Nate Hagens (00:00:02):

You're listening to The Great Simplification with Nate Hagens, that's me. On this show, we try to explore and simplify what's happening with energy, the economy, the environment, and our society. Together with scientists, experts, and leaders, this show is about understanding the bird's eye view of how everything fits together, where we go from here, and what we can do about it, as a society and as individuals.

Nate Hagens (00:00:34):

Gerardo Ceballos is a well known ecologist and conservationist working on animal population ecology. He is world renowned for his influential work on global patterns of distribution of diversity, and extinction risk in vertebrates. Gerardo and I have a wide ranging discussion about animal populations, the 6th Mass Extinction, his new project called Creatures United, and how we can better care about and protect Earth's remaining biodiversity. This conversation got kind of intense at times, well, because the subject matter is so important, what's happening is so tragic and is so little regarded in our national discourse. I hope you listen and learn from my conversation with Professor Gerardo Ceballos, and perhaps it will change how you think about the natural world in some small way.

Nate Hagens (00:01:41):

Okay my friend, we have a lot to talk about. You have written numerous books and are a very heavily cited ecologist. Your books range from mammals of Mexico to the annihilation of nature, and we're going to talk a lot about this. But first I would ask you, how did you first get interested, personally, in studying animals and animal populations?

Gerardo Ceballos (00:02:06):

Well, as far as I know, my parents say that since I was very, very little, I used to say that I was going to study animals. I didn't know that it was biology, but then when I was like 12, 13 years old, I got a book, they were tiny books, and I got one it's called The Last Eskimo. And it was the story of the Eskimo curlew, who was once the most abundant species on the planet, and it was a novel written in 1954 and basically talks about the last two curlews who will be flying from Patagonia in Argentina to the Arctic. And one was killed, the female, and the male continued to fly. It was one of the longest migrations in the planet. And he spent the whole summer singing for females and nobody shows up.

Gerardo Ceballos (00:02:58):

And I got full of anxiety thinking that I could go to the streets in my city and another city, another city, without finding another human being. And at that point I decided that what I wanted to do is to save species from extinction. And then, at high school, one of my teachers taught me that it was ecology and so on. But basically that was the origin of my interest in extinction and animals.

Nate Hagens (00:03:25):

So you started with your heart, and then your head followed.

Gerardo Ceballos (00:03:28):

That's exactly right. And I think, still, a lot of what I do is from my heart, and then I just frame it in terms of the science to be able to make it available to everybody.

Nate Hagens (00:03:41):

Okay. So Gerardo, today, how many species exist on earth other than humans? And how do we know this?

Gerardo Ceballos (00:03:49):

Well, that's a very interesting question. We know, so far, that around two million species have been described since 1758 when Linnaeus created systems for classifying animals and plants and organisms on the planet. But what is very, very interesting is that the estimates, the current estimates of how many species are in the planet range from 50 million to several billions. But it would take the most conservative thing that we estimate that there are around 50 million species of plants, animals, and microorganisms in the planet, and we have described only two million. It means that most of all the biodiversity in the planet is unknown to science.

Gerardo Ceballos (00:04:39):

And this is not surprising though, then that every year more than 18,000 species are scientifically described. And in terms of mammals, there are not only rodents or small animals that include big animals like whales. Last year, two new whales were found in the waters of the US and Mexico. And since 2000, more than 80 species of monkeys have been described. In 2017, a whole new species of orangutan was found in Sumatra. So the wealth of the biodiversity in the planet is really unbelievable, it's amazing, and what is unfortunate is most of the species are unknown to us.

Nate Hagens (00:05:24):

It almost feels paradoxical that soon after discovering some of these species, they might go extinct in some of these cases.

Gerardo Ceballos (00:05:34):

In many cases, for instance one of the most interesting stories is that the Steller's sea cow, it was described 27 years after it was found in the 1700s in the Bering islands, and it was found actually by the Bering expedition to Alaska and this area in Russia and they collect it, and after it become extinct it was described. And there are species like the saola that is the largest, at 100 kilograms, 250 pounds, animal until a like animal who was described in Vietnam in 2006, something like that. And it is most likely extinct to now. So many of those species are at the brink of extinction when they are discovered by science.

