Conservation Technology with Shah Selbe
Ologies Podcast
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Oh heeey, it's your weird lady-uncle, who sometimes finds Reese's Pieces in the pockets of blazers she hasn't worn in weeks and eats them, Alie Ward. Now, I'm kind of excited for you, you get to listen to this episode for the first time, it's all about to happen! I've already heard the conversation twice, maybe three times now in edits, but you haven't even heard it once and it's amazing!

It's about the Earth and also saving it. In the coming weeks we have episodes about ants, and Egyptian mummies, and crime, and crow funerals, and breast health, but last week's episode was on oceanology and we really got a glimpse of how sick we've made the seas. I heard from a lot of you that it was inspiring and informative, so I thought that could be the one punch and this is the two punch. So this week we're following up with another eco-episode that's really, really colorful, and adventurous, and inspiring, and it's gadget-driven, and it will restore your faith in the future even more. I think so, I hope so!

This one is such a weird ology because it might be one of the newest ologies out there, but it's also at the intersection of nature, and the future, and machines, and animals, and brainiac do-goodery all suspended in an atmosphere of adventure. This dude has good intentions, a truly boggling capacity with technology, and some [*echo effect*] stories. Dude. Has. Stories.

But first, you know I do a little effusive thanking up top. Thank you to the Patrons who spend as little as 25 cents an episode supporting the show, it adds up and keeps it going. For the last year this has been a totally independently-made passion project and Patrons help me pay an editor to keep it professional, they help me pay myself a little for the time I put into making it, and you know, we buy batteries, sound cards, things like that.

Speaking of buying, OlogiesMerch.com has all new back-to-school items like backpacks printed with sharks, and coffee mugs about trains, and there are college sweatshirts that say *Ologies*, and crested items. Thank you to Boni Dutch and Shannon Feltus for making those available and designing them!

You can also rate, and review, and subscribe. That keeps *Ologies* up in the charts, so thank you for that. It takes just a few minutes and it feels like a good deed, it doesn't cost a dime. Also, I lurk around the Apple Podcast reviews and yeah, I take a peek, and each week I read a fresh one just to prove it, and this week, I want to thank D. Hepting [phonetic] for saying:

> *I am wicked stoked about this podcast, y'all. It's every nerd's dream come true. The podcast is essential because it makes science fun. You'll even pick up useful phrases. I recently worked a 'boy howdy' into a presentation I gave at work last week.*

So thank you, D. Hepting, for your wicked good "boy howdy" slip, keep doing it.

Okay, conservation technology. Ward, what is this all about, what kinda word sandwich is this? Oh, it's a good one! It's a real fluffernutter of an ology, you guys.

“Conservation” in this sense refers to that of the Earth or plants or animals, and “techne” comes from the Greek for art or craft. So it’s the art of saving the world. No biggie. This conservation technologist was recommended by our lepidopterologist, Phil Torres, aka Philly T. Exoskele-Torres, and it turns out he also knows last week’s oceanologist Dr. Ayana Johnson. So he runs in some great nerd circles.

He started the nonprofit Conservify, which makes open source technology to very broadly [*pause for effect*] help save the planet. He’s also a Fellow at the National Geographic Society, he’s been on expeditions all over the world, and in this episode we talk about [*hushed, excited voice*] tracking gorillas in Congo, taking the pulse of Canadian glaciers, working with indigenous communities in the Amazon to monitor logging, some shark tagging, and also, fishing vests. And hippo butts.

To score this interview I trekked all the way to the remote reaches of Downtown Los Angeles to see his really cool lab/office, and I made him give me a tour first, which really consisted of me pointing at objects and asking him what they were. So please, shore up your hip waders and roll up your sleeves to dig into a really wonderful chat with conservation technologist, Shah Selbe.

[Intro Music]

Alie Ward: So you're going to give me a tour of your lab. I walked by and I just saw that there's a whiteboard and all it says on it is [*excited voice*] “SCIENCE!” and I'm like, okay, give me the tour!

Shah Selbe: [*laughs*] Yeah, this is our lab, it's kind of in between a makerspace or hackerspace.

Alie: You also have a gurgling, algae-filled terrarium. Let's go look at it!

Shah: Yeah, so this is just a regular fish tank, but we've kind of allowed it to grow into this ecosystem in and of itself. But we wanted to do that because we build these sensors that can test water quality in different parts of the world, and if we were just using a regular fish tank the data would be boring. So we allow it to kind of grow and get all this weird stuff.

Aside: For visual reference, imagine a small, gurgling aquarium, thick with algae strands. Kind of like if Beetlejuice dropped his wig into a fish tank, but more vibrant, and alive, and with electronics submerged.

Shah: You can see there's a whole bunch of sensors that are sitting in there now and we have some of them connected to some of our electronics monitoring it. This is the sort of setup that we end up taking and deploying in places like Botswana, or the Amazon rainforest, or some of the other places that we work.

Alie: And you're testing it in a fish tank in your office in downtown Los Angeles.

Shah: Yeah, well, I like to call it our ecosystem.

Alie: [*jokingly*] Pardon! “Fish tank,” I meant ecosystem. How dare I?! And then you have... let's see, I'm just going to start naming things off. It appears you have mallets, hammers, soldering equipment? Correct?

Shah: Yeah.

Alie: More microscopes. What are you doing with all this? Are you tinkering with technology to make it work better for you?

Shah: We use this setup to build the technology that we take out on expedition. It's actually a lot of the same gear that you would find in your local makerspace, because we use a lot of the same methods that makers use when they're building their projects, but we do all the building and the testing and everything here before we take it out on expedition.

Alie: Wooow! And do you 3D print things?

Shah: We do. We have two 3D printers, we have a laser cutter. It's a lot of fun stuff.

Alie: [*high-pitched voice*] Dang! This is awesome. Okay, let's sit down.

Aside: Okay, let’s get to the interview. What’s Shah’s job?

Shah: I'm a conservation technologist, which is actually a title that didn't really exist before, I sort of made it up. And fortunately now other people are calling themselves conservation technologists, so it's become more of a thing. The work that I do came from stuff that I was doing when I was going to grad school at Stanford.

I studied engineering in university. I always only wanted to be an engineer, that's all I wanted to do. But I always also felt that engineering kind of had this great role, that it could do some amazing things in the world, right? I mean, it helps us protect people, solve diseases, build these cities and everything that we live in. And so I thought that there was more profound work that I could do with engineering, so I was always searching a bit.

Aside: Shah got his bachelor’s at UC Riverside in chemical engineering, his masters at USC in systems architecture, and he also studied engineering at Stanford. In grad school he started working with an environmental nonprofit, using technology to address illegal fishing and he was like, “oooooh! Weeeeeellll! I can use gadgetry to help address Earth’s ills. This is a thing!”

Shah: From then on, everything just kind of took off. So I was looking at ways that we could use new technologies, like mobile technologies, and drones, and satellites, and all sorts of stuff like that to help to find people who are fishing in places that they shouldn't be fishing.

Alie: And then it kind of expanded to doing work in a lot of different areas in terms of, like, conservation, and ecology, and saving the general planet from just current fuckedness that's happening, right?

Shah: Yeah, totally. A lot of those technologies that I was looking at for that one very specific problem could be applied to other problems as well. And so I started branching out

more and more, reaching out to beyond just ocean conservation stuff into terrestrial stuff. So now the work that we do is kind of a mix of both.

Alie: [*sentimental high-pitched voice*] Take me back to your childhood. At what point did you know you were good at engineering, or mechanics, or had a passion for environmental things? Did you take toasters apart?

Shah: Yeah, I was that kid that would take things apart. I was very curious about what was inside of... it actually turns out that I was very curious about what was inside of my dad's expensive audio equipment. [*both laugh*]

Alie: It's like, "uuuuuh, why did we have this child?"

Shah: [*laughs*] Exactly! But credit to my dad, instead of getting angry at me, he would teach me how to put it back together, and I feel like that put that little engineering bug in me at an early age.

Alie: Oh, what a good dude. I love that you went for the expensive audio equipment, like, not a Walkman from 1986, but you're like, "hmm, the new surround sound!" What did you take apart?

Shah: Yeah, it was his amplifier and his whole setup that I ended up kind of taking apart initially, and then we would just start to take other things apart and learn about how they worked. My dad wasn't even an engineer, but he was very curious about that stuff all the time. So we'd explore it together and I knew from then on that I wanted to be somehow involved in technology and making things like that.

Alie: Then when you were deciding what your major was in college or deciding what your path was, I understand and it seems to be well known, that you were just, like, a casual rocket scientist professionally for a number of years. [*DJ airhorn*] Like, how did you go from being a curious kid who took apart amplifiers and probably made them even hella sweeter before putting them back together to being a rocket scientist?

