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**Sarah Beck:** You're listening to Garden Futurist. I'm Sarah Beck, here with Adriana López-Villalobos. Hi, Adriana.

**Adriana López-Villalobos:** Hi Sarah.

**Sarah Beck:** So, Adriana, our topic today is fascinating and it's probably the first time we have included the work of a philosopher and discussed Diversity, Equity, and Inclusion. What can you say about this?

**Adriana López-Villalobos:** I also found this conversation fascinating, because it's not only about plants—yeah, it is about plants, but it's plants intertwined with our cultural viewpoints. I think it provides a nice comprehensive perspective of how we think about ecosystems and the species that live in them.

**Sarah Beck:** Should we give a disclaimer? This conversation gets into some loaded words that don't feel comfortable, and this is because there's historical language associated with invasive plant biology that really is hard to reckon with.

This conversation is in some ways about human language and really culture and there is a positive story to be found here with respect for Indigenous cultures and relationships with nature.

**Adriana López-Villalobos:** Yeah, it's about definitions. And definitely, a more culturally inclusive viewpoint might actually be the key to some solutions to caring for our natural environment.

**Sarah Beck:** Our guest and her multi-disciplinary team have taken a unique approach that takes into account language and cultural context around how plants in complex ecosystems can be managed



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We are going to hear from Dr Susan Cordell, Director and Research Ecologist with the US Forest Service. She's at the Pacific Southwest Research Station in Hilo, Hawai'i, on the Big Island.

"In many parts of the world, we cannot uncouple the fact that humans and natural systems are linked and that pristine landscapes are often, in fact, a mirage."

This quote is from a paper that you authored that was published recently in *Frontiers of Ecology and Evolution*, and something that is noticeable right away is that this essay gets very quickly into talking about the language we use when we talk about nature. In fact, something that I was really excited to see is that you have a philosopher among your authors.

So let's get right to this idea. The conversation about native plants, non-native, or if we're saying invasive plants, I think this is so much at the core of this conversation that I want to make sure that we're really defining our terms.

So if you don't mind, can we start with a definition of what we're talking about when we talk about native, non-native, or invasive plants?

**Susan Cordell:** Yeah, sure. And this is a question that a lot of people get confused by, because it does get into the weeds, per se.

So when we talk about native species, we can even break those down into two categories. The first category I would break it down to is what we call endemic, and those are species that arrive and evolved in a location to the point where they exist nowhere else but that location. So a place like Hawai'i, where I'm coming from, we have 90 percent endemism in our plant species. So it's pretty amazing.



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There's also a native category called indigenous. And what indigenous species are, are species that also arrived here on their own, like the endemic species, but they also exist in other places. So sometimes you get these pantropical species, if you travel around the world, you say, "Oh, I know that species," and you probably do because it is the same species.

And then when you get into the non-native, there's also several categories that people often refer to. And one of those non-native categories would be called noninvasive. What that is, is a plant that got somewhere with the help of something rather than on its own. So it arrived but it doesn't seem to cause problems. It may not even survive. Many non-native, noninvasive plants don't even really perpetuate in the ecosystem and they don't tend to become invasive, meaning they don't spread everywhere or cause harm.

And then you get in the invasive category. What those are, are species that come in and they disrupt the ecosystem in ways that are harmful for plants and animals and even humans, to an extent.

Then in Hawai'i, and likely other places too, we also have another category that's non-native that we refer to as canoe plants. And these are plants that the Polynesians brought on their canoes that they required to sustain life in their former communities. So these are plants that often had high utility for food or fiber or cultural practices. We call them canoe plants, so they have their own category.

**Sarah Beck:** Wow.

**Susan Cordell:** And what's really interesting is that very few, if any, to my knowledge of these species have become invasive. So they continue to be a really important component of plant communities here in Hawai'i.



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**Sarah Beck:** I'd like to get more into that in a few minutes, this idea of cultural relationships to plants, because I realize there's so many facets to this conversation.

Talking about a little bit of historical context, something I found very striking in this essay, was the description of historic language being militaristic, and this idea that invasive species biology, and I'm starting to realize that, when we use this term invasive, it's kind of a loaded word.

So, I'm curious if you could describe within this historical context, what it means that militaristic language has been used in terms of invasive species biology?

