



S2E2: Transcript

Whale Song & Alien Intelligence

with Dr. Laurance Doyle and
Dr. Fred Sharpe

Tavia Gilbert: Welcome to Stories of Impact. I'm producer Tavia Gilbert, and in every episode of this podcast, journalist Richard Sergay and I bring you a conversation about the newest scientific research on human flourishing, and how those discoveries can be translated into practical tools.

This season, we're diving into the question: What are diverse intelligences? Today we're going to hear Richard Sergay's interviews with Laurance Doyle and Fred Sharpe, two scientists who are exploring intelligences that take us from the bottom of the ocean to the farthest reaches of outer space.

Let's begin with what might sound familiar, if otherworldly.

WHALE SONG

Tavia Gilbert: Many of you will recognize those sounds—the classic recording that awakened and inspired hearts and minds the world over in the early 1970s. When listeners heard ground-breaking recordings of whale song made by Frank Whatlington and Roger Payne, it led to a world-wide whale conservation effort that still impacts our thinking today. I'll share more of the eerie, strangely beautiful surprisingly human whale song later in this episode, but let's turn our ears to this sound, which I suspect is less quickly identifiable:

VELA PULSAR SONG

Tavia Gilbert: What in the world is that!? That's star song, or, more specifically, the sound of the Vela Pulsar star. And today, our story is about how understanding the language, or the song, of the whales, might someday lead us to understand the language of the extraterrestrial intelligence – communication that comes to us through the cosmos, which might even lead to a better understanding of ourselves.

But let's start nearly two decades ago, when Dr. Fred Sharpe, an expert in humpback whales and the Principal Investigator with the Alaska Whale Foundation, received a very unexpected phone call. It was Dr. Laurance R. Doyle, an astrophysicist specializing in alien intelligence, calling with a big idea: What if studying humpback whale song could reveal something about the way aliens might be trying to communicate with humans? Dr. Doyle was also on a new mission to explore another question. Here's Dr. Doyle:

Laurance Doyle: So most of the years SETI has operated they've asked is there technology out there. They haven't asked, is the message intelligent?

Tavia Gilbert: If it took Dr. Doyle a few attempts to finally get in touch, Dr. Sharpe can't be faulted. Who wouldn't have been a little skeptical? The man on the phone introduced himself as the Principal Investigator of the SETI Institute: SETI, or the Search for Extraterrestrial Intelligence. Here's Dr. Sharpe.

Fred Sharpe: I think a lot of people when they first hear about SETI, just think about what UFO's and flying saucers, right? SETI was developing tools that could um, look at these signals coming in from deep space.

Tavia Gilbert: What would Dr. Sharpe, an evolutionary biologist, have in common with the caller, Dr. Doyle, an astrophysicist? But Dr. Sharpe soon learned why Dr. Doyle wanted his attention. Dr. Doyle didn't only want to know if technology existed. He wondered if it was possible that there alien intelligences were transmitting signals to us, and because we couldn't recognize the language, we were missing their message, or, as he explains:

Laurance Doyle: So unless the transmitter and receiver know the same meaning we're going to miss the signal. So what's new about SETI and our work is

that we are introducing the idea of looking at the message itself and asking, is it intelligent?

Tavia Gilbert: When Dr. Doyle realized that the vastness of the ocean is a lot like the vastness of the solar system, he had the spark of an idea that made him reach out to Dr. Sharpe: What if the way humpback whales sing and chatter through their unique, global, oceanic communications systems, might prepare us to someday make sense of messages that alien intelligence are speaking to us through their cosmic communications system? Dr. Sharpe was immediately inspired.

Fred Sharpe: I immediately was just like intrigued by the hard science that was going on, the challenging science, the challenging tools. I think it's a brilliant idea to apply that to animal communication systems. And it's like yeah, this is a great idea.

Tavia Gilbert: Dr. Sharpe's expertise about humpback whales was exactly what Dr. Doyle needed to advance his own study of cosmic communication. Not only humpback whale's unique song, or vocalization, but other characteristics made Dr. Doyle think whale song could give him insight into those potential alien communications.

Laurance Doyle: Their tool use, their complex social society, their very complex vocalizations, and their global network are all reasons that we want to start with humpback whales. They put all their communication into vocalizations. They don't use facials or gestures. Because they're in the ocean they depend heavily on signals, so we don't get half the system in gestures like humans, we get all of this system in terms of the audio. We think.