Shah: Yeah, I don't like saying rocket scientist...

Alie: Come oooon!

Shah: Because it sounds... My official title was a spacecraft propulsion engineer, so I would work on all the rocket engines, and tanks, and everything that would move around satellites when they were in space. I did that at Boeing for 10 years. I ended up going to school for chemical engineering, and coming out of school I was looking around at the kinds of jobs that a chemical engineer could get, and the only thing I could find at that moment was working in waste treatment plants, which is a very important role but I didn't feel very inspired by working in waste treatment at that moment.

Aside: By the way, I have someone on deck to do this. A, shall we say, reclamation hydrologist named Lori. I mean, I want to know all about wastewater and what happens. Where does it go? What do we do with it? It's so important! Okay, but that's an ology for another time.

But okay, so Shah was less interested in underground waterworks and instead looked to the sky for his first post-college job. He says he sent out letters and reached out to as many people as he could. And he landed a long-running and very successful gig at a little space place called Boeing, where he worked on satellites, including thirteen satellite launches. He said, "twelve of which made it into space." I was curious, I had to ask, how does it feel when one does not make it?

Shah: We sat around for about an hour, hour and a half. Everyone knowing something kind of went wrong, but we didn't get the official word from them until then. So people are starting to get more and more depressed, and finally we just all ended up at a bar.

Alie: You're like, "hot wings, anyone? Let's do that!" But I mean, part of science is failures. Everything that you do that isn't a huge success out of the gate, like literally out of a launch gate, [*ba-dum-tsh!*] you end up learning from, right?

Shah: Totally. I would say even more so now, failure is part of our process. We're trying to do some really hard things here at this lab, we're trying to bring technology in places where technology doesn't want to be, you know; in the middle of wetlands, at the bottom of the ocean, all sorts of places where the environment is drastic and we're trying to do it in a way that's affordable for anyone to use, or for scientists that are outside of the richest universities in the world to have access to. So that means sometimes things fail. You have to be okay with that.

Alie: When you left Boeing, what was it like to be like, "I've been here for a long time. I'm good at what I do. It's time to move on to something that is maybe more enriching on a personal level"? What was that decision like, did you just wring your hands about it for a year or were you just like, "boom, I made a decision yesterday, it's happening"?

Shah: Yeah, it was a bit of a process, as these things tend to be. You know, I was kind of known at Boeing as the do-gooder engineer. I worked with Engineers Without Borders for a long time, and then this stuff started happening, and towards my last year at Boeing, I was going on expeditions all the time. I'd be gone for a month in Africa or something, and it just got to a point where it very clearly made sense for me to move forward into this other one.

The thing that kind of lit the fire underneath was when I was offered a Fellowship at National Geographic Society. It's a very prestigious thing to be able to get to be a Fellow there, and so once I got it that came with funding that allowed me to start my nonprofit and do this full time. But I had been doing this work for a decade before.

Alie: What was it like when you gave your notice?

Shah: It was very exciting!

Alie: [e*xcited*] What did you do? Did you write it on a cake and be like, "hey guys, there's cake in the break room and it's like, I'm oouuut!"?

Shah: [*laughs*] No, I remember I walked into my boss's office, and I sat down next to her, and I started to tell her, and she's just like, "I already knew, yeah, I knew this was coming. This

is not a surprise." So she said that's fine. Boeing really liked me being there, so they offered to put me on an extended leave of absence, just to see if things worked out. And I never went back, so that worked out. [*laughs*]

Alie: You're like, "see ya!" So you work on so many things in so many parts of the world, can you give me a little bit of a rundown?

Shah: Sure, yeah. We do a lot of stuff and it's quite exciting. The longest-running project that we've had was what has now become a major initiative at National Geographic called the Okavango Wilderness Project. That's the project that's in Botswana, Namibia, and Angola, and it's really focused around how we can better protect the Okavango Delta in Botswana.

Alie: Which is where a lot of animals live, it's very rich with wildlife. Right?

Shah: Yeah, incredibly rich with wildlife. It's just this beautiful wetland, it's a series of rivers that flows into the middle of the Kalahari Desert and just becomes this paradise. I mean, there's so much wildlife there that some of those days I'd open up my tent and I'd walk out, and it felt like you were in the middle of a Disney movie. There's elephants hanging out with giraffes and wildebeest and zebras, everything. It's just... it's amazing.

Alie: You know, bird lands on your shoulder, a butterfly comes and offers you coffee, and you're like [*screaming*] what's happeniiing!

Shah: Totally! So what we were doing with that project was actually pretty interesting. Traditionally when scientists want to protect an area or understand an area better, they do these biodiversity assessments, so they go on these expeditions through the area, and they count wildlife, and they take other kinds of scientific readings. But the way that had always been done in the past was they would write their stuff down in notepads or something and then they would come back, it'd all go in some Excel file or something on their desktop, and then it gets locked away and eventually the scientists would want to publish it. So it'd take them a couple years to publish papers on it.

And we thought, "you know what? That whole process isn't really welcoming to anyone outside of the science field, right? Scientists are going to these amazing places all the time and they're not really sharing what they're seeing," and we wanted to try and facilitate a better way to do that. So that's what became the Okavango Wilderness Project. We thought we could build these technology tools that allow the scientists who are on expedition to be able to share everything that they're seeing and all the data they're collecting absolutely live, like, immediately as it's happening.

And so with other partners, we built this website called *Into the Okavango* that you would go to while we were on expedition and you would see where we were at. You'd see the pictures we were taking, you'd hear the audio of the places we were at. If you went to the website, you'd see a little bubble that had an 'S' on it, and that was me, traveling down the expedition as we're going…

Alie: Whaaaat! That's better than watching Coachella live on YouTube and avoiding having to wear sunblock!

Aside: For more on this, National Geographic made the documentary *Into the Okavango*, which came out this April, and it details the challenges of doing research in the region, from dried up riverbeds to leftover landmines from Angola's civil war. It's also a really, really great portrait of the teams going out doing the work, from tons of local scientists and guides, and researchers from all over the world with different specialties.

And of course, I started poking around the Instagram IntoTheOkavango for visuals. One recent post is a stunning photo of a field scientist [*horrified*] writhing from having a tick embedded in his ear! It was clasping onto his eardrum! But mostly, there's just gorgeous photos of wildlife. In summary, it's beautiful and it's not easy work. What was Shah up to there?

Shah: Yeah, it was cool, and we would gather all sorts of data because we were just curious about what would come out of gathering all this data and seeing this interesting stuff. So I built sensors that would measure water quality and weather, we took 360-degree photos through the whole expedition so you can put on VR goggles and see. We even took the measurements of the heartbeats of the researchers while they were on expedition. We gathered as much data as we possibly could and we had it all streaming live via satellite.

Part of what we were trying to do with that project was outreach, right? Reach out to the public, explain to them what a wonderful place this is, why it's so special. As part of the 2015 expedition, the team was in a part of Angola that was very difficult. It was, like, rough, you know? The rivers were windy, boats kept on capsizing, there were bees everywhere. It was just a very brutal part of the expedition. A lot of fires, and landmines, and all sorts of things that you have to avoid.

And so in the nature of sharing everything with the public, we complained about it on Twitter. We told everyone about what a horrible time we were having at that time. So one of our followers actually ended up seeing that complaint and tweeted us down this message of support, and that follower was Samantha Cristoforetti, who was a European Space Agency astronaut on the International Space Station, and following our expedition from space. So she took a picture of the delta and tweeted us down this message of support and good luck and let me tell you, that was the most uplifting thing you can imagine.

Aside: I looked this up and yes, AstroSamantha tweeted down from frickin' space, a "you are here" kind of aerial shot of this massive, glimmering river delta, this network of tributaries fanning out over wetlands. It was taken from 250 miles above Earth, and beamed down, via Twitter, to the scientists and guides dragging their heavy canoes over riverbeds, and fighting bees, and yes, the whole thing made me cry.

Alie: [*amazed*] Someone in space is like, "good luck with the bees!" and you're like, "what is life right now?"

Shah: Yeah, it was unreal. It was unreal.

Alie: What other parts of the world have you been to, and what kind of projects have you done in them? Because I can't even imagine your passport, dude. Like, it's got to be... how many shots do you have to get a year? Where have you been?

Shah: I mean, I've been vaccinated for everything! I even have a cholera vaccine, which most people don't have.

Alie: Yeah, I didn't even know you could get one of those!

Shah: When I got it at the travel clinic, they're like, "are you sure you need this? Because nobody ever gets this," And I'm like, "yeah, I think I need it."

Alie: That's like an off-menu item at In-N-Out, like "wheee, hit me with the cholera," and they're like, "ooooh! He knows his stuff!" So where else have you been?