**Susan Cordell:** Yeah, sure. A lot of this I learned when researching this paper. So working with a philosopher was really wonderful. And we need to do that more, I think multidisciplinary approaches to issues and problems can really open our eyes.

And so I'd really like to acknowledge my colleagues, Dr. Becky Ostertag and Dr. Celia Bardwell-Jones from the University of Hawai'i at Hilo. I've been working with Becky for over 25 years on a lot of these ideas. And then my colleague, Amanda Uowolo here at the Forest Service. And Nicole DiManno, who has worked with us forever on our restoration projects, who's at Oregon State University.

My eyes opened at the same time as some of the readers opened to a lot of these concepts. This was one of them and I never thought about it until I started looking into it.

But the idea, when you look at the research, comes from a paper that was a seminal paper in invasive ecology, and it was done in 1958 by Charles Elton. He was coming off of dealing with the impacts of World



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War II and plant and animal species that were brought in were impacting the economy, the British economy, and food supply. So it probably derives because it is associated with World War II and similar terminology of something coming in and taking over is almost war-like.

So it's probably where all of that started. That's where we first see it in the language. I think it just stuck and people didn't really think much about it.

**Sarah Beck:** So the language had this sort of negative undertone, how does that play out? When we hear these words, do we actually treat a plant differently because we have this very negative impression of how we describe it?

**Susan Cordell:** Oh, definitely. Definitely. My training, and I'm going to date myself here, but my training was in the '80s, in my first view of ecology and learning about species assembly and conservation.

In all of the readings and all of the lectures that I heard during that time, the conservation movement really felt that we needed to protect ecosystems and that no humans could be in them, that they were only valuable in the absence of human pressure and the concept of invasive species, then, really quickly became a native plant is good and an invasive or non-native plant is bad.

It just starts from there that you form these opinions, and you continue to replicate that to everyone you talk to. And I would even find myself talking to tourists because I live in a tourist economy here in Hawai'i and people would talk about how beautiful a plant was.

"Oh, look at the beautiful plant, the flowering plants and the orchids and all of these things." And I would completely just discount them



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and just go, “No, that's a terrible plant. You can't like that plant. It doesn't belong here and it's ruining everything.”

So I would say people educated in conservation in the '80s and '90s really got that viewpoint, even in the 2000s, I would say. And it's really kind of recently where I think people's viewpoints are shifting. And if you look in the scientific literature, you're starting to see a lot of work looking at this concept of native good, non-native bad.

**Sarah Beck:** You point out that in today's context of the dialogue around diversity, equity, and inclusion, this idea of the language of ecology and conservation, particularly biological invasion, you're right. This does feel strangely dated when we use the term alien, exotic. These are words that we would not use about people, and we certainly can start feeling uncomfortable using them about anything.

I'm curious, while these words might make us uncomfortable now, this isn't just about words. This is also about changing perspectives in management of landscapes, this idea of novel systems.

I'm curious if you could provide some examples of how this idea of novel systems, which you mention, can share that a plant might have valuable ecosystem services. Maybe we can start separating away the enemy talk and start thinking of some of these plants at least in a neutral way, if not no longer a militaristic way.

**Susan Cordell:** Yeah, of course. And I think that's exactly what we wanted to do with this paper, is to not pass judgment on plants. They don't deserve that from us.

I also want to make it clear because one of the things I worry about, writing this paper, because I've been in conservation and ecology my



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whole career, and I don't want to come off as someone that is discounting the importance of native biodiversity.

**Sarah Beck:** Right.

And the respect I have for that and the need for it. We need it more than ever in our world to have functioning natural ecosystems. And I really do want to make that clear because there are many cases in many ecosystems around the world where if you just remove a threat, a single threat, whether it's logging or something, that ecosystem can recover on its own. And if a system can do that, I am all for that. We don't need to put in a ton of resources to fix something that can fix itself.

This is important for me to say, because I think there's a lot of pushback in the scientific community when you start going down the line of embracing non-native species. But I do live in a place where the threat of invasive or non-native species is huge. You can't go into an ecosystem that isn't touched by multiple invasive species or non-native species. So we have to think about a new way, moving forward.

And most people don't understand the difference between a native or a non-native forest or a novel forest. What they do understand is if they lose the service that nature provides to them, and that loss can be huge because all of the provisioning services that nature provides to us. It doesn't always matter if it's native or non-native. Sometimes it does, but in many cases, non-native species can provide those resources such as clean water and recreation and carbon sequestration and pollination services that other species, other native species have done.