Nate Hagens (00:06:25):

So I don't think you can definitively answer this, but the number of species alive today as a conservation biologist, how would you estimate that versus 10,000 years ago, or even longer ago than that, the same, more or less?

Gerardo Ceballos (00:06:42):

Well, the most important part of this is right now, we have the highest number of species in the last 700 million years in the planet. We are in a pinnacle of a species diversity, and this is well established because we know how many species has been accumulated. And remember an evolution is a trade off between extinction and speciation. And basically during normal times, there are more species evolving than species becoming extinct. And we know now that there are more species than in the last 700 million years. We also know now that unfortunately in the last 10,000 years, we have lost a great deal of species, but also population and also of individuals of those species. We don't know exactly how many, because we don't know how many there are. How can we know how many that have become extinct? But we have good grasp for what has happened in the last, let's say 100 years in terms of what have we lost.

Nate Hagens (00:07:49):

Well, I know most people in the United States, we have this fascination with dinosaurs and Tyrannosaurs Rex, and Brontosaurs, and they lived 70 million years ago. And most people don't realize that North America was a veritable Serengeti like 20,000 years ago, where we had five species of giant cats and

beavers the size of a Volkswagen and wooly mammoths and unbelievable biodiversity, not that long ago.

Gerardo Ceballos (00:08:22):

Well, I mean, this is what we know, the place to see extinction, and the place to see it is the last 2 million years, in the late place to see, let's say 18,000, 20,000, 30,000 years ago, a lot of the species, big species become extinct in the planet. And this is a combination of a couple of things, changes in the climate in the planet. Remember then in the Maximum Glacial, 18,000 years ago, there were around three kilometers of ice on Kansas, just to give us an idea how different was the planet. But at that time, when humans start to disperse from Africa, they start to exterminate some of the largest species. There were still some mammals alive, something like 4,000 years ago in some of the islands in Alaska and in the region.

Gerardo Ceballos (00:09:13):

In the last few thousand years, humans, we were able to exterminate most of the larger animals like mammals, mastodons, and so on. Many of them directly, and many of them because we destroy the prey of the large carnivores, those carnivores eventually succumb to the lack of food, to the changes in the climate, and to human exploitation.

Nate Hagens (00:09:37):

Fast forward to today. How many roughly, vertebrate, animals with a backbone, how many vertebrate species are there on the planet?

Gerardo Ceballos (00:09:45):

Well, we mean by vertebrates' mammals, birds, reptiles, amphibians, and fishes are basically around 40,000, 45,000 species in the planet.

Nate Hagens (00:09:57):

Out of 50 million or so?

Gerardo Ceballos (00:09:59):

Out of the 2 million species that we know, around 45,000 are vertebrates.

Nate Hagens (00:10:07):

Okay.

Gerardo Ceballos (00:10:08):

And many, many more are still undescribed. But we don't really know how many will be at the end, accounted for. Just let me tell you that, if we maintain the pace of describing species like we have been doing since 1758, they will take a few thousand years to complete the description of all these species. So it is impossible that we will know how many species and what are those species in the planet.

Nate Hagens (00:10:35):

That right there, what you just stated is one of my greatest wishes of all time, that 2000 years from now we are still cataloging Earth's species.

Gerardo Ceballos (00:10:44):

Wow. That will be wonderful. Because if in 2000 years or 3000 years, we will still be cataloging species, it will be great for two reasons. One, we will still be here, humans, humanity will be still on the planet. And second, it will mean that our activities didn't impact so much the planet. So many of those species will be alive at that time.

Nate Hagens (00:11:07):

Well, we're going to get into the factors that influence that. But first, let me just ask you a personal question. Do you have a favorite animal or a favorite vertebrate?