Shah: This year we've done some work in the Amazon rainforest, so that's a big project that we have. It's basically around citizen science in the Amazon, and we're trying to track migratory fishes as they travel through. So Cornell's Lab of Ornithology built this app to allow them to track the fishes and then we're building sensors that we're going to put through the Amazon, and we're trying to do it to better protect those fishes. There's some fishes that start in Brazil and end up in Peru and go back to Brazil. The longest freshwater migration of any fish in the world is in the Amazon.

Alie: How many miles is that?

Shah: It's thousands of kilometers. And the amazing thing about it is they can do that, and that fish is important to every single indigenous community along the way. But there's a lot of plans to put things like dams in the Amazon and if you were to dam up a lot of those rivers, it ends up stopping those migratory fishes from getting through. So we're trying to document things now, before they start to change.

Another trip that I recently did: I went to the Republic of Congo. We went to Odzala National Park, which is very close to Gabon. The work we were doing there was with one of the world's leading researchers on western lowland gorillas...

Alie: Oh my god!

Shah: ...which was pretty amazing stuff. So I came in to use drones to help map out those sorts of areas. The reason was these gorillas have this very interesting behavior around certain types of trees, where they like to dig up parts of the root and eat them, and we wanted to find out where all those trees are so we can try and see where all the gorillas are. And that's a very difficult thing to do if you're just hiking through the rainforest.

Alie: Yeah, that's a lot of land. A lot of trees. Lot of gorillas.

Shah: Exactly, very dense, hard to see. Yeah, it's just very difficult. But with a tool like a drone, you could fly it over the whole area and you can map out that area. And then you can, like, either individually go in the model or the picture and identify those trees, or we can even build artificial intelligence that will go through all the data for us and pull out the stuff that we need to do for it.

Aside: So, Shah is using technology to preserve areas from technology. It's kind of like an inoculation, like a little bit of the virus in a vaccine, maybe? As perhaps the first ever conservation technologist on the planet, does this intersection ever befuddle people?

Alie: How misunderstood is your field, where you're using technology to help the planet, when technology is kind of to blame for the problems of the planet? Like, do you know what I'm saying?

Shah: You know, the crazy thing about it was when I first started working on this stuff a lot of people didn't get it, right? I mean, some people got it, but, when I was in a room of conservationists, they were all saying, you know, "we don't need this technology, we could do this the old-fashioned way." When I was talking to the technologists, they were like, "how are we going to make any money off of that? That doesn't make any sense." Nobody really got what we were trying to do, but now it's really changed. Now it's to a point where every single major environmental NGO out there has technology programs.

Technology in the science and conservation space is not entirely new. You know, it has been used there in the past, but the way it's been used has either been one of two ways. One is, you know, you have a PhD student that needs to measure something weird and as part of their PhD they developed some technology. But usually it's developed by a biologist, it's not necessarily optimized or using the newest kind of technological approaches, so as a result it's expensive. The other way is you would buy it from one of the very few companies out there making this sort of thing. And then, again, it's expensive because these companies are only selling it to a handful of people.

Aside: Computers, of course, get better and better every year, with — according to one figure I saw — a one trillion-fold increase in computing power from 1956 to 2015, and then upwards from there. Shah says that every year he sees a rise in the availability of tech to help out with nature. Remember when our tiny purse computers, aka phones, couldn't even do portrait mode? And we didn't have a robot with a microphone in our living room so we could shout, "please play me some solid '90s jams — [*song clip: chorus from Chumbawumba's Tubthumping*] — I'm sad today!" Just, every year, keeps getting better.

Shah: So now we're in this really amazing time with things like smart phones and the maker movement and all this, where the price of developing technology has just dropped to the floor. It's become incredibly cheap to do that sort of stuff. We ended up leveraging a lot of that maker technology, a lot of the open source technologies, to go into these places and implement solutions and also work with the communities there, and allow those solutions to become the community's solutions and not some random guy from the US that's flying in and saying, "you should do this better." Like, help to build capacity in those areas overall.

Alie: And do you feel like the main thing conservation technology can do is gather information so that we can better protect the environment?

Shah: Yeah, for the most part now, it is. And it's starting to transition a little bit, but the biggest threats that we had to the planet... well, the biggest threat to the planet is humans and the impact that we have, but the threat behind that related to conservation is the fact that we hadn't ever been able to quantify it very well, right? There's a lot of parts of this world where anybody who wants to do anything that's bad, like poaching or anything illegal, nobody's ever going to know about it, right? If you go out to the middle of the high seas, it's like the wild west. People are just doing whatever they want out there, you know, because they could always get away from it.

And so now, the first part of conservation technology is, how can we start to document what's actually happening in this planet and gather this data, and then also create a baseline so we can see how things are changing over time?

Aside: So by gathering data and monitoring, scientists can catch things like heavy metals in a river when it's still early, instead of just seeing the effects of, say, crocodiles dying off. I know some of you are like, "okay, yeah, I'm not super concerned about saving a crocodile because they would literally eat my butt off my body if given the chance," but they are part of the ecosystem, and they do have birthdays, and feelings, and if their tiny claw hands could hold pencils, they would probably journal.

Also, isn't it weird that every crocodile has a birthday and thus, an astrological sign? Okay, I'm sorry, I had to figure this out. In the Southern Hemisphere, crocodile mating season is between November and March — they're out wildin' for a considerable time — and eggs take three months to hatch, so I think, by my calculations, most crocodiles are probably Geminis. Anyway, what about rivers without crocodiles?

Alie: Do places like the US have those kinds of sensors in our rivers, and how well monitored is it in different countries?

Shah: Not really. You would think that the US would have a lot of them, but because of the regulations and the strength of the industrial sector here, a lot of those places are not monitored. So that's why we see environmental issues happen in this country from time to time. In other parts of the world, it's not monitored at all. And it's a lot easier for us to go in and install these sensors because the communities where we're installing them, they love to have this sort of stuff.

When I was just in the Amazon, we were talking to a lot of the indigenous communities there - people who are our partners in implementing some of these ideas - and they were so frustrated because of the oil spills, and the other kind of chemical spills that happen in the Amazon, and the fact that they have absolutely no way to prove that it's happening. You know, when it happens, the government says "no, nothing happened there." Right? And they brush over it. So these communities feel marginalized, like they can't do anything about it.

We want to build sensors to give to them, to allow them to say, "hey, no, this is actually happening." And right when that starts to happen, it automatically posts to the Internet. So there's no like, 'take that information, give it to someone and then it gets swept under

the rug somewhere'. That information goes straight to the world to see what's actually happening there. So it's quite a powerful thing.

Alie: And what other kinds of technology are you using? We already know drones, gorillas; sensors, fish. Like, what else are you using to help what?

Shah: So we're using sensors in other ways as well. One example is a project that we had in Canada in Banff National Park. This project was a partnership with the city of Calgary and Parks Canada, and basically what we were doing was monitoring a glacier that was melting. But instead of using the big expensive equipment that's used in other parts of the world to do that, we built low-cost sensors.

It was pretty much the same sensors that you find in your cell phone, that can tell when you turn your cell phone and move it. So we would put those around the glacier and we could be able to tell in a three-dimensional perspective how the glacier's melting over time.

Alie: Whooooa! So you're like, "oh, it's shifting to the north, which means that this face of the glacier is…"

Shah: Yeah, yeah!

Alie: [g*asps*] Whoa.

Shah: The cool thing about that project is all of that data is streamed back live. So we built this little observatory on the glacier that collects that data, and it sends it back to a lodge, and that lodge then posts it on the Internet. Then we have it and we're giving it to glaciologists to do their research on it, but they're also going to take that data and they're going to stream it to this installation in Calgary.

So in downtown Calgary they're building a park that looks like the glacier that we're protecting and all the movement and melting and everything is translated to lights and sounds through that park. So people will end up seeing that that glacier is melting over time. And the reason why the people of Calgary care is because that glacier, named the Bow Glacier, feeds the Bow River, which ultimately flows right through Calgary. So once that glacier melts, it's going to impact the people there because they're going to have a dry river now, it's not going to flow anymore.

Aside: So imagine a sleek, modern building in downtown Calgary. A series of vertical light tubes display almost like an EKG of glacier shifts, and cracks, and pops, and movement, while all these ambient sounds play in a line of speakers nearby. Without context, you'd just walk through and be like, "oh, cool, this is trippy." With context, knowing that this glacier is melting in real time at an alarming rate you're like "one sec, while I sink to my knees and hoarsely cry into my scarf, as one does."

Alie: So what happens when people see, [*funny voice*] "oh shit, our glacier's melting"? Like, does that mean that different legislation gets put in place? What practical things do they do to be like, "uuh, we gotta save this glacier"?