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So I think people are really starting to look at that because as we're moving into a world where climate change is really impacting us, we do need to think about how other species can benefit us.

So, some of the examples you asked to provide, and Hawai'i has a lot of them and we're starting to see them everywhere, actually. But because we have so many non-native species here, and we have also the highest number of threatened and endangered species in the world here in Hawai'i. A lot of times when an endangered species can benefit from a non-native species, that's its only way of existence into the future.

So for example, there's a native tree in the Solanaceae family, which is the tomato family, that provides food habitat for an endemic and endangered caterpillar. And the tree species is also endangered. So it's a situation where they both require each other, but then a non-native species was brought in, in the same family, and has done really well and provided a similar resource. And now we see this caterpillar expanding its population with this non-native species.

We also have an endangered hawk here on the island of Hawai'i and its normal diet is native birds, but the native birds have declined because of invasive mosquitoes and disease coming into the system. So they have responded positively to all of the increases in rodents and they're doing very well. In fact, they just got taken off the endangered species list.

So, we can start to see that these services can be shared with native and non-native species. Well, now the jury is still out because, it's hard to know if the benefits are exactly the same or as good as the native species might be, but in a way you can say, well, some service is better than no service.





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So I think that's where you need to draw the line, but we do need to be cautious, and we need to always be observing and paying attention to monitor how these interactions are going. And as a scientist, that's fun. That's what we do.

**Sarah Beck:** What's a realistic view of how many species are causing the trouble? If we've got non-native species, a lot of them, not all of them are being harmful. Can you give a sense of which ones are, I'm not going to say bad, which ones are causing trouble?

**Susan Cordell:** I know, we always have to correct our own language now that we've written this paper. So it's actually a small percentage. You would be surprised.

I'll take Hawai'i as an example again. In Hawai'i, there's about 8,000 to 10,000 plant species that have been introduced. And of those, about a 1,000 have been successful enough to have self-sustaining populations. So that's already 10 percent of the 10,000, let's say, and of those 1,000 there's only 90 that are really considered problematic. So I guess it's about 10 percent of 10 percent of the self-sustaining population. So it'd be about 1 percent of the introductions.

**Sarah Beck:** Wow. So all these other introduced, maybe introduced is a good term to use, these non-native plants, what are a lot of them doing? They're hanging around, maybe being fairly unsuccessful?

**Susan Cordell:** Yeah. Yeah. I mean, it's a hard life. You come to a volcanic island and you have to deal with very little soil and it's hard to make a go at it. And so to be successful, you have to have the right set of traits and then you also need your pollinators and the other things that require it to maintain its life cycle.



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**Sarah Beck:** I love how you share what you call a place-based approach. This idea that there are solutions or this moderate space that you're entering saying, okay, here's perhaps a nonjudgmental way to look at some of these circumstances that are the right circumstances to consider, "Okay, are these plants causing trouble? Is this a novel situation where the species interactions are good?"

And you have this graph that you share in the essay, which I think is cool. It's sort of a weight scale image. And you show things like non-native species could be evaluated on these various aspects of how they play with others. Can you describe what your approach was, just how do you make sure your share using an equitable view?

**Susan Cordell:** Yeah, sure. We have put a lot of thought into this, most of the colleagues that are coauthors on this paper have been discussing these ideas for a long time, because we've tried to work in these lowland wet systems, and we've tried to restore them, and we have had no luck at all.

And we finally found that the only way we were going to have luck is either we are just going to garden these small patches to promote the native biodiversity, or we needed to find a hybrid system where maybe we could use other species to help serve a function to help promote native biodiversity.

So we really went back and forth on all of these different theories and approaches of community assembly and thinking about that and all of our ecology training. And we had a postdoc working with us at the time and she really summed it up—and I'm going to use her analogy because I thought it was so brilliant—to fantasy football.

Now I don't really know fantasy football. So some of your listeners may laugh at my interpretation of it. But you want the big blockers, right?



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And you want the fast quarterbacks, and you want all of the different components and traits that you want of humans so that you find this perfect team. And so we started thinking about these combinations of plants that could work together and help each other in this same way.

So the way we did this, and we all have some training in it, is we use biological metrics, what we call functional traits. And these are traits that plants have that allow them to utilize resources like nutrients and water, and plants have many, many different strategies, and many, many different functional traits.

