geographical source from a piece of timber could mean the halt to illegal logging and a means to an end for timber theft. It could allow conservation efforts to thrive.

KF: So trees are important. Trees make up a very large carbon sink for the world, so basically they can remove carbon dioxide from the atmosphere and release atmosphere and this helps to reduce the amount of carbon dioxide in the atmosphere and Carbon dioxide could lead o climate warming and change in general, so that is one reason why trees are very important. They produce oxygen and they take out carbon.
Secondly, forests house biodiversity, basically. They provide shelter for mammals and birds and then other plants and fungi and microorganisms live in forests as well. they're still valuable in their place in the world in that they are available for our discovery and they're also available or they could have any number of connections with other organisms that just keep our forest alive in a way, keep our forests healthy in an ecosystem with undiscovered services and if they're lost, we'll never discover and that could potentially lead to problems in the future.

PS: A healthy forest and ecosystem means that we aren't just planting trees but preserving those that already exist.

KF: Firstly it would be very rare for a tree that has been cut to re-grow. There are base sprouts but for a tree to re-grow from a stump is very unlikely. the tree probably took a hundred years to get large enough for someone to find this log valuable enough to cut down and so it's just years of this tree taking carbon out of the atmosphere and building cells and becoming larger and larger and through those years, many micro organisms like fungi and birds and insects and lichens and all of these other organisms are building a home around this tree. So there are any number of interactions with organisms that are removed, just by removing a single organism. That's really shocking thing that

people have to realize that it isn't just about that one tree and it isn't just about that huge plot of land that now has no trees on it, it's that all of those interacting organisms are displaced. Maybe not fatally displaced but they've definitely been disrupted and they've had to move or they've lost their home completely.

PS: Studies like Kristen's come with many caveats. If she were able to identify the location of any tree in the world from a confiscated sample of wood, she would first need a complete index of trees that have been positively identified. And that just doesn't exist yet.

KF: On a bigger scale, if we had a chemical database where we had wood chemistry information from all trees species,where all the geographic sources where this tree is growing naturally, then potentially if we had an unknown wood sample, we could get the chemical analysis, put that into the database and hopefully and in an ideal world, know what species it is and where it came from.

KF: So that is what people are looking into now, they're actually working to develop the database. it's going to take a very long time. Recent estimates have said that there are 60k tree species in the world and that's probably a conservative estimate, and I am pretty sure that they have less than 10% of the trees collected for that database but like I said it's still very early on, but that is the direction that we will need to go to be able to identify timber to species and geographic source.

PS: In the mean time we can take helpful and important steps towards identifying wood that is so readily available in the mass market. And it can be as simple as asking.

KF: So right now, there are people around the world that can help you to identify your wood if you are say a company of guitar manufacturers that wants to start certifying their wood. It seems like pretty soon there are going to be more labs that are available to identify the unknown wood. So if you want to be a better consumer or better manufacturer, you can have those types of services to help you. Wood ID is currently being used to process illegal logging cases and parties are being found responsible for their illegal logging. So even though we're in the R&D phase for say geographic identification there is already work being done for those species that are at risk.

In the future it'll just be more robust and faster and more available.