Sidedoor (S10E16) – Dude, Where's My Carbon?

Lizzie Peabody: Hey there, Sidedoorables. Today's episode is the second of three stories we reported from the Smithsonian Tropical Research Institute in Panama. And for this one, well, I hope you're not afraid of heights. Let's go!

Lizzie: This is Sidedoor, a podcast from the Smithsonian with support from PRX. I'm Lizzie Peabody.

***Sergio dos Santos:** Ready?*

***Lizzie:** Ready.*

***Sergio dos Santos:** You ready?*

***Lizzie:** I'm ready.*

***Sergio dos Santos:** All right!*

Lizzie: I'm actually not sure if I'm ready, because the trees in this tropical forest are very, very tall.

***Lizzie:** Hopefully these helmets will not be useful.*

***Sergio dos Santos:** If you fall off the tower, no they're not very useful. Obviously. [laughs]*

Lizzie: Sergio dos Santos is a project manager for the Smithsonian Tropical Research Institute's hydro-meteorological and oceanographic monitoring program here in Panama. And he's about to lead me up one of the research towers he works on..

***Sergio dos Santos:** It's over 120 feet going up.*

***Lizzie:** Uh-huh.*

***Sergio dos Santos:** So it's—yeah, kind of a ways up.*

***Lizzie:** I'm really glad my mom doesn't know I'm doing this. [laughs]*

Lizzie: The tower's about 10 stories high, and it's basically a four-sided ladder. It's about as wide as my shoulders. The rungs are as thin as pencils. We start the climb, and with every rung I step onto, I have to unclip one of the two giant hooks attaching me to the tower and move it up a rung. Right. Left. Right. Left.

Lizzie: It's slow going, but little by little I start to get into the groove. And then we come across something that looks like a cobweb full of little sesame seed-sized specks.

Lizzie: *Oh, look! We have a little nest up here!*

Lizzie: As soon as I touch it, the seeds burst into motion.

Lizzie: *Oh my gosh! They came out, I think there's spiders!*

Sergio dos Santos: *So you just try to overcome them, okay?*

Lizzie: *Okay. Oh my God! [laughs]*

Sergio dos Santos: *It's fine! It's fine! They're fine!*

Lizzie: *Sergio, this is challenging me in more than one way.*

Sergio dos Santos: *Yeah?*

Lizzie: *Oh, yeah.*

Sergio dos Santos: *But you're good, right?*

Lizzie: *I'm good. I'm good.*

Sergio dos Santos: *If you're not good, let me know.*

Lizzie: *Okay.*

Lizzie: If you're wondering why we're climbing through clouds of baby spiders as the ground recedes below us, I was asking myself the same question.

Lizzie: *The spiders are a nice distraction from how high we are.*

Lizzie: But from the top of the tower, we'll have a bird's eye view of the longest-studied forest in the entire world. For decades, researchers here on Barro Colorado Island have systematically monitored this forest as its trees have flourished and grown, died, and regrown.

Lizzie: You know the old saying: if a tree falls in the woods and there's nobody to hear it fall, does it actually make a sound?

Joshua Tewksbury: *It's a really good question. Like, why do we care what happens to a forest?*

Lizzie: This is Josh Tewksbury, director of the Smithsonian Tropical Research Institute, also known as STRI.

Joshua Tewksbury: *It turns out, even if you didn't hear the tree fall, that changed the amount of carbon in the forest. So we do care about where carbon is in the world, for example, because it is the driving force behind our climate.*

Lizzie: Sergio and I aren't the only things getting higher around here. As we know, global temperatures are rising because humans are releasing huge amounts of carbon dioxide into the atmosphere. And well, forests are working really hard to save our behinds, because they help suck that carbon back up.

Joshua Tewksbury: *They are by far the largest storehouse of carbon on the land surface. And tropical forests in particular are far more effective at storing carbon than temperate forests in general.*

Lizzie: Tropical forests are like a sponge, soaking up carbon and protecting us from the worst effects of climate change. But how much carbon can these forests keep absorbing? It turns out nobody actually knows. And the only way to find out is to roll up our sleeves and get our hands dirty—and also, apparently covered in spiders.