Shah: There's two ways. One is when we collect this sort of data, like glacier data or other types of animal data, we always go to work with the governments who are involved with it to show them this is what's happening real time and allow them to use that data to do something good. But we also like to just put it online for people to see. Because if people see this kind of information and get excited about it, that can lead to additional pressure that can, you know, try and force the government to do what's right when it comes to that sort of thing. So that's the two-pronged approach we like to take on things.

Alie: And then tell me about some other technologies?

Shah: Sure. Another technology that we're working on right now is GPS tracking of animals. A lot of scientists like to put these tags on animals to understand where animals are going. The great thing about putting a tag like that on an animal is that once the researchers leave, then the animal starts acting actually how the animal acts when people aren't around...

Aside: It's like when you bid your lover adieu for the day, and then, once in solitude, you can finally fart.

Shah: ... and we can start to learn some really interesting things about them. Researchers have been tagging animals for a very long time, but the tags that they use are made by just a handful of companies and they're very expensive. I have one over here that if you wanted to buy, it would cost you $5,000.

Alie: What!? Are these the radio collars like you see on pumas and they're very huge and they have, like, a big antenna sticking out?

Shah: Yeah. The one I have is not very huge, it's pretty small, but it does have a big antenna sticking out of it. And yeah, that's exactly what they are. Now they cost $5,000 because they're just made by a handful of companies that have kind of cornered the market. But the amazing thing is we could use that same technology that we use for other reasons, you know, the smartphone technology, the maker technology, to create low cost versions of these, open source versions. So we've been working with some other collaborators that are also in the conservation technology space to develop these sorts of tags.

Aside: Sidenote: later this year Shah is just casually heading to Belize and Antarctica to tag sharks and sperm whales, just in case you needed, like, a dream job for your vision board. How do these aquatic tags work though?

Alie: Is it like smacking a tile on one of them and being like, [*high-pitched voice*] "berbyyeeee! See ya!"

Shah: The whale one is actually really interesting because there's a second component to this project. Traditionally in whale tagging for those sorts of whales, the best way to attach it to the whale is to essentially put harpoons on the end of it, so they end up stabbing it into the whale and it stays on as the whale dives. Well, the main part of the project is around how can we develop a mounting mechanism for this tag that is noninvasive, that actually doesn't hurt the whale.

So we're trying all sorts of crazy material stuff and looking at the way geckos attach to walls and all sorts of things. We have a lot of crazy ideas and a lot of strange materials that we're going through now. But ultimately the idea is that this thing is going to be able to attach to a whale without actually hurting it.

Alie: I mean, if you stabbed me in the butt, I would act weird for days, if not forever. Like, a knife hits me in the butt, and then it's like, "okay, go off and be yourself". And you're like, "no, I've got to deal with this thing!"

Aside: Through all of this, I just can't get over thinking about one nagging question...

Alie: I'm still trying to wrap my brain around your passport. Every time you mention a new country, I'm like, "that's another stamp in your passport." Did you have to get extra pages in it?

Shah: Yeah, I'm actually on a new passport recently. I mean, maybe in the last year or so, but it's filling up pretty good!

Alie: How do you decide which project you're going to be working on next, 'cause you've worked in oceans, you've worked in deltas, you've worked in glaciers, like, so many different animals. How do you know what's next, how do you decide?

Shah: In certain times it would be an idea that we have that we want to develop, but I'd say 90% of the time, it's someone who is working in an area that needs something and can't afford it, or has an idea for something new and comes to us and we help to develop it. We can be experts in the technologies and how the technologies can help conservation, but we don't necessarily have to be experts in gorillas.

So a lot of the projects are started by those people coming up to us and saying, "hey, I have this crazy idea, do you think it could work?" and the fun thing about having a lab like this is we could take a week and we could see if it would work, you know, we have a bunch of electronics in here and 3D printers and things like that, and so we'll quickly prototype something and see if it looks like there's a possibility there, and if there is, then we'll either go and find grant funding from a foundation or something, or we'll wait until an opportunity when we can actually go and deploy these things.

Alie: How important is waterproofing in what you do?

Shah: It's very important. In some of these places we're putting electronics, it just will not live there unless you waterproof it very well. Wetlands, rain forests, things like that. It's got to be very well-built and engineered to be able to withstand that.

Aside: Shah is also always looking at how to keep costs low. He says he wants to move beyond the days of good science just coming out of well-funded universities, and empower more people locally to keep collecting and sharing environmental data.

Shah: The other thing we really try and do is work with scientists that are in other parts of the world. Traditionally scientists have gone into these countries, studied a bunch of stuff, and then left and gone back to their universities. A good friend of mine, she calls this

"parachute science," because it doesn't really help the community that's involved. And so we try and partner with people in the community: an engineering university from that country, or scientists that are in the field that are from the country themselves.

Alie: What is the craziest thing you've seen out in the field? What's the craziest moment where you're like, "damn, if I ever write a biography, this is going in!"

Shah: I would say one of my favorite moments… I do a lot of talking to, like, classrooms for STEM stuff and this one kills with little kids. [*laughs*] The work that we were doing in Botswana meant that we were always in the water. We were always in canoes and we were always surrounded by hippos. I don't know how much you know about hippos, but they're, like horribly, horribly mean.

Alie: Right, they're feisty beasts.

Shah: I mean, super territorial. I've never seen something go from completely asleep to the angriest thing you've ever seen your entire life faster than a hippo. It's insane.

Alie: Real bitches!

Aside: Quick apologies to hippopotami for calling you bitches. I thought you killed more people each year than other animals but it turns out you kill, like, 500. Which is still a lot of people, but crocodiles kill double your amount: they're such Geminis. Rabid dogs kill 25,000 people a year, and snakes kill 50,000! But really, what are the animal kingdom's biggest bitches?

Well, mosquitos, responsible for 750,000 deaths annually through the spread of infections. And [*deep breath*] I feel that I can call mosquitoes bitches because only the females take blood meals, but really, you know what? None of these animals are bitches. They're just doing their jobs, living their lives, they're snacking on people, or standing up for themselves. So in summation, hippos are boss bitches.

Shah: Yeah, so we've been charged by them. They've charged us underwater, which is scary. I mean, when they charge you underwater, they drop to the bottom of the river and they run, so you just see this wave coming towards you. It's super terrifying, especially when you're just in a little fiberglass boat, and they're doing that, running towards you.

But my favorite encounter was something that hippos do very rarely, but they do it when they're very angry, it's a threat display. This hippo was outside of the water and we were in the water in the area where that hippo considered its home. So it ran from where it was at, up to the very edge of the water. And it started spinning its tail in a circle, and... started defecating…

Alie: Ooohh my god! [*laughs*]

Shah: It starts spraying it. And the reason why kids love it when I tell the story is because I called this the "poop tornado." So the hippo does this massive poop tornado and I ended up just picking up my camera and taking a picture, and I just got the perfect shot of this hippo. You see the tail and then just all these brown specks flying through the air.

Alie: Oh my god, that is rough! That's like shit hitting the fan!

Shah: That's exactly what it is, yeah! It's meant as a threat display and, like, it is a very threatening thing.

Alie: Oh that's threatening alright, are you kidding me?!

Shah: You see anything doing that with its poop and that's a threatening thing!

Aside: Umm, I just watched videos of this and I'm so sorry, but it is very funny. It's very good. It's a super boss bitch move! And I challenge anyone to try this maneuver, especially if you keep getting interrupted at meetings.

Alie: Oh my god, have you ever been super afraid for your life? Have you ever been like, "oh, this is a widow maker"?

Shah: I don't think I've ever been truly afraid. There was one time that we were charged by a mother elephant that was with her child, and that was very frightening because she got very close, and I think that's the closest I felt to death. But usually when we're out in these places, as I said, we're with experts and we've learned enough to know what we can and can't do. So I've been in the water with big sharks before, or been around lions and all sorts of stuff, and never really felt truly scared.

Alie: Is it true that people who are explorers wear a lot of khaki vests with pockets?

Shah: [*laughs*] Yeah, pockets are important when you're exploring!

Alie: What do you keep in all those pockets?!

Shah: Oh, you got to have a lot of stuff. You have to have flashlights...

Alie: Okay… trail mix?

Shah: Yeah, trail mix sometimes.

Alie: Flares?

Shah: Yeah, compass, things like that.

Alie: Do you actually have a khaki vest, like a fishing vest?

Shah: I do, I do have a khaki vest.

Alie: Do you wear it in the field?

Shah: No, I don't usually wear it in the field.

Alie: I've been thinking about getting one of those just in general for, like, going into airports, like, not having a purse. Why don't I just wear a fishing vest? It has so many pockets!