Fred Sharpe: They do appear to be the most dynamic and diverse communicators. Certainly the use of the feeding calls as an inner species herding cry as far as we can tell that's unique. 73 The complexity of the song, the fact that the song is constantly evolving, it's using rhyming, syntax, um, you know it's structural. I feel like that's the Rosetta Stone getting at their communication system. 80 It's crazy, it's almost word-like. They produce these you know half-second to three second sounds that are punctuated by silence, very, in some ways very language like.

- Tavia Gilbert:** And Dr. Sharpe agreed that in addition to the vast area over which humpback whales communicate, the whales' complex *song cycles* — might very well be a key to unlocking the secrets of interstellar conversation.
- Fred Sharpe:** Sound speed in the oceans is five times faster than in air, so oceans have this amazing acoustical conductivity. Sounds in the ocean in some ways make amazing interstellar analogs. They can travel over hundreds if not thousands of miles. And studies have shown these song themes radiate out across the Pacific, suggesting that they're in touch over hundreds and even thousands of miles.
- Laurance Doyle:** It's global because maybe a thousand kilometers away they can transmit a signal and receive it.
- Fred Sharpe:** In fact, it's thought that blue whales prior to human ship noise could communicate from pole to pole with their very low frequency sounds.
- Tavia Gilbert:** Both scientists thought that getting a better understanding of how humpback whales successfully communicate with each other as far as pole to pole would teach them something about how alien intelligence might manage to transmit their messages through the cosmos.
- Fred Sharpe:** So they can probably be communicating with each other very efficiently. So it can take you know many hours for these sounds to propagate across the oceans they're probably packaging and creating their signals for long distance transportation, long distance movement.
- Laurance Doyle:** And that's similar to what we will start to experience when we put humans in the solar system. It will be hours to get a signal and months to get contact again.
- Fred Sharpe:** These humpback whales they've essentially had the ocean internet for millions of years. So the humpback just made a perfect animal, a perfect organism, a perfect system.
- Tavia Gilbert:** Because he'd spent his career studying humpback whales, the perfect

system to explore in relation to Dr. Doyle's work, Dr. Sharpe could easily see the analogy between whale song and extraterrestrial conversation:

Fred Sharpe: It's almost like a multiverse hypothesis really. You have these song innovations that ripple across the Pacific Ocean that are picked up by non-interacting humpback whale groups. And so it's remarkable to have these cultural themes that come on down from high and are incorporated in and then passed on through across the Pacific. It may take a couple of years for the song innovations to move across the Pacific and that is absolutely remarkable and that suggests a global communication system. For an individual to respond to that it may take days or weeks to get over there, and that's the same challenge that we have with interstellar communication is that we're you know have light and signals raining down upon us, right. But for us to respond to those it would take lifetimes, you know, centuries, millennia, to actually travel or even longer to get to these sites and so whales are probably also making this, having to make this decision about what's actionable intelligence and how quickly can I get there.

Tavia Gilbert: Humpback whales gave both these scientists their dream species to study:

Laurance Doyle: Especially for SETI purposes — we wanted to go to a larger species that has a global communication system that also has not been influenced by humans, hopefully.

Fred Sharpe: Humpbacks are extremely loud, and they have an extremely complex acoustic vocalization. And then you look under the hood at their brain, at the processor, it's magnificent. Their brains are laced with spindle neurons and in humans spindle neurons are associated with language acquisition, social intelligence, facial recognition, and compassion. So the ability for other worldly beings with the humpback whale was absolutely marvelous.

Tavia Gilbert: So how did Dr. Doyle propose to study humpback whale song? He was going to apply to whale vocalizations one of his unique areas of expertise. He told Dr. Sharpe:

Laurance Doyle: What we want to do is quantify the degree of complexity in non-human communications systems. And we can do that with information theory. Information theory was not connected to animal communications before recently. That's the other advantage is the mix and match of fields. You need a multidisciplinary approach in order to answer deep questions.

Tavia Gilbert: Dr. Sharpe quickly got up to speed about what information theory would bring to their multidisciplinary approach — they would be measuring what was consistent in the whale song across time and space:

Fred Sharpe: Information theory will help us understand the complexity of these signals. It will tell us how many whoops, how many throps, how many shrieks are being given. We want to start to look for rules of communications for certain patterns that are consistent.