Lizzie: So this time on Sidedoor, we follow researchers up, down and sideways to figure out just how much carbon dioxide is stored in our tropical forests, the lungs of our planet, and how a better understanding of how that carbon is absorbed and released moment to moment could impact all of our lives in the years to come.

Lizzie: *Whoa! Oh my gosh, this is incredible! [laughs] This is an amazing view, and it's tons of greens and blues and it feels like we're just below the clouds.*

Lizzie: That's coming up after the break.

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Lizzie: Back on the ground, David Mitre and his team of tree guys are trudging through the forest with a ladder, spray paint, string and measuring tape. Their job is simple.

David Mitre: *Take the measure of every tree.*

Lizzie: *Wait. Every single tree?*

Lizzie: David is a research manager here at the Smithsonian Tropical Research Institute in Panama, but it's a job he finds kind of hard to describe, even to friends and family. When they ask ...

David Mitre: *"Hey, what are you doing to live?"*

Lizzie: *Uh-huh.*

David Mitre: *"Okay, we census trees."*

Lizzie: People just blink at him.

David Mitre: *"Seriously, what are you doing to live? Seriously, we do census trees!"*

Lizzie: *[laughs]*

David Mitre: *Sometimes the people don't understand the importance of things like this.*

Lizzie: So what *is* the importance of this tree census? Why would anyone get paid to count trees? Well, these aren't just any trees. In 1980, scientists here on Barro Colorado Island mapped out a 50-hectare plot—that's about a hundred football fields of forest. And they counted and measured every single tree on it, from the bendiest saplings the width of your pinky finger, to the most towering trees in the forest. Today, that adds up to ...

David Mitre: *200,085 stems or trees measured.*

Lizzie: ... nearly a quarter million trees. David is part of a research team that continues that work, conducting a tree census every five years. I watch as David's assistant wraps a measuring tape around the trunk of a large tree. He calls out the measurement to a guy logging the data, checks the identification tag and sprays the trunk with spray paint to mark where he measured it.

Lizzie: This may seem simple, but it's hard work because trees don't all grow with straight trunks and bushy tops like cartoon broccolis—especially in the tropics!

Sidedoor (S10E16) – Dude, Where's My Carbon?

Lizzie: There are more than 300 different species of tree in this forest alone. Some have huge buttresses fanning out at the base like the flaring end of a rocket ship, meaning David's team has to use ladders or sometimes even a tree climber to get high enough up to measure the trunk's width.

David Mitre: *Sometimes we have tree that have multiple stem.*

Lizzie: Researcher-speak for tree trunk.

Lizzie: *Oh!*

David Mitre: *Or palms tree, or trees that make colonies that have multiple stems.*

Lizzie: *Oh, yeah!*

David Mitre: *Yes. So you need to record each stem.*

Lizzie: *Oh my gosh!*

David Mitre: *And link it to the main stem.*

Lizzie: All this information gets recorded. It's like a tree equivalent of marking your height in pencil on the door frame. You can look back and see how much you and your siblings grew in a given span of time—if you had over 200,000 siblings. And because that's a lot of door frames, David carries an iPad where he can log the data, and with the tap of a finger, pull up the 40-year health history of any given tree.

Lizzie: *So you're not only measuring how large the trees are, but you're also making notes about whether they're leaning or they're upright, and how healthy the foliage is.*

David Mitre: *Yes.*

Lizzie: *And you've got all these different codes, so you can track the health of each individual tree in this 50 hectare plot?*

David Mitre: *Yes.*

Lizzie: *Wow!*

Lizzie: David can also see how many of these trees were around for the original census.

David Mitre: *We saw who die. In what condition die?*

Lizzie: And new growth.