Shah: You should! I support this idea.

Alie: Okay. I'm going to look into it.

Aside: Oh man, I am so glad I investigated this important piece of American history. Okay, so, the modern fishing vest was conceived of and invented in 1930 by a man

named Lee Wulff, who ran a fly fishing school on the Beaverkill River in the Catskills. And not only did he have impeccable style, he also was very active in conservation efforts. He was a key player in popularizing the catch-and-release method of fishing. He coined the popular motto, "Game fish are too valuable to be caught only once." It's also like, "well, maybe don't hook them in the mouth in the first place, Lee," but yes I hear you, good call.

Anyway, Lee Wulff, inventor of the fishing vest, died in 1991 at the age of 86, piloting a small plane, and journalist Charles Kuralt eulogized him, saying, "Lee Wulff was to fly fishing what Einstein was to physics." Now his personal fishing vest remains on display in a fly fishing museum in the small town of Livingston Manor, New York. Next time you see me I will be wearing a khaki vest, and it will be stuffed with lip balm, and phone chargers, and quarters, and errant Reese's Pieces that I will eat upon discovery.

Okay, it is time for the rapid-fire round: questions courtesy of Patrons who support the show for $1 or more a month.

[e*thereal notes of deep string music*] But first, super quick before the Patreon question round, I do want to give a special shout out. I'm doing a little bit of a promo swap with another really, really good podcast I'm excited to be in cahoots with. So this is just a promo, if you like this podcast you might want to check out a podcast called *Flash Forward*, which is hosted by Rose Eveleth, and she's amazing.

So the premise is that each week she takes on a possible future scenario, like the existence of artificial wombs, or what would happen if space pirates [*incredulous*] dragged a second moon to Earth, what happens if we lived under the sea, and if we could understand animals with some common language. Each episode starts with a little audio drama, like a radio play, and then transitions into these interviews with real experts about what would happen if that really happened.

You can find out more about it at *FlashForwardPod.com*, and she's had guests on like Katie Mack, Jenna Wortham, Kim Stanley Robinson, Ed Yong, and all these great people. People say it's like *RadioLab* meets *Black Mirror*, but with jokes, and I very much agree with that. So, if you like this podcast, check out *Flash Forward*.

And now, we're gonna go ahead and do the rapid-fire round, here we gooo...

Alie: Patreon questions, you ready? Betsy Long wants to know: Why can't those of us with lots of snow send it to parts of the world suffering from droughts?

Shah: That's actually a question I've heard before. Part of the problem is that we don't really realize how much water people use. I mean, it's a crazy amount on a daily basis, like, what each household uses, how much water goes into producing different types of food. I just think logistically it wouldn't make sense... would it be financially feasible for a pipeline to be run from some snowy area into southern California? It doesn't make any sense.

I think the best option is trying to conserve, we have to be better about how we end up using water. Maybe we need to stop putting it in a bunch of plastic bottles. And then

there's desalination technologies that people have started to use, but that's also very expensive and it can have wildlife implications as well.

Alie: Yeah, that was the next question. Christopher Royce wanted to know: I'm interested in desalinization tech. Will it ever become cost effective or are water wars [*intense voice*] inevitable?

Shah: I honestly think that they probably are, you know.

Alie: [*anguished, speaking far from mic*] Oh my god, that sucks!

Shah: It's gonna be rough. Yeah. I mean, the way the planet's changing, there's nothing good about it. There's actually an area of the south-central part of the United States, Texas and Oklahoma and a lot of that area, and they're all fed by the same aquifer, and they think that it's going to basically dry up in the next 30 years and so we're going to see it in this country.

We're going to see lots of impacts when it comes to that sort of stuff. Unfortunately, I think desalination technology is going to become viable once things are dire enough that it has to become viable, but it's not the best option.

Alie: This is a real dumb question. [h*igh pitched voice*] How come you can't just boil the water and the salt stays behind and then you gather the water?

Shah: I don't think that's how it works. [*laughs*]

Alie: Okay! [*lightly*] I have no idea how desalinization works.

Aside: So I looked into it and apparently there are two main ways desalinization is happening. There's multi-stage flash distillation, which uses heat to evaporate water and leaves the salt behind. This accounts for 84% of desalinization and it's what I guessed happened, so I feel very smart and important right now. There's also reverse osmosis desalination... Desalinization, or desalination? I don't know, say whatever you want!

Reverse osmosis takes less energy than heating all that water but still takes quite a bit of energy to pump water through these filtration membranes. So some folks are working on low temperature heat desalination too, which might work with clean solar power. But for now I guess the point is, you have to burn fuels to heat the water or pump it so it's costly in terms of energy consumption and carbon output. But when I have a hydrologist on we will talk all about this, and also our future, drinking sewer water! [*toilet flush*]

Alie: Catherine Chavez, Tobias Milton, Olaf Dashki, and Aneka Merkelbach all asked essentially the same question: What can I do besides just recycling? What's the simplest daily change we can make? What's one thing we can all focus on? [a*nguished, echoey*] What can we do? What do we dooo?!

Shah: There's a ton we can do. The choices that you make as a citizen and consumer have a massive impact on this sort of thing and they can actually help to stop environmental

destruction happening in other parts of the world. One example of that: single-use plastics are just generally a bad idea all the time, things like Styrofoam, things that can't be recycled. By stopping doing that - by using reusable bottles, bringing your own bags - you can actually make a massive impact on that problem.

Eating less red meat is always a really good thing. Red meat actually has a pretty massive impact on the environment. Being more of a vegetarian is actually very helpful, to do that sort of stuff. Also buying products that don't have palm oil in them. So if you were to look on the back of a lot of candies or other processed products in stores, they have palm oil in them, and palm oil largely comes from these plantations in Southeast Asia where they've basically cut down a lot of the rainforest and made these plantations and it's putting orangutans and all sorts of animals at risk as a result of the stuff that they're doing.

Aside: So for more on this, you can catch *Ologies* episode number two on Primatology.

Shah: So I think just by being a smarter consumer and picking better options, there's a lot that you can end up doing and helping.

Alie: Do you think we're going to look back and be like, [*raspy voice*] "Oh my god, so much plastic, so much meat. What were we doing?" My mom told me a story once, she went to the obstetrician when she was pregnant with one of us, I can't remember, and that her doctor was smoking. And we look back and realize that would be, like, over the top if you saw that in a comedy sketch. Are we going to look back and be like, "my god, we used to order things from Amazon and it would get shipped to us in a big truck, billowing smoke and carbon, and then we'd open it up and then we throw away a bunch of plastic for, like, a little tiny item." Are we going to be appalled?

Shah: We are 100 percent going to be appalled. I think future humans will look back on our generation and just say, "what were they thinking? That's just absurd." I mean, we're at the point now where we know better and the only way things are going to change is if people demand that it changes and so that's why each person's opinion matters. That's why these little acts can actually make a massive impact, when the entire country is doing it. Then we can force these companies to stop using these stupid methods.

Alie: I remember when they banned plastic bags in LA. Everyone knew it was coming and was like, "Oh man, you're going to have to bring your own bags at grocery store." And now it's so commonplace. I keep a bunch of canvas bags in my trunk because I don't want to be that asshole in front of the line that's like, "load me up with all the plastic you've got!" You just adjust.

Aside: Another patron by the name of Larry Ward, himself a fishing vest aficionado, also my dad and thus, your grandpod, asked about photovoltaics and hydro power, and what kind of batteries need to be developed to really make the best use of those forms of renewable energy?

Shah: I love solar. I think solar is fantastic. I think one thing really holding that stuff back is, like your dad said, battery technology. Battery technology is something... we're dying for an amazing innovation to come out of that. I mean, once that comes, everything's going to change, and we're still kind of operating on this old technology that we've had for a long time and they're just tweaking the chemistry just a little bit here and there to try to get a little bit more efficiency out of it. If we can bring that up even higher, that's great, but we *have* to move towards renewable sources of power.

Aside: On that note…

Alie: Radha Vakharia wants to know: How long until I can buy a solar car? Like, months, dates if you could be specific?

Shah: [*laughs*] We could probably make him a solar car, if you'd like. But yeah, if you did make a solar car nowadays, it'd have to be very light and basically full of batteries!

Aside: This just in: a Dutch company called Lightyear is working on a fully solar-powered car, due out in 2020 and priced around $140,000. So Tesla, watch yer back. Although, I feel like if you have solar panels on your roof, and they juice up your Tesla, you kind of have a solar car, but that's like saying that all cars are solar because petroleum is dinosaurs and they could've eaten plants. But that's bullshit, you know what I mean? Anyway, the point is: all-solar cars, they are better, let's have them please.

Alie: Jack Kelleher wants to know: Solar, wind, water; which is the best renewable resource overall?