So we thought maybe we could have a combination of species that grow really fast together with species that are slow growing and sequester carbon slow. Some that can use nitrogen quickly, others that decompose slowly. Big leaves, small leaves, shade tolerant, deep rooted, shallow rooted, so that you're partitioning the resources in the system so that many things can work together rather than a system where everything is competing for the same resource.

So this aligns with theories of ecology, of what we call complementarity and redundancy. So complementary systems are systems that have very different functional traits like I mentioned. And so that system tends to be more resilient.

If you look at the literature about that higher biodiversity can exist when they have complimentary traits. We thought, how can we combine these things and create our fantasy plant team to help with our goals? And our goals were to promote native biodiversity and to reduce the likelihood of aggressive species in our systems so that they're more resilient and can perpetuate on their own.

So that's where this idea came from where we promoted these hybrid ecosystems. And we set up an experiment to test that, and we're still



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monitoring that experiment. It's over a decade old. It really started affecting our thoughts about how these novel systems work and how we can evaluate plants. Not saying they're good or bad but that some play better together than others.

**Sarah Beck:** This really goes back to this original quote that I read earlier about this idea that pristine landscapes are perhaps a mirage. I'm curious if you could elaborate on this idea because human involvement seems to be where we are. At least, there may be patches of the world that are still wild. I think when we talk about the Pacific region, we are living in places that have been human managed for an enormous amount of time. In some cases, as long as humans have been in these places.

So you're analyzing all of the parts that it's almost like a recipe, it's interesting. It's like all here are all the pieces that, "We need a little bit of this, a little bit of that. We don't want something that's going to overpower everything." It's a really interesting view.

You just mentioned the human relationship and I'd love to hear you talk more about how that, because clearly there are cultural relationships people have to plants, and that's yet another layer.

**Susan Cordell:** Yeah, I love your recipe analogy. I'm going to use that one if that's okay.

**Sarah Beck:** I like the fantasy football too.

**Susan Cordell:** Okay, we can both share.

**Sarah Beck:** Yeah, the super team is fun.



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**Susan Cordell:** Yeah. The more you read in the literature and there's a lot of new studies coming out now that many forests that people thought were pristine have had a human footprint, including the Amazon and other areas, where we just assume that these were untouched areas, but actually have been managed for utility by humans forever, and have been shaped by that.

And Hawai'i is definitely a case where that has happened, and many Indigenous cultures around the world. Humans aren't separate from nature. Humans are part of nature and the whole concept in Hawai'i called *Aloha ʻĀina*, it translates to a love of the land or taking care of the land that nourishes you.

There's probably many different forms of cultural rules that people had to follow to manage these functioning forests. And we can learn a lot from that. We really, really can. And I think people are starting to do that.

So, in modern times we have a similar relationship with nature. It's different than the past, because most of us don't make the connection between food and fiber with forest, even though it's there, we just don't see the production line. But do need to have nature for beauty and awe and inspiration. So we have maybe different values that we associate it with, but nonetheless, equally important.

**Sarah Beck:** So that's part of the recipe, right? This idea that the human is part of the system. Maybe this does bring us back to this idea of diversity and allowing inclusion, we're all part of it. That's really cool.

If you don't mind, let's turn to gardeners and individuals just thinking about how these bigger ideas apply. For those of us who are really interested in stewardship of our landscapes, what do you think is a



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takeaway for those of us who are, just as an individual, thinking about being a participant and gardening?

**Susan Cordell:** I think gardeners even might even have a leg up because they're already putting things together that either they like or want or they want to eat, or they want to look at, or they want to see the butterflies that come to pollinate it. And so there's already that idea that you have this image or this perspective of what you want to see in your garden. And so you're already making decisions. If something comes in and takes away all those, you're going to work hard to make it go back to what you want.

So that's the ultimate place-based approach, is a gardener. And I think maximizing complementarity in a system like I talked about earlier is always a good goal. I think if you can put things together that utilize resources differently, you can really extend the resources that you have.

I think, based on ecological principles, the more resources you have and the more diversity you have in a system, whether it's native or non-native, it's going to increase the resilience, of your resource and your place. So I think gardeners inherently do that, maybe not without knowing that it's utilizing scientific principles, but it seems to be reflective.