David Mitre: *We're taking new recruits.*

Lizzie: *I love how you call them 'new recruits.' It's like they're doing a job. It's almost like military.*

David Mitre: *Yeah, it's like new recruits!*

Lizzie: *Sentinels.*

David Mitre: *Yeah! Because they come to working for us!*

Lizzie: Everything David is doing in Panama will probably come to impact decisions you make every day. How, you might ask? Well, picture this: you're booking a flight to Panama—hypothetically speaking. And when you're paying for your ticket, you get an option.

Lizzie: *"Do I want to pay a fee to offset my travel emissions?"*

Lizzie: I sometimes choose this option because it makes me feel better, but when I click that button, what does it actually mean? Well, it means I'm buying into something called the 'carbon offset market.'

Joshua Tewksbury: *There are two types of carbon markets. There's a compliance market and a voluntary market. And it's important to understand the difference because a compliance market is what a government does.*

Lizzie: STRI Director Josh Tewksbury again. He says the first kind of market, the compliance market, is about a government setting a cap on emissions, and then gradually lowering that cap. It's called a compliance market because companies have to comply with the government's requirements.

Lizzie: The other kind of market is the one you're more likely to interact with.

Joshua Tewksbury: *The other market is voluntary carbon markets. And this is when the private sector, notably companies all over the world, have set zero carbon emission goals.*

Lizzie: A zero-carbon emission goal is exactly what it sounds like: when a company says, "We are not going to add anymore carbon to the atmosphere." But it's hard to imagine any company functioning without polluting even a little bit, unless, I don't know, maybe it's a bicycle messenger service? Or basket weaving? But even then, you have to ship the baskets in trucks or planes. Unless you're using the bicycle messenger service to deliver the baskets and you only sell locally. But then who made the bikes? And what are the messengers eating?

Lizzie: My point is, until fossil fuels are a thing of the past, almost any company is going to leave *some* carbon footprint. There's no way around it. So how do you become carbon neutral?

Joshua Tewksbury: *Well, in most industries, being carbon neutral means reducing the carbon that you're responsible for putting into the air. And then, doing good works elsewhere to take carbon out of the atmosphere and put it in the ground.*

Lizzie: For example, let's say your inspirational basket-weaving company, True BeWEAVErs, contributes 10 metric tons of carbon dioxide to the atmosphere each year from shipping. So you pay to plant enough trees to suck up 10 metric tons of carbon dioxide each year. Bam! You're offsetting your carbon emissions. Now you're carbon neutral, aka net zero.

Joshua Tewksbury: *And it's net zero. Exactly. That's the principle, that I'm responsible for removing as much carbon from the atmosphere as I'm putting into the atmosphere, and therefore I'm good as a company. And the hard part about this is you have to be able to attribute an action—let's say, reforesting a forest in a land you've never visited, which is quite common—to an actual change in carbon being removed from the atmosphere and put in the ground.*

Lizzie: The markets only work if you actually know how much carbon is absorbed or released by a given action, right? How many trees would need to be planted to offset the carbon burned by shipping my basket to Guam? Well, that depends on what kinds of trees we're talking about. Where are they planted? How long will they live before they're chopped down? These are things you can measure, but ...

Joshua Tewksbury: *The measurements we use today, they're just fundamentally not reliable. And you can't pay for that which you cannot measure.*

Lizzie: And this is a big problem when the carbon market, like any market, depends on standardized measurements. Let's say you go to a supermarket to buy five pounds of potatoes.

Joshua Tewksbury: *You just put your produce on the scale, you get a weight and you pay for it, right? You might go to a different supermarket because the price is lower, but not because the scales are better.*

Lizzie: You know that five pounds of potatoes will weigh the same at any store you go to because a pound is a pound is a pound wherever you go. Because we as a society agree on what a pound is, and we calibrate all our scales to reflect that.