Gerardo Ceballos (00:11:17):

Well, yes. I work with jaguars and bison and many animals, but I think perhaps my most preferred animal are flying squirrels.

Nate Hagens (00:11:26):

Hmm. We have those here in Wisconsin.

Gerardo Ceballos (00:11:28):

Yes, I know. And we have them here in Mexico. I discovered them in central Mexico many years ago. And they are so unique, so beautiful that I become really in love with flying squirrels. Most people think I prefer jaguars or something like that. I love them, but I really like flying squirrels.

Nate Hagens (00:11:45):

You're at some property in your hometown there in Mexico, right? Is there nature and wildlife there, or are you in a big city?

Gerardo Ceballos (00:11:55):

I live in a city. It's a big city, but around the city, there is still a lot of forest and I have a ranch close by that is basically just in the middle of a forest. And we have a lot of wildlife there.

Nate Hagens (00:12:06):

Do you have a wildlife camera where you go and see what ran by in the night? I have a couple here and I love it.

Gerardo Ceballos (00:12:12):

Definitely, that's one of my passions. One of my passions is to photograph wildlife and I travel with my family and I have forced them to go with me to Africa, Asia, to so many places to take photographs of animals.

Nate Hagens (00:12:26):

Yeah. I've been really fortunate to go to Africa several times. I would have to say my favorite animal is the Cape hunting dog. And I've seen three packs of them live in my life on three different trips. So I love wild animals.

Gerardo Ceballos (00:12:41):

You're very lucky.

Nate Hagens (00:12:42):

Yeah. I know. I'm lucky. I mean, my story just briefly, my parents moved around a lot when I was a kid and my mom always took me to zoos when we were in cities and I would sit in the front seat of the car and scan the horizon for animals even when I was three years old. So whatever it is, that's what motivated me.

Gerardo Ceballos (00:13:01):

I think it occurs. And it is a blessing.

Nate Hagens (00:13:05):

Yeah. Well, I mean, at the end of the day, Gerardo, that's what's sacred to me is the animals that we share the planet with. And I question how our culture is stressed with economic and poverty and political things. Could we ever have a cultural consciousness where we recognize the species that we haven't even described yet and we're changing their ecosystems? Could that ever be primary in people's heads? I know it is in yours and many of the people that we have as friends, but could that ever be a cultural calling? I don't know.

Gerardo Ceballos (00:13:47):

I definitely don't know. I see some good signs that we're going in the right direction, but I see so many bad signs that we're really in a bad direction just in Mexico right now. The Mexican president is investing a lot in fossil fuel. I mean, who in his right man will be investing in fossil fuels? And he was mocking the other day in the US because somebody in the USA said that they were investing in electric cars and he say, "oh, come on. Why do you invest in electric cars?" And this is the president of Mexico, with the #11 economy of the planet. Let me tell you that people ask me a lot of times if I am interested in people, in saving other peoples and so on. And of course I am, but to be honest, I mean, my major quest in life is to save as many species of plants and animals from extinction.

Gerardo Ceballos (00:14:42):

I know that if we manage to infect other people with this idea, these species are our companion, these species has been with us since our first ancestors, 3 million years ago started to walk through evolution towards what we are now. And those companions, those species, plants, animals who have been with us along this journey is what we're destroying, it's what we're killing. It's what we're directly or indirectly destroying with our activities. And for me, that really makes me wonder if we don't have any sensibility to understand that, what hope we have for humanity? If we don't even know how to treat those species who has been working with us.

Nate Hagens (00:15:30):

Do you think it's more that we don't care or that we don't know or some combination?

Gerardo Ceballos (00:15:35):

Well, definitely at least combination of that we don't care because we don't know, but sometimes we know and we don't care because the society, we have been moving to that idea, that having wealth, to accumulate things and so on is better than anything else. And most of the young people here in Mexico throughout the world are feeling that they are a failure if they don't have a house or two houses or three houses and a car, huh? When there are 20, 22, 23 years old, many of them, I mean, I see so many young people who have grown so detached from nature, from understanding the value, the beauty of all this manifestation of life. I wonder if we ever want to change. And I have seen that this has become even worse with the advance of technology with cell phones and tablets and so on.