Tavia Gilbert: Was Dr. Doyle claiming that if he could listen closely to whale song through the perspective of information theory, he could actually translate those whoops and throps and shrieks?

Laurance Doyle: No. Information theory itself does not do meaning, it does complexity. In other words, does humpback have a complexity and rule structure to allow a translation of something written in human into humpback given common symbols. You couldn't answer the question, what are the humpback whales saying with information theory yet.

Tavia Gilbert: Even if his observations of Dr. Sharpe's whales wouldn't allow Dr. Doyle to translate whale vocalization into a human language yet, it was a vital step in progress toward someday understanding extraterrestrial communication.

Laurance Doyle: In order to make progress with the communication systems of complex animals, I think we have to start to recognize that they're capable of symbolic communication. So In other words there's an in-between step that's required before understanding, you have to understand what the signal units are, and you have to understand the

signaling unit's relationship to each other.

Tavia Gilbert: Dr. Sharpe knew the perfect humpback whale behavior for Dr. Doyle to observe in order for him to begin to learn about the whales' communication rules structure, or signal units. So Dr. Sharpe and Dr. Doyle went out to do watery field research — observing one of the most fascinating and complex humpback whale pod behaviors: their use of tools. That's right — whales don't just communicate, they use sound and a tool called a bubble net to work together to hunt herring.

Fred Sharpe: With these humpback whales we see this very unique use of sound in the ocean. The feeding calls are an interspecies herding cry. We see them team hunting, using these bubble tools and in a co-operative communal fashion. If there ever was a system where complex information can be exchanged, it's with these bubble netting teams. Certainly these social sounds — they're very complex and the amount of surface area for them to encode information is huge. These are highly important sounds. They could each be their own sort of symbol or glyph. And they had lots of information. And that's why working with the SETI to help decipher these signals is really exciting.

Tavia Gilbert: Dr. Doyle was excited by the spectacle and signals of a bubble net.

Laurance Doyle: One whale starts to blow bubbles in a cylindrical orientation and as the bubbles rise the herring get herded in by the other individuals at the bottom of the cylinder and the herring can't escape because bubbles are pretty good size and they drop so they of course they're freaked out by that and then the humpback whales come underneath and make vocalizations that scare the herring to the surface and on the surface it looks like about a 100 foot diameter bubble ring rising to the surface pretty soon fish come flying out and immediately followed by all these big mouths open. So the whole process is repeated about every 20 minutes.

Tavia Gilbert: And the whales use sound to communicate with each other, to create and coordinate the bubble net.

Fred Sharpe: They can bubble net without making any sound except for the pulsed

herding cries. They force the fish up from the darker, deeper layers, up towards the surface where they normally would avoid. They can do this for hours, pound away at these fish schools, screaming, flying up through the water, these fish schools trying to get away from these whales. And all of a sudden to be trapped against the surface and within the confines of the bubble net, so it is a terrifying interspecies trumpet of doom. So they can be engaged in very sophisticated activity silently, but other times they're just making a racket.

WHALE SOUNDS

Tavia Gilbert: Dr. Doyle was fascinated by the whales' communication coordination.

Laurance Doyle: Humpback whales communication system: We can measure the complexity but it's definitely non-human. I hesitate to use the word syntax without quotes because humpback whales are communicating on their own and we don't really fully understand exactly what and how they for example can generate a bubble net and heard herring into it in a coordinated effort, but they somehow get all the ideas across. As far as we know humpback whales don't make democratic decisions but they do make decisions based on ability.

Fred Sharpe: So it shows that they're very good at planning for the future, anticipating events, and accommodating each other.

Tavia Gilbert: All these revelations solidified Dr. Doyle's hunch that these marine mammals could bring aliens an unfathomable distance away into greater focus, because:

Laurance Doyle: To have an extraterrestrial intelligence, you have to have astronomy, you have to have a communication system that's complex enough, and you have to have tools.

Tavia Gilbert: And Dr. Doyle had just learned that whales had two of the three.

Laurance Doyle: They have the requirement of a complex society communications system and they have tool use. And if it turns out that they use stars to navigate it all that would be the big three. I'm not saying they'll build

the radio telescope of course but they are a good example of a species that would fulfill the three requirements of an extraterrestrial intelligent technology.

Tavia Gilbert: He was also learning something more about whales from observing their bubble nets: not just what made them like alien intelligences, but what made them...like human beings.