Lizzie: But that's not how it currently works in carbon markets. It would be like going to a supermarket and holding up a bag of potatoes and the grocer saying "A potato is about a pound each. You've got five. Let's call it five pounds." But they're not differentiating between baby potatoes, or Russets or Yukon Gold. That's basically how carbon markets look at trees.

Joshua Tewksbury: *There's a whole science behind calibrating those scales. It's called metrology. We need metrology for the planet.*

Lizzie: Josh says without a common standard for measuring and then verifying if planting this tree equaled that much carbon absorption, the market will not work.

Joshua Tewksbury: *Could you have a banking system if no one kept track of where the money was? Wouldn't work, right? That's the problem with forest carbons right now. We haven't kept track of where the carbon is. And so how can you start a market if no one knows where the carbon is? That requires science. We can't guess this.*

Lizzie: So how *do* you measure just how much carbon is in a tree? Well, measuring them, like David is doing with the tree census, is a start. But not all potatoes—I mean trees—are created equal.

Helene Muller-Landau: *If you look at a fresh wood of a tree, you can kind of break it down into three general categories.*

Lizzie: This is Helene Muller-Landau.

Helene Muller-Landau: *There's water in there, there's air in there, and then there's, like, the real wood, basically the hard wood stuff. And for the carbon, all we care about is that hard woody stuff.*

Lizzie: Helene is a senior scientist at STRI, researching tropical forests and ecosystems. She says how much carbon a tree can hold depends on its wood density.*

Helene Muller-Landau: *The density essentially of the tree varies a lot among tropical tree species. I mean, it varies among temperate tree species too—people talk about softwoods and hardwoods. But for tropical trees, it varies a lot more.*

Lizzie: For example, on one end of the spectrum you could have balsa wood—the kind you use to make model airplanes. It's a super lightweight, low-density wood, and it's all over this forest.

Helene Muller-Landau: *On the other extreme, there's these tropical, really, really hardwoods that* *literally the wood sinks in water, right?*

Lizzie: *Wow.*

Helene Muller-Landau: *You take a chunk of the wood or you have a tree, and you put it in water and it does not float.*

Lizzie: *It plunges.*

Helene Muller-Landau: *It sinks.*

Lizzie: So when calculating how much carbon is in a tree ...

Helene Muller-Landau: *You gotta know something about the density, because otherwise you still have a huge amount of uncertainty in how much woody—like, really woody mass is there, and how much carbon is there.*

Lizzie: Helene has her ways of figuring out just how dense a particular tree is. As we're talking, we come across a tree that has recently fallen in the forest.

Helene Muller-Landau: *Okay so the way we get the sample is we pull out a tool called an increment bore.*

Lizzie: She drops her backpack on the ground and pulls out a thin metal instrument.

Helene Muller-Landau: *So there's the handle, and then there's what's essentially a drill bit that's gonna go into the tree.*

Lizzie: As I watch, Helene thunks it into the bark of this fallen tree and twists the little T-bar handle, drilling into the wood.

Helene Muller-Landau: *And then we pull the extractor, and if everything has worked out as it has in this kind of case ...*

Lizzie: *Whoa!*

Helene Muller-Landau: *... we have a wood core here on the extractor.*

Lizzie: She pulls out what looks like a twig, a little plug straight from the core of the tree, and sheathes it inside a 'highly sensitive' storage device.

Lizzie: *[laughs]*

Helene Muller-Landau: *Which is plastic drinking straws.*

Lizzie: *Oh, great!*

Helene Muller-Landau: *Turned out to be ...*

Lizzie: *That is perfect!*

Helene Muller-Landau: *And that keeps it from, you know, falling apart or such as we transport it back to the lab.*

Lizzie: Back at the lab, Helene will measure the volume of the sample, and then dry it in an oven to get rid of the water.

Helene Muller-Landau: *And then we take the dry mass and divide it by the fresh volume to get a measure called 'wood-specific gravity.'*

Lizzie: Basically, wood density. Pair that with David's measurements of the tree's size and you can get a pretty good estimate of the tree's carbon content. Now this is the traditional way of measuring forest carbon—and it's definitely tried and true. But there are a lot of trees, and only so many Davids and Helenes. So what do you do?