Shah: I like solar. I think wind's pretty great too, if you're smart about how you put it. A lot of people like to talk about the impact that wind has on birds. But if you look at the impact of that buildings have on birds, it's far more than wind turbines do...

Aside: I looked into this and almost a billion birds a year die from window strikes, mostly to residential and shorter commercial buildings. But wind turbines kill about 75% fewer birds than windows do. Top bird killer, though? 'S kitties. Up to 4 billion birds are killed every year in the US at the hands — or, I guess, the paws — of the nation's outdoor and feral kitty cats. I could not, however, find statistics on how many birds were killed by American hippos.

Shah: ... so I think that's just something that's kind of drummed up by opponents to wind technology as a means of kind of slowing it down. I think if done responsibly, it's a fantastic resource.

Alie: Those same people are probably, like, eating chicken parmesan as they're being like, [*pompous accent*] "well, we can't use this, we need oil because of the birds!"

Elliot Anaya wants to know: What emerging technologies do you foresee having the most impact on conservation?

Shah: I think that's pretty exciting. There's three that I'm really excited about, one would be satellite technologies. The amount of stuff that we can now sense from space, and do it cheaply, is amazing. And so if you take a picture of the Earth every single day, then you

can really start to see how fast things are changing. You can see deforestation, you can see algal blooms, you can see all sorts of stuff that's really fascinating from a conservation perspective, and important for us to know.

Aside: It's like taking a selfie every day to see if your haircut looks stupid as it grows out.

Shah: The second I would say that I'm excited about is low-cost sensors. In the past, we built this sensor device, and I talked to a scientist that used a similar device 15 years ago, and that device cost him almost $40,000 to buy, and then we built it for $1,200.

Aside: [*baritone*] Oh my god.

Shah: Instead of buying one of those sensors, he could have bought 10 of them! Now we can start to measure more things in more areas, or keep them out for even longer in ways that we just had not been able to do before, so that's super exciting. Then I would say the last technology I'm excited about is the stuff that artificial intelligence can end up doing, because, as we talked about, as conservation technology gathers more and more data about this planet and how the planet is changing, we need to build better tools to be able to go through all that data and pull meaning out of it.

Alie: That's cool. You're like, "computer, tell us how fucked we are," and it's like [*robotic voice*] "we are very fucked", and you're like, "thank you! That's so helpful!" [*Both laugh*].

Katie Cobb wants to know: Other than 'what's wrong with you?', what do you say to someone who feels that recycling, or any other simple means of conservation, individual responsibility to the environment, isn't worth their time because, "they will be dead long before it matters"? What do you say to those people?

Shah: Yeah, you know, it's rough to deal with people who are cynical just to be cynical. The hardest thing is to try and get through to those people. Sometimes it just helps to tell those really sad stories about the kinds of things that you see out there. I'm an optimist when it comes to conservation and for the planet, so I try not to be too much of a downer. Like, I try not to talk about poaching and all these sorts of things unless I need to, unless it's relevant to the stuff that we're doing.

What was it, a week ago, a week and a half ago, there was that story about that pilot whale where they found 80 pounds of plastic bags inside of its stomach. And so the poor whale is going around the ocean eating what it thinks are jellyfish, because it eats jellyfish, but they're really just plastic bags. You've picked up a plastic bag, you can imagine how many plastic bags it would take to get to 80 pounds of it. It's a lot! It's a lot and that killed the whale. So your choice, the decisions you make on a daily basis about the things that you buy, or the things that you take, and what you throw away actually matters.

And I think... I didn't say this earlier when you were asking what we can do, but I think the other thing is, we as a society need to learn to use things longer, or repair things that break. It's very popular now to get a new phone every time the new phone comes out. I've even been guilty of this as well, but each time you make something, there's an

energy that goes into it. There's resources that have to be mined to be able to create these sorts of things.

And then once you throw it away, it goes into the landfill and it's there forever, right? And there's this great movement that's happening in certain parts of the world, this repair movement, where people are trying to repair some of the things that they have instead of throwing them away to kind of give a longer life on it, and by us doing that, by us buying better quality stuff and keeping it for longer, we lessen our impact on this planet.

Alie: What is that saying… "You can buy it nice or buy it twice."

Shah: Oh yeah, exactly.

Alie: Invest in something that's a little bit better and that'll last a long time instead of just getting things that you'll keep throwing away and be like, "oh, I'll replace it with whatever."

Shah: Yeah, I like that.

Alie: I think back, my great-grandparents had this thing that was next to the hearth that was a shoe repair iron. And they would put the shoe on it upside down and then they'd nail on another sole. And I remember being a kid being like, "what is this?" and my dad was like, "oh, that's the thing you put your shoe on when you repair it," and I'm like, "who did that?" But that's what they used to do. Now you would just throw your shoes in the garbage and be like, new shoe times!

Shah: I was at this conference, and I cannot remember the name of the individual, I think he was Austrian, but he did this thing where you would set up these repair shops in cities and the repairer would be, "I will repair anything that you bring it in." So it's your toaster, your espresso machine, your TV, whatever.

Alie: [*joking*] You bring your boyfriend, you're like, "can you help us?"

Shah: [*laughs*] Yeah, exactly! So you bring it in and the one requirement was that you have to sit there with him as he repairs it and learn how to do it, you know? They were saying that some people would come in and they would just get furious, they'd be like, "No! Just fix it. I'll pay twice the amount, just fix it." And he said, "no, the whole point of this is that you learn how to fix these things. You learn about the importance of repair," and he'd go through it, and some people would come in and spend all day with him to repair an espresso machine or something and learn a ton out of it. And I think that's amazing.

Aside: I couldn't find exactly who this gent was but in researching I did learn that there are 'Fixit Clinics' at local Goodwill stores and other places. There's even a whole organization called IFixit.org, dedicated to repairing things instead of throwing them into a chasm of trash and replacing them. So Google 'FixIt Clinic' in your city and then bring your broken hair dryer over and learn how to tinker it back to life. And then you can rightfully brag about it for several years and also teach other people how to fix their hair dryers.

Also, when I went to track down who started this movement, I found some leads to something that began in the Netherlands, but in Googling some key words, something went wrong because I somehow found myself reading a news article with the headline "Dutch mobile euthanasia units to make house calls." And I was like, "well, okay, that's very different than a broken toaster." [*voice effect like an old radio*] Anyway...

Alie: Do you try to apply that to the technologies that you use, whether it's in the field or if you're developing a technology from an old technology?

Shah: Yeah, totally. That's why all our stuff is open source, so that we can share the information and move off of it. One of our collaborators on one of the projects that we have is this individual named Topher White, he's a great guy. He started this organization called The Rainforest Connection, and they do amazing work. What they do is they take cell phones, smartphones that people don't want anymore, and they recycle them as these "forest guardians."

Basically what they do is they put a microphone on this smartphone, they write some software, and they put it up in the rainforest, and they put it out there to listen for illegal logging happening in the rainforest. So he just gets all these old smartphones nobody wants anymore, and then ends up taking them and giving them this life as a protector of the rainforest, which is a really amazing thing to do. Because normally those were just gone and would've been thrown away.

Alie: It's cool that you can use technology and people who are passionate about the environment to have like an eco-snitch movement where you're like, "listen, you're poaching dolphins, you're logging areas you shouldn't, we're watching!"

Shah: Totally! That's a big part of some of the stuff that we do. The technical term for that is called environmental justice.

Alie: Oh!

Aside: So, environmental justice. That is a way better and more apt term than eco-snitching. I am not very good at marketing.

Shah: Basically, a lot of these communities, they don't really have a voice and when they see this kind of environmental stuff happening to them, it's hard for them to find someone to tell it to. So the environmental justice movement is all about making tools and mechanisms, like legal mechanisms and stuff like that, where they have someone to go to to say, "hey, you know, they cut down our forest," or "they've been poisoning our river that we depend on," and document the impact that this stuff is happening.

Alie: Right, which is amazing because it would just go untold, those stories would be undetected and untold.

Shah: Yeah, like they have been for a very long time.

Alie: Right. Speaking of legalities, Rhonda Grizzle wants to know: I'd like to install a water catchment system at my house, but they're not legal in my county, so I'm not sure who

to work with to get these systems added to the building code here or what arguments to make. But I'd love any ideas, how you can help make that happen.

What do we do about rain catchment? Is that legal? What's the deal?

Shah: Yeah, I mean in some places it's not, it's really weird why it wouldn't be. I think it's a holdover of weird regulations that came as a result of working with water groups and all sorts of stuff like that. But I think just getting involved in the municipal process and trying to talk to the right folks in your local government to change that, there's really no reason that rainwater catchment should be illegal, ever. You know, it's completely natural.