Being a gardener myself, I have a sense of peace and awe and beauty when I go out to my garden, because it has the things I really like in it, and then also provides me food and it feels so good to have all of those things come from something that I can do with my hands.

One thing that is very sad in Hawai'i is the loss of species, and the prediction of future loss and those stories can't be replaced, of the importance of these plants and their connections. And some endangered species are really hard to recover, but others actually, you



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just remove the threat that took them to extinction or to the, the level that they're at, and they do fine. Some of them actually can grow like weeds.

And so I'm really a proponent of gardeners and practitioners and educators, and even working with obscure, agencies that we don't normally work with as scientists, like Department of Transportation, and incorporating these endangered species into our plantings, so that we can broaden the awareness to more people and plant them in school yards and help perpetuate the survival of these species.

So I think that's another way that gardeners can really help with this, in terms of taking care of the biodiversity that we're losing.

**Sarah Beck:** You're absolutely right. That's a real opportunity. It is interesting to think maybe there are some ways we can socially and culturally come to terms with some of these losses by reconnecting to nature, reconnecting to these plants.

**Susan Cordell:** Yeah. I really like that.

**Sarah Beck:** We have these social changes that are happening right now, I think there's such an awareness around social issues, access to land, access to plants and green space in urban settings. I think we're reaching a much more sophisticated set of conversations about the social existence humans have.

**Susan Cordell:** Yeah, I hope so, and it's great. It's wonderful to see this, but we also need to do this for the natural world because novel ecosystems for most of us is all we're ever going to see. Very few of us have the ability to get out to these vast, wild places.



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And so we need to derive the benefits from plants right in our backyards or in our communities.

**Sarah Beck:** Adriana, this is really a data love thing. I really like how Susan shared some real numbers about how many species of non-native plants are actually causing problems. Not every plant from another place is “bad” or capable of causing trouble.

I mean, we have to find ways to live with the situation we’re in and be selective about our resource use, and yes, sometimes that might mean removing a plant that is a serious problem and focusing in on that. But there’s this whole array of other plants that might be playing a positive role or might not be doing much at all.

In that sense, it’s about selecting the components that contribute to, again, this novel ecosystem idea. There might be some kind of balance to be found.

**Adriana López-Villalobos:** It’s like a new ecosystem forming in real time.

**Sarah Beck:** Wow.

**Adriana López-Villalobos:** This data-driven science interpretation also lends this more equitable view—it takes some of the “alien species” and other poisonous sounding language out of the conversation.

**Sarah Beck:** It really does. It is important, though, for us to recognize that we have talked to a lot of scientists that don’t like this idea of novel ecosystems. This idea of a pragmatic approach—what Susan’s team calls a site-specific process and index of species belongingness, this place-based method of determining viability of non-native plants—this is not an idea that’s shared by everyone in the field.





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**Adriana López-Villalobos:** Yeah, it also takes time, right? Like with any new theory or idea, it takes time to build some of the empirical evidence needed to be accepted widely. But we are in an unprecedented time and there is room for new ideas and theories.

**Sarah Beck:** I can't tell you how often people have said that. I've heard a lot of scientists say, "What we're experiencing isn't what they taught me in the '80s, in the '90s." Someone who is expecting the climate to maintain the same set of rules, it's just not applying.

**Adriana López-Villalobos:** Somewhere in between, perhaps?

**Sarah Beck:** Yeah, it's like a spectrum, right? I think an ecologist who really dislikes this idea of a novel ecosystem, maybe they're willing to make certain practical decisions but someone who more deeply embraces it, maybe it's because they're in an environment like the one Susan is in.

I wonder, thinking as garden futurists, knowing that islands are already extremely vulnerable places—with pressures and extreme climate chaos and this complex blend of non-endemic plants—are we seeing the future, possibly even of the West Coast, through time machine goggles when we look at Hawai'i?

**Adriana López-Villalobos:** I also like to think as a futurist, but the truth is that I don't think we have the right answers or solutions yet. What we do have is theory and empirical evidence, and then we have islands, like Hawai'i, which have served as model systems for understanding ecological and evolutionary processes.

What you see in other islands in the Pacific or even in Asia that are getting flooded or people are being displaced, extinction rates are



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highest, these are where we should put all the emphasis now on understanding what's going on.

Perhaps we are just witnessing an experiment in real time, which can allow us to glance into the future.