Laurance Doyle: The bubble netting groups are not related to each other. So they form long lasting relationships based on fishing ability and we know humans form long lasting relationships based on ability and profession. But as far as we know no other species does that beside humpback whales. So we may have more in common socially with humpback whales than we know.

Tavia Gilbert: Dr. Sharpe shared Dr. Doyle's interpretation of whales' surprising similarity to humans, and their willingness to work collaboratively outside their own birth family.

Fred Sharpe: There is a bizarre co-evolutionary convergence between humpback whales and humans. They are extremely vocally complex. We both vocalize in the same central frequency range, both have language like sounds that are given. These bubble netting coalitions. I mean they're like a food co-op. I mean they came up with the food co-operative idea probably millions of years ago, open membership, they're diverse, in their age and their sex, everybody seems to get in on the action. You know there seems to be this amazingly equalness to their groups. And the fact that these are not relatives. They're just running buddies, they're just friends, they're just partners there. It's a meritocracy.

Tavia Gilbert: And the whales run their food coop with the same membership for an incredibly long period of time:

Fred Sharpe: Some of these bonds are lasting across summers, decades, perhaps even lifetimes for some of these individuals and they don't appear to be kin so they're forming, you can just call them economic bonds, but boy when you watch these whales they sure seem like friendships.

Tavia Gilbert: Dr. Sharpe knows that it's not that great a stretch to use the word friendship in relation to whales.

Fred Sharpe: I mean look at the humpback whale, they're laced with spindle neurons and spindle neurons and we also find them in some of the apes and dolphins and we know that they're sort of like the fire wire of the human mind, language, social intelligence, facial recognition, compassion.

We know that we share a deep common ancestry in the part of the mammalian mind that controls basic emotions as a really ancient you know the same neurotransmitters that coursed through their veins and brain is similar ones to ours. So there's all kinds of reasons to think that these animals live very complex emotional and cognitive lives.

Tavia Gilbert: In fact, humpback whales are not only reknown for their singing and their long sustained relationships, they're widely known as deeply compassionate animals.

Fred Sharpe: Humans do not have the market cornered on compassion.⁹⁴ Research has been really amazing to show us how incredibly compassionate these humpback whales are. Humpback whales have this very unusual compassionate habit to run towards individuals that are distressed. A recent paper was published documenting over a hundred incidences of humpback whales coming to the aid of other species. This includes their own calves, gray whale calves, dolphins, sea lions, seals, even ocean sunfish, that they'll come to the rescue, when they're in distress. And it's like, these humpback, it's like firemen running to a burning building. They just charge over to render assistance.

Tavia Gilbert: The fact that humpbacks are cooperative, compassionate, and protective was surely interesting to discover. But what did those virtues have to do with extraterrestrial intelligence? Dr. Doyle has an idea:

Laurance Doyle: If any extraterrestrial civilization has gotten it together enough to do space travel it seems like they would have gotten it together enough

not to be warlike or quibble with each other.

Tavia Gilbert: So, maybe we need virtues like compassion or cooperation — or maybe our species can't sustain itself long enough to accomplish more space exploration — or survival — without them. And maybe we naturally want to communicate with other life forms, even if they're outside of our species (or solar system). Something happened that made the scientist duo think that maybe the fact that humpbacks are human-like in their emotional lives already made them want to get to know us better...by communicating directly with us. During that ocean field trip, the doctors actually experienced the real possibility that the whales were, in fact, reaching out to the humans on the boat above.

Laurance Doyle: Well it's, when you try and talk underwater when you're in the swimming pool or something, (SOUNDS) it was what we sounded like talking in the boat to the humpback whales, and they were trying to not mimic us, they were making noises within our frequency range, maybe just an imitation, but maybe in an attempt to get our attention, I don't know. All I know is that uh, it blew us away.

Fred Sharpe: It's hard not to put all kinds of emotion and thoughts into these sounds because they're so complex and marvelous. 99 That is other worldly. I mean, that's incredible right.

Tavia Gilbert: That experience was astonishing, moving, unforgettable. But could what happened that day be applied to Dr. Doyle's research? And did they really think that the whales behavior indicated they were really trying to communicate?