Alie: And I guess a lot of people do that just by having a barrel out in the garden.

Shah: Totally! Yeah, that's what a lot of people do. When I was doing a lot of work with Engineers Without Borders, we built a lot of them all over the world. We never built them in the US because in some parts it is illegal, but it's a fantastic way to get extra water. Even if you just use the water for irrigation then that's great.

Alie: Do you have to worry about more 'skeeters?

Shah: Not if you engineer it right, usually it's not just an open barrel. And then the one thing you do have to sometimes worry about is, it's not necessarily good water to drink, so it's more like greywater.

Aside: 'Greywater,' heads up, is the term for relatively clean waste water like from sinks, and appliances, and the bath. Anything that doesn't involve toilets, if you catch my drift. So, reusable, but maybe not something you'd drink.

Shah: Because if it's coming off your roof, you don't know if birds have been pooping on your roof or something like that. So it could be bad. So if you did want to use it for drinking, you'd have to add a filtration system and what they call a first-flush device that basically takes all the first water that goes on the roof and just pours it out onto the ground.

Alie: Oh, got it. What kind of water filtration system do you use when you're in the bush?

Shah: Yeah, that's a good question. I don't use anything special, I use iodine tablets and then I have one that has a little carbon filter in it, but in some parts of these places I just drink the water there, you know.

Alie: How's that worked out for you?

Shah: It's fine. I mean, I don't think I have any parasites living inside of me. [*laughs*]

Alie: [*laughing*] None that have tried to get out explosively, at least?

Shah: Yeah! In the Okavango Delta, the water is just so amazingly clear and pristine that it just tastes wonderful and it's fine. I mean, you don't want to drink a leech or something, but other than that you're fine. But in some parts you just have to buy bottled water, which is rough, but that's the only option that they have in certain areas.

Alie: Then Mike Monikowski... this is a great question: Are biofuels used for vehicles energy positive or do they consume more energy to produce and transport than they provide? So biofuels, what's the deal?

Shah: I think that's a great question. I think there's a lot of potential for biofuels and I've had friends that have converted cars to biodiesel cars and stuff like that before, but I think generally what we need to do is just try and move away from any kind of fossil fuel for that sort of stuff. If I could buy an electric car, I would.

Alie: What about veggie diesel, where you just get this stuff from fryers?

Shah: So the friends of mine did convert cars from veggie diesels. It smelled like Chinese food when you drove behind them.

Alie: I love that. How come more people aren't doing that, do you think?

Shah: I don't know. I think that, like, you have to build the equipment in your garage that allows you to filter and process it in the right way, and that just seems like too much for some people.

Alie: Right… but it's like, we are a country that relies so heavily on cars, *and* onion rings, and chicken tenders. You'd think it would be a match made in heaven. It's like the one thing that we have a lot of is fryer grease, [*sizzling oil sounds*] like, welcome to the United States! No shade on that.

Aside: Shah and I also talked about ocean conservation and plastics, and even Baltimore's own 'Mr. Trash Wheel', but I trimmed a lot of it out because we went into such detail about the same thing last week with oceanologist Dr. Ayana Johnson. So if you missed that, listen to it next. Doctor's orders.

Shah: We've pretty much ruined things when it comes to plastics in the ocean. [*Price is Right loser horns*]

Alie: Oh my god, that's the most depressing thing in the world… but it's also true! Oh, man. How do you approach fatherhood, knowing what you know about the environment?

Shah: For me, it fuels my passion in the work that I do, because I want us to not be that society that future humans are like, "what are you guys doing?" Or my daughter when she's older, say, "oh, you know, my parent's generation were all idiots." You know? I want us to be able to solve some of these problems before it's too late and help to bring back spaces where wildlife can grow and thrive and not go extinct.

So for me, being a dad, it's a big driver in every single thing that I do. And it's really kind of changed my focus in terms of trying to solve some of these bigger problems as opposed to just, like, tinkering around with really cool technologies in different areas, starting to think about things in a big system and how do we solve that broadly across the globe. Hopefully I'll be successful in that, so she'll live in a better world.

Aside: So if nothing else, we can all feel a little better knowing that people like Ayana from last week and Shah are on the case. Leslie Nielsen said it best: [*clip from Airplane, Dr Rumack: I just want to tell you all good luck, we're all counting on you.*]

Alie: Guy R. Thomas wants to know: Are IoT devices useful or will they just make the problem worse? My question, what the hell is an IoT device?

Shah: IoT is the Internet of Things.

Alie: Oh, got it, got it!

Shah: So when I talk about sensors, I'm essentially talking about IoT devices because, you know, the sensors, we attach these small processors and we attach radios to them. So that's basically what an IoT device is. We've actually leveraged a lot of the technology that you see in smart cities and smart homes and brought them into these sorts of places to create the same sorts of networks.

For example we use similar radios that they use on IoT devices. We use similar processors that they use on IoT devices and the project that we have that came out of the Okavango work that we call Field Kit, is basically an open source IoT ecosystem to allow you to be able to put these sorts of things all over the world, and it's all free and open and available for anyone to use.

Alie: How are those devices powered?

Shah: So with a small battery and a solar panel, typically is how we do it.

Alie: Oh! That makes sense. Can you tell me in a nutshell, how screwed are we in the ocean, global warming, and water access for people? I feel like those are our biggies.

Shah: Yeah, they're big. They're really big. I would add one more, and it would be extinction.

Alie: Oy-yoi-yoi.

Shah: So let me start with that one, just because I mentioned it. This planet has gone through five mass extinctions before. There's actually a fantastic book called *The Sixth Extinction*, which is what we're going through right now. And the thing... you ask any school kid about extinctions and they've all heard of the ice age or dinosaurs, and they know that that sort of stuff happens. But this is the first time in history that it's all been caused by a single species, and that's us, that's humans.

Alie: Oh my god!

Shah: The level of extinction that we're seeing, the biodiversity loss that we're seeing right now is a thousand times higher than what we would consider just baseline. So it's incredibly bad. I mean we're seeing things die off super fast, faster than we can even discover them or learn more about them. Most of that comes from human impact; it comes from poaching, it comes from habitat loss, it comes from things that humans are doing to this planet that's making it harder for wildlife to live.

As I said earlier, I'm optimistic about that. I think we're starting to become smarter about it and we're doing better things with our land use and habitat protection and creating parks. What was the second one?

Alie: Global warming, climate change.

Shah: Global warming, oh yes. I mean, I get very scared about global warming just because human behavior isn't necessarily one that we'll see a threat coming, and then make the smart decision to avoid that threat. We usually wait until the threat kicks us in the face and then we're like, "oh, we shouldn't do that anymore."

So I feel like with global warming, I guess I don't have a lot of faith that we're going to do the right thing until some really bad stuff starts happening first.

Alie: How do we know that it's definitively our fault and not just like, "a weird, solar flare's happened and the climate goes…" Like, can you debunk that flimflam?

Shah: We 100% know. I mean, they throw this, like, 99 or 97% of scientists or whatever number, but global warming is caused by humans, 100%. It's entirely caused by humans.

Aside: Okay, this was just some major flimflam that I needed triple debunked, just in case anyone out there still doubted it. Like, triple flimflam debunkage.

Shah: There's no concern or skepticism in the broad scientific community about that.

Alie: Just checking!

Shah: And I mean, if you just think about things logically: the Earth is a closed system, we're pumping a bunch of stuff into it, it's going to change. It will change the system. So human-caused global warming is a thing. It doesn't help when we have administrations like we have now in the US that go back on a lot of the work that we've been doing for a number of years.

Alie: Yeah, ya think?

Shah: So yeah, I'm not super optimistic about that topic with this current administration. Global warming stuff is really going to change when we start to see sea level rise impacting communities, and weather events getting much more severe and having huge economic decisions, and we get to the point where we have to do something about it.

Some people are in favor of geoengineering and things like that. I don't know, maybe we'll get to the point where that's okay. I get worried about unforeseen circumstances if we start pumping…

Alie: What is that?

Shah: So there's a lot of ideas about how we can put different things in the atmosphere that will reflect sunlight or change the chemical composition of the atmosphere and slow this climate change that's happening. There's a new technology that came out that has brought down the cost of extracting CO_2 from the air. That's a way of slowing that, is by

removing some of the greenhouse gases and CO_2, but I'm not necessarily in the camp of throwing a whole bunch of particles into the atmosphere and seeing what happens.

Alie: There's plenty of conspiracy theories about chemtrails anyway, right?! Can people plant more trees?

Shah: Planting trees is a fantastic way to help, there's a lot: drive less, plant trees, do a bunch of stuff like that, I mean that's super helpful.

Alie: Enough with the straws already, plant a tree! And then a little bit about clean water access, you also work in that?