Lizzie: A little ways off in another part of the forest, Luisa Fernanda Gomez Correa unfolds a tripod, heaving a heavy cylindrical canister on top of it.

Luisa Fernanda Gomez Correa: *So here when we connect the battery, the laser turns on.*

Eline de Loore: *It will make a sound maybe. [laughs]*

Lizzie: Luisa and her research partner, Eline de Loore are using a remote-sensing laser scanner to create a 3D digital scan of the trees and vines in the forest.

Lizzie: *Oh, it's spinning!*

Lizzie: We have to move out of its way as the scanner swivels around, pulsing invisible beams of light that bounce off the trees like sonar uses sound or radar uses radio waves, to create a map.

Lizzie: *Oh look, I can see the tree in there.*

Lizzie: As the scanner gets information back, a grainy black-and-white image appears on its screen.

Lizzie: *Wow, so it's creating a picture of the forest.*

Luisa Fernanda Gomez Correa: *But then when you see the data on the computer, we will see, like, tons of points.*

Lizzie: Picture a pointillist painting, an image created from thousands of tiny dots. And then imagine that every dot is a data point. That is the level of detail we're talking about.

Luisa Fernanda Gomez Correa: *So you have a 3D point cloud. So you can zoom in and you are, like, indeed in the forest. So you will see everything in a volumetric form.*

Lizzie: *Whoa! It's like virtual reality.*

Eline de Loore: *Yeah.*

Luisa Fernanda Gomez Correa: *Yeah, like virtual reality is made of 3D models.*

Lizzie: Once you have a 3D model of the forest, you can do all kinds of stuff. With these data, scientists can identify the types of trees, their volume and associated density, and with that information, estimate the carbon content of the forest. So between hand-measuring trees, coring for wood density and ground-based laser scanning, we've got it all figured out! We can confidently say how much carbon is in this forest, right?

Lizzie: Well, sort of. Because—okay, don't be mad, but trees are constantly exchanging carbon with the atmosphere. Moment to moment, just like you are right now.

Joshua Tewksbury: *When you breathe a bit of carbon into your lungs, it has probably been a part of a tree, you know, a part of an ant or a termite. It's been flowing as a part of a stream. That carbon molecule has been around for eons, and you're just the latest recipient of a little bit of carbon.*

Lizzie: When we come back, we'll zoom out—and up—to find out how carbon moves in and out of the forest. Don't go away!

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Sergio dos Santos: *It's clear skies! So we're no problem.*

Lizzie: *This tower is shaking a little bit.*

Sergio dos Santos: *I mean, we're on top of it. So it moves a bit. I mean ...*

Lizzie: Remember where we started this episode, with me in my helmet and harness, clambering with Sergio dos Santos up a tower above the forest? Well, that was 17 minutes ago, and in real time, that's about how long I've been climbing. And since then, I've encountered a few more critters.

Sergio dos Santos: *What is it?*

Lizzie: *An ant bit me. [laughs]*

Sergio dos Santos: *An ant?*

Lizzie: *Yeah, yeah!*

Sergio dos Santos: *Are you sure?*

Lizzie: And right about now, I'm wishing I'd done some Pilates in preparation for this trip.

Lizzie: *This is definitely a core workout and a hand workout. And an exercise in maintaining a singular focus on not looking down. Okay.*

Lizzie: But at long last, we make it to the top of the tower, the entire forest splayed out below us. And in the distance, the Caribbean Sea.

Lizzie: *Okay, so we are—we are up at the top of the tower.*

Lizzie: But that's not the only thing we can see.

Lizzie: *We are next to a bunch of boxes. They look like fishing tackle boxes that are strapped to this—this narrow tower. And there's tons of cords coming down. And they're all different kinds of sensors.*

Sidedoor (S10E16) – Dude, Where's My Carbon?