Laurance Doyle: I would say that, I think I need to be a little bit more cautious as far as animal behaviors go, but yeah, it sounds to me, they're not going yee-- or out of our range of hearing or anything, they're, and also the waa-- waa-- sounds like the tempo that humans speak at. And the frequency that humans speak at, and as far as I know that was the first time that ever happened. If we got anything like that with a SETI signal, we'd say that's it.

Tavia Gilbert: Whether or not the whales were actually making an effort to converse

with the researchers, the collaboration between the two scientists to study whale song and its insights into alien intelligences was off to a successful start.

Fred Sharpe: It was a brilliant match of theory and going into the field and being able to test it.

Tavia Gilbert: The doctors knew how to record with a hydrophone the huge amount of information the vocalizations of whales forming a bubble net were transmitting. And Dr. Doyle knew he could only speculate what the purpose of the whales' communications was the day he and Dr. Sharpe heard them vocalizing in the human frequency range — maybe it was an imitation, maybe it was not. The purpose of vocalizations, though, was the central question in his work researching extraterrestrial communication.

Laurance Doyle: By knowing the purpose of the communication and how much information was transmitted you can actually begin to quantify meaning.

Tavia Gilbert: Dr. Sharpe was looking for meaning, as well, and he was learning as much from Dr. Doyle's SETI research, as Dr. Doyle was learning from the whales.

Fred Sharpe: In some of these astrophysical signals that are raining down, there could be real structural relationships in there that have greater meaning than we have yet been able to decipher, and by looking at the multitude of natural experiments here on earth, and then applying it to our search algorithms and filters in deep space, I think we're going to be a lot more informed.

Tavia Gilbert: Both men wanted to be informed, yes. But were they truly convinced of life in outer space?

Laurance Doyle: If I wanted to be honest about what I think they could be and give credibility to everything's been checked out, there's no secret Air Force satellite or anything. We may have intercepted something like that.

Fred Sharpe: I think it was the song of the humpback whale that made us realize that there are other worldly beings right here in our oceans. I don't feel

alone at all with the splendor and the beauty and diversity of life on earth. Now is there life out there in the universe yes, there most likely is, and will we someday be able to have a conversation with them? I think through these collaborative ventures, between people in the animal sciences and SETI I think will get closer to this wonderful and perplexing question.

Tavia Gilbert: Both researchers' curiosity about whale communication had positioned them to ask the questions that might lead them to make breakthrough discoveries; their openness to diverse intelligences beyond human intelligence structures, was deepening their work and their thinking.

Laurance Doyle: We haven't mastered what exactly human intelligence is. So I think a lot of effort's been put into that. But the extension to animals of the usual measures of intelligence seemed like a natural thing to do. But it's time to outgrow that because it has generally limited our perception of how really intelligent and complex other species are.

And so I think this is a breakthrough concept. The reason that we should go to and include other species in the SETI concept is that there are different structures in a communication system than just the way humans have structured things. And I think that we could miss a signal if it was structured in such a way that we would have analyzed it as a human language instead of as a non-human communications system.

Tavia Gilbert: Dr. Sharpe agrees.

Fred Sharpe: Different types of intelligence, different ways of communication I think can be hugely informative for the SETI search. And intelligence can take countless forms.

Laurance Doyle: Diverse intelligence, I warmed up to that term right away because to me the first impression of that title was to deprovincialize our thinking about intelligence. In other words, recognize that intelligence can express itself in distinctly non-human ways.

Tavia Gilbert: What does Dr. Doyle mean when he says that thinking about diverse intelligences, or the search for alien intelligence, “deprovincializes thinking”?

Laurance Doyle: Provincial thinking basically does permutations on the existing data instead of original thought. So deprovincialized thought means ok, we're getting completely out of ourselves working with non-humans and coming up with a truly original way of approaching a problem. Deprovincialization of thought is one of the great things that SETI's contributing.

Tavia Gilbert: But that practice of getting out of ourselves isn't just a great way of thinking as a scientist. It's a great way of thinking about the human soul and the relationship humans have with our own ecosystem.

Laurance Doyle: I think the effort itself deprovincializes our thought about ourselves. It's very educational to think of extraterrestrials and their environments. And I think SETI is one of those things that deprovincializes thought. It gets you thinking big. Let's face it. It's putting us in perspective. When we do that picture of the astronomers staring up at the sky and saying are we alone. Two things strike me, one is that we need to pay attention to the non-human communication systems here for practice. But the other thing is as we look up and say are we alone, we're asking what is the context in which humans have built a space faring technology and where do we fit in. It's kind of like we went to the moon in Apollo 8, got that picture of the earth, and that really sparked the ecological movement. Hey this is a spaceship we're riding first class and we need to take care of it.