Shah: Yeah, I think that's going to be a big thing. The one thing I do want to say is, these projects, to give access to clean water to places they have to be really thought about in a sustainable sort of a way. A lot of the work that we're doing with Engineers Without Borders was repairing the clean water projects that previous generations did.

In the '80s and '90s there was a bunch of churches and nonprofits that decided they were just going to drill a bunch of wells all over Africa, but they didn't really think about the lifecycle of the well, who's going to maintain the well, what happens when the well breaks. So there's just a whole bunch of broken wells in a lot of these places and we would have to go through and try and fix them. If you think about these sorts of projects in a more sustainable or holistic 'whole lifecycle' way, then you can really do a lot more good work out there and not waste money and effort.

Alie: I bet that's not as glamorous, like, "we're fixing an old well" isn't as glamorous as "we've given you a well! And we're leaving now!" You know what I mean?

Shah: Totally, yeah. But they built these wells, they put in pumps that they brought over from some company in the US. So if a piece on that pump breaks, you know, those people in that community can't buy replacements. They can't just go to the Internet and order something to some random part of the community that they live in. And so we have to think about the solutions that we make in ways where they're maintainable: if they fail, they fail in ways that aren't catastrophic, and that they empower the people that they're looking to help.

Alie: How can you convince people not to be morosely depressed about the environment and life?

Shah: I think the planet is still an incredibly beautiful and wonderful place. [*DJ airhorn*] There's parts of this planet you can go to that will literally... there's not a single person on this planet that their mind won't be blown. It's just this beautiful, wonderful place and it's incredibly resilient.

I mean, this planet wants to get better and all we have to do is just give it a little bit of room and allow it to get better. So that's a really exciting thing. I mean, it's been around for billions of years, it's going to be around after humans, and we just want to make sure that it's around in a way that is best for everything that lives on this planet.

Alie: Are we like bedbugs on Earth? Are we like a bedbug infestation in an apartment building?

Shah: Yeah, there's definitely people out there that consider humans parasites.

Alie: Yeah, like an infestation.

Shah: I think humans are wonderful. [*inspiring campaign music as Shah speaks*] I think we do an incredible and amazing things and we have the power to just inspire millions and really make this place a better place. So let's make it a better place. Let's not destroy it. [*music increases in volume and plays for a few more seconds*]

Alie: [*record scratch*] What's the hardest part about your job?

Shah: I would say the hardest part about my job is... that's a good question! I absolutely love my job. But I'd say the hardest part of my job is just being able to do as much as we want to do. It seems like there's never enough time or there's never enough money to really fix the problems at a fundamental level.

That being said, we've also very recently — in the last couple of years — seen this amazing change in terms of people who are excited about funding and getting behind this sort of work. So I think there's never been a more exciting time in conservation, or in conservation technology. I'm super excited about it and I think we can really... we don't have to be the generation that ruined everything. We can be the generation that fixed it, you know?

Alie: [*laughs*] That's so optimistiiic! What's your favorite part of your job? Do you have a moment that was just like, [*high pitch vibrato, imitating angels singing*] aaaahhh!

Shah: My favorite part of the job is, without question, the field. I love, love just being in a place that is completely new to me, entirely different from my life in Los Angeles. I'm surrounded by things like wild animals and mosquitoes, and I'm trying to figure out some technological solution, or how to fix some bug without having any of the resources that I have here in my lab. I love that puzzle, I love being stuck in those situations and trying to figure out a way out of it.

Alie: That's like extreme camping, that is some hardcore camping! What's your next trip?

Shah: So we have a couple trips. We're going to Cameroon with UCLA and deploying a bunch of sensors around some of the research stations that they have in that part of the Congo Basin.

We're also going back to the Amazon where we're deploying sensors with the Wildlife Conservation Society across all the countries that make up the Amazon, so this is a longer project.

Later on this year we'll be going to Sri Lanka, where we're going to be using drones to try and monitor the very aggressive whale watching industry that's happening there, which is impacting this unique type of blue whale that only lives near Sri Lanka.

Alie: So it's like, they've got the paps following them, [*paparazzi sound effects*] like whale watching, just, like, super aggressive, like, what are they doing? So you have to be like, "hey, leave him alone"?

Shah: Yeah. And if we can document it, we can talk to the government about it and we can make some changes there. And then, we'll be going to Belize to tag sharks and we'll be going to Antarctica to tag whales, which will be pretty fun.

Alie: Oh my god! Is that all coming up this year?

Shah: Yeah, it's this year into next year.

Alie: [*incredulous*] Oh my god! So you've got some packing to do, right?

Shah: Yeah, it's a lot. And I've got a lot of building and testing to do.

Alie: [*even more incredulous*] Oh my god! Vastly different wardrobes for those expeditions. Vastly. So now, where can people find you? Where can they learn more about it? And you're a nonprofit. So conceivably if people wanted to donate, they could help.

Shah: Yeah, of course. The organization is called Conservify. You can find us on Twitter and Instagram at that. And then I tweet a lot and post a lot on Instagram. My Twitter is @ShahSelbe and my Instagram's @SSelbe.

Aside: So there'll be links in the show notes, as well as up on AlieWard.com/Ologies because maybe you're listening to this while operating a forklift or doing kidney surgery, brushing your cat's teeth, I don't know. It's okay, check the show notes later!

Shah: You can follow the expeditions and see the sort of stuff that we're doing, and if you are an engineer or if you... actually, you know what, if you have any kind of skill and you want to help a conservation project, definitely feel free to reach out to me because I know people who need not only engineering skills but marketing skills and design skills, all sorts of stuff that could actually help a lot of these conservation groups or NGOs and scientists that are out in these amazing parts of the world that can use all the help that they can get.

Alie: What if someone's like, "I'm really good at baking cookies?"

Shah: Cookies help, cookies are important! [*both laugh*]

Alie: So, reach out if you have any skill and you want to help save the planet.

Shah: Yup.

Alie: I don't know how you do all of the things you do. How do you do it? Do you sleep?

Shah: Uh, not much!

So, while we all might lose a little sleep over the state of the Earth, no one more so than the amazing, brilliant and hard-working conservationists out there. Thank you for all that you do, on behalf of me and the 8 billion or so of us who need this big planet to live on.

So follow Shah on social media, check out his nonprofit Conservify, and if conservation technology is something you'd like to get all up in, reach out to him. Sounds like the more the merrier. Follow *Ologies* on Twitter or Instagram @Ologies, I'm on both @AlieWard, and there are tons of links for each episode up at alieward.com/ologies.

You can become a patron at Patreon.com/ologies, you can get merch at OlogiesMerch.com including brand new designs this week: very exciting, major autumnal and collegiate vibes thanks to Boni Dutch and also Shannon Feltus.

Thanks to Erin Talbert and Hannah Lipow for adminning the great Ologies Podcast Facebook group and I'll see y'all at Camp Ologies this weekend, some of you.

Thank you to Steven Ray Morris for conserving my sanity, technologically, by editing this all together, you're a boss bitch, and to Nick Thorburn who wrote and performed the theme music. He's in a band called Islands you can also listen to.

Speaking of listening, if you listen to the end of the episode, you know I tell a secret, and this week's secret is that... I don't know if I've told this secret before, but I do have all my books out on my bookshelves, except all of my self-help books I keep on a shelf in a closet, that way if anyone comes over, they can't just see this whole array of psychological topics about myself I'd like to fix.

But I did realize, why don't I just go to the library, and get my self-help books there? It's one quick, possibly embarrassing transaction, and then, once I'm done with it, I just put it in a chute in the dead of night, and I never have to hide that I have a book about like, 'Overcoming Anxiety with Meditation and Stuffed Animals', or something. Anyway, that's my secret... self-help books, man, get 'em at the Library.

Libraries are so great. Libraries are really wonderful. When was the last time you went to a library? Just go to a library and spend an hour there, just kick it. They're so... it's, like, my new thing. Anyway. Okay that's it.

[*robotic voice*] Berbye.

[*Outro Music*]

[*clip: end of the Magic School Bus theme*]

Lin: Step in, step in, step inside, it's a wilder ride! Come on!

Kids and Lin: Ride on the Magic School Bus!

[*bus honking*]

Transcribed by Aska Djikia.

Some links which you may enjoy:

Nat Geo's "Into the Okavango"

Tweeting up to the ISS

Trying to research crocodile astrology

Hippo butt fan

Calgary's glacier exhibit, "Herald/Harbinger"

More on the Bow Glacier

Bow Glacier Video

Which are the world's deadliest animals aka biggest bitches?

The skinny on salt water

Lightyear cars: sun-powered machines

Cats kill birds. But we all knew that.

Windows also kill birds. But fewer birds.

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