Sergio dos Santos: *You see the—you see the white instrument there?*

Lizzie: *Yeah.*

Sergio dos Santos: *Looks like a little dome?*

Lizzie: *Yeah.*

Lizzie: Sergio points out a bunch of sensors mounted to the top of the tower.

Sergio dos Santos: *So there's an emitter on top. And then there is—there is this 3D anemometer, which has three fingers on the bottom, three fingers on the top.*

Lizzie: *Uh-huh.*

Sergio dos Santos: *Right?*

Lizzie: These sensors measure wind speed, direction, and concentration of gasses in the air—most notably carbon dioxide. See, to grow, trees take in carbon dioxide through little holes in their leaves called stomata.

Joshua Tewksbury: *And when they open those holes in their leaves to pull the carbon in, it releases water. So it's a constant exchange between water and carbon in the atmosphere that trees are always balancing throughout the day and night.*

Lizzie: At night, trees release carbon dioxide back into the air in a process called respiration, when they convert sugars to energy. And the instruments Sergio shows me measure how much carbon dioxide is going into the forest or coming out.

Joshua Tewksbury: *That's right. They're measuring the balancing act in real time, and so we can see how carbon is moving at a micro level from low down to high up and above the canopy.*

Lizzie: *That's so cool!*

Lizzie: And this is important to measure because while trees pull carbon out of the air to build their trunks and limbs and roots, they're only holding that carbon temporarily. When a tree dies—whether it's chopped down or struck by lightning or strangled by a vine—it re-releases its carbon back into the atmosphere as it decomposes.

Joshua Tewksbury: *So a forest that's releasing carbon is a forest that's essentially dying in a very slow way. It'll be dropping limbs, it'll be having trees fall down. A forest that's gaining carbon is a forest that's growing. It is a place that absorbs carbon. It's like what you can pour water into and it'll hold that carbon. And so that's why we think of forests as large carbon sinks.*

Lizzie: So measuring just how much carbon is in a tree or a forest becomes a game of trying to predict the future. Because as the Earth warms with climate change, forests are already changing too. And that's where all these measurements from STRI come in handy, because they're helping climate scientists come up with more accurate models to predict how forests could respond to climate change.

Helene Muller-Landau: *There's still a lot of uncertainty in the predictions across models. They all agree that climate's gonna get warmer and natural disasters are gonna increase. There's some really common themes.*

Lizzie: But Helene says when you look at the difference between the most conservative models that say it won't be so bad, and the most aggressive that say oh, it is way worse than we think ...

Helene Muller-Landau: *It turns out that one of the very biggest pieces is what's going to happen with tropical forests.*

Lizzie: It's a critical piece of the equation. On one hand, a warmer climate could cause forests to grow faster and suck up more carbon dioxide, slowing climate change. Or things could swing in the exact opposite direction: extreme storms could mean more trees are blown down or struck by lightning. More carbon will be released, compounding climate change. It could go either way.

Helene Muller-Landau: *Growth rates are shifting, and tree mortality rates are shifting. And so to project into the future, we need to know how, you know, those sorts of pieces of the puzzle essentially are changing under climate change.*

Lizzie: Now you might be thinking this is just one tropical forest on one island in the middle of the Panama Canal. But Smithsonian researchers are teaming up with scientists all over the globe to collect and compare data on the world's forests through the Smithsonian plot network, Forest GEO and the other networks taking part in the global network called GEO-TREES. Using the same methodology ...

Joshua Tewksbury: *We're now measuring in the same way 78 different forests in 28 different countries all over the world. That represents something like seven million stems we're measuring now. It's by far the largest effort to understand forests in the world. And it's done in a standardized way which allows scientists from Malaysia and Madagascar to work with scientists from Suriname and Panama and the United States, and understand in general how forests change through time and what* *are the factors affecting their health.*

Lizzie: Even with all this teamwork, it's not practical to measure every forest in the world. These research sites are just pinpricks dotting the globe. But with the data from these specific locations, we can zoom out—way out—and connect the dots from space.