Tavia Gilbert: Dr. Sharpe agrees that looking at diverse intelligences is not only inspiring, it's important, and it leads him to consider what that teaches him about the kinds of intelligences that might travel by star.

Fred Sharpe: I guess what has been so remarkable is that these whales have evolved these incredible social institutions and complex vocalizations without technology. And it shows you that there are exoplanets that are drifting around in the cosmos, they can be full of intelligent life that is not transmitting its presence. The more examples that we have here

from our beautiful planet, we have thousands, hundreds of thousands, probably millions examples of evolved communications systems. And it's kind of best to understand what you have in your own backyard as you're looking up into the cosmos.

Tavia Gilbert: Study with Dr. Doyle certainly didn't turn Dr. Sharpe into a conservationist — his life's work is evidence that he has always been — but it has enriched his perspective on Planet Earth as a space ship that needs protecting, like whales need protecting:

Fred Sharpe: Oh my goodness we're just a little beautiful orb floating out here in the middle of the oceans. And it's up to the next generation of innovative astrobiologists to figure out how we're going to protect this life.

Tavia Gilbert: Dr. Doyle believes that hearing whale song and star song — receiving any message that, as he said, deprovincializes thought — is galvanizing.

Laurance Doyle: Just hearing them, kind of wakes you up to the non-human world. Hearing a non-human intelligent communication, it wakes you up. So I think it has that effect on people I mean in a way that just talking head or a lecture doesn't do. When I give this talk and I play these. People wake up.

Tavia Gilbert: What's Dr. Doyle's hope for this research partnership? Is making contact with an extraterrestrial technology for the sake of accomplishing something extraordinary his only aim? Or is there some higher purpose in his work? What does he think could happen if he achieves what he's worked for decades to achieve?

Laurance Doyle: Well you know if we contact honest to goodness extraterrestrial intelligence technology, I think people's thinking will shift to halfway between them and us. I think we'll begin to look at the Earth more as a spaceship and take better care of it I hope. It will challenge a lot of philosophy and a lot of religion and that will enable us to put ourselves in perspective for the first time in the history of life on Earth. I think it's good for us. It's humbling but humbleness is good for us.

Tavia Gilbert: We are so close to the stars, to extraterrestrial life, every moment,

because we are made up of stardust. You may have heard that before. But did you know that our oceans were formed when Jupiter stirred up the comet clouds where water condenses and threw them into the inner solar systems? Dr. Doyle puts it this way:

Laurance Doyle: So our ocean is probably forty thousand comets. So you say to yourself, that's a showstopper.

Tavia Gilbert: What a gorgeous concept, and one that leaves me feeling simultaneously infinitesimally small, and less lonely. Our connection with our solar system feels indeed humbling, and it's a call to action: We cannot, should not live disconnected from or disinterested in our own home. The value in Dr. Doyle and Dr. Sharpe's work, then, is not just that it's exciting or interesting, but it reflects on a grand scale the value of seeking to learn another language — the language of various intelligences, rather than just own species' grammar. Deprovincializing our thinking can keep us humble and inspire us to care better for our Planet Earth spaceship, and, perhaps most importantly, deepen our appreciation for the virtues shared across species on earth or in the cosmos, which may help us evolve, or, even more essentially, survive.

Tavia Gilbert: We're excited for our next story in the Diverse Intelligences season. We'll return next week with a conversation with Andrew Barron, whose special focus is research into the honeybee brain.

Andrew Barron: So if we can model the bee brain, we can take insights from those models and translate them directly into technological applications. If we can model the bee brain, all of this intelligence, all this dynamic autonomous behavior that we get out of bees, we should be able to capture that in the model. There'll be things that we can learn from that that we could translate into robotics.

Tavia Gilbert: We look forward to bringing you more from that conversation next week. In the meantime, we hope you enjoyed today's Story of Impact, and that you're looking forward to hearing more about honeybees, dogs, AI, and more. If you liked this episode, we'd be grateful if you would take a moment to subscribe, rate and review us on Apple podcasts. Your support helps us reach new audiences. And for more stories and videos, please visit storiesofimpact.org.

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The Stories of Impact podcast is generously supported by Templeton World Charity Foundation.