Helene Muller-Landau: *For the large-scale picture of forest biomass and carbon, an increasingly important set of tools is space-based laser and radar sensors.*

Lizzie: Remote-sensing satellites can give us really detailed pictures of the world's forests from above.

Helene Muller-Landau: *But we need good ground data in order to figure out what that signal tells us.*

Lizzie: In other words, without measurements on the ground, satellite pictures are just that: pictures.

Joshua Tewksbury: *We can provide that authoritative answer to how carbon is changing in all the world's forests by connecting the space-based community with the network of ground-based observations in a standardized format all over the world.*

Lizzie: So that whether you're in space, Malaysia or Panama, you know how much carbon is in each kind of tree and how that adds up, whether it's acres of tropical jungle or the three dogwoods on your local traffic median.

Joshua Tewksbury: *GEO-TREES is the effort to do that, to create one standardized reference for carbon in all the world's forests by combining technologies from simple tape measures around trees to satellites going over the planet.*

Lizzie: Josh says this is metrology for the planet.

Joshua Tewksbury: *And then that allows the market to function where it needs to function, which is on the actions that change carbon.*

Lizzie: *Pricing the apples and oranges.*

Joshua Tewksbury: *We want to price the apples and oranges, not price the reliability of the scales, right? And, like, we're just trying to get the market pushed in that direction.*

Lizzie: All this hard work helps us better understand climate change, to quantify and track and reflect the changes already happening. But measurement is just a tool. To alter the trajectory of that change is about our behavior, as we humans fight for our own survival by thinking about our own carbon emissions. So I asked Josh ...

Lizzie: *What can we as individuals do to kind of help move our climate in the right direction?*

Joshua Tewksbury: *There are some very easy ways to reduce your own carbon footprint, and oftentimes those are the less easy things to do, like not flying instead of flying, or like taking a train instead of driving. Solar is a better place to get your electricity than a coal-fired plant. And consumers increasingly have choices on what cars they buy and how much they drive and what their commutes look like. And our actions drive economies. So consumers have a lot of power to change carbon. It's not out of our control.*

Lizzie: *Oh my gosh! I cannot believe I get to be up here. This is the best job ever—except for the spiders.*

Sergio dos Santos: *I'm glad you enjoyed it.*

Lizzie: *Yes, I'm loving this! Thank you so much for bringing me.*

Sergio dos Santos: *You're welcome.*

Lizzie: You've been listening to Sidedoor, a podcast from the Smithsonian with support from PRX. This is the second episode from our Sidedoor road trip around Panama. Stay tuned for number three in just two weeks—it's sure to leave you bright-eyed and bushy-tailed.

Lizzie: The Smithsonian is grateful to the Bezos Earth Fund for their support of GEO-TREES. To learn more about the Smithsonian ForestGEO plot networks and the work of GEO-TREES, check out our newsletter. You can subscribe at SI.edu/Sidedoor.

Lizzie: You can also find some behind-the-scenes photos of me with Sergio on the tower—and me getting stuck inside my own shirt when I tried to take it off over my helmet.

Sergio dos Santos: *[laughs] I'm sorry. I shouldn't laugh. No, wait wait wait wait wait. Take it easy. Take it easy.*

Lizzie: *Like this?*

Sergio dos Santos: *Take it easy. Wait wait wait!*

Lizzie: Look for it on our Instagram @sidedoorpod.

Lizzie: For help with this episode, we want to thank Joshua Tewksbury, Stuard Davies, Helene Muller-

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Lizzie: If you want to sponsor our show, please email sponsorship(@)prx.org.

Lizzie: I'm your host, Lizzie Peabody. Thanks for listening.

Eline: *I had like twenty ticks only on my hands but also on the clothes we wear in the field we never wear the clothes the next day because otherwise we will be extra full of ticks and chiggers, so.*

Lizzie: *Oh! I've been wearing these pants for three days straight.*

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