Gerardo Ceballos (00:16:25):

I mean, most of these children never go out to play. And it really makes me wonder if we're going to win this battle with this, all the technology and all these stimulus, taking the people, children, young adults, and adults away from what really matters in terms of the environment.

Nate Hagens (00:16:46):

Because you can get the same neurochemicals from a phone that you could from going on a bird watching trip in the forests, even though it's a total false representation of it, you can get the same stimulation from games and pictures of animals, where it's a lot of effort to go into the woods. And so our brains can be hijacked by technology when the real thing is just out there.

Gerardo Ceballos (00:17:13):

It definitely that they are being hijacked and you are right that our brains, the same regions of the brain that are stimulated by alcohol, by drugs, or by pleasure, all different kind of things, or by entertainment are being moved by these video games and so on. But let me tell you, when I was young, when we were kids, we didn't have to go out far away. We will go out, outside in the garden and play there with the dirt and with stone and rocks. And I mean, I understand that sometimes it may take a lot of effort to go out, away, but I don't know when you were a kid, we just go out anywhere, sometimes to the forest and sometimes to our gardens, sometimes even to the streets. And we'd have a wonderful time having the same kind of stimulation that they have now with this fake stimulation with their cell phones and so on.

Nate Hagens (00:18:09):

We were blessed Gerardo. We were blessed with that when I grew up, when I was in grade school, fourth, fifth, sixth grade, I would come home from school every day, get my dog. And we would go into the foothills of the Siskiyou Mountains in Southern Oregon. And I would just explore for three hours until dinnertime, looking at trees and finding salamanders, every day that's what I did. Looking at deer and other things. I knew there was a small, small, small chance. There would be a mountain lion out there and that's what made it really exciting. There was a movie called Citizen Kane where Rosebud was his sled that he longed for in his childhood. That sort of experience in the natural world, kind of carefree, is my Rosebud. And that's perhaps why we are friends and we're having this conversation.

Gerardo Ceballos (00:19:01):

It is so interesting because when I was at junior level, we live close to Toluca, this city is called Toluca and now it's very big, but at that time it was small. And just next to my house, there was a lake and I will spend, I will go home, have lunch, Mexico lunch around two, three in the afternoon and then go to this place. And until my parents will have to come to look out for me at seven o'clock, eight o'clock at night when it was really dark, because it was so addictive that I will spend day and day, and day looking for Salamanders, as you said, snakes and raccoons and bats and so on. Those was the years that really formed me as a naturalist. I wrote my first paper that obviously was kind of, really bad in the sense, but it was a natural history paper on the natural history of the water snakes on that lake, because I will remember, and I will write down what were they doing in the spring and the summer and the winter.

Gerardo Ceballos (00:19:59):

And so sometimes I will see what they were feeding on, who was preying upon them and so on. And I managed to write something like a 10 page thing, so it was my first paper. My parents used to laugh and say, "this is so weird. My kid is so weird." But they were very supportive. And as you said, we're incredibly lucky that we have that. And this is what we have tried to give to my children. They were able to go, and let me tell you this story. We used to go to Africa and those places and I used to say, "okay, we'll go to Disneyland, and then we'll go to the Everglades," or "we'll go to this place in Europe and

then we'll go to Africa." And then one day, my 16 year old, he was becoming a teenager, he said, "oh, where are we going this year?"

Gerardo Ceballos (00:20:45):

And I explained the places we were going to Africa. And he said, "do I have to go?" And I said, "no, you don't, you don't have to." And I left him and we left. And then three years or four years afterward, he said "Dad, when are we going to Africa?" And I said, " why?" He said, "because I'm dying for Africa." It was amazing. I mean, he managed to understand the value, the beauty of all of this, after passing his teenage years and they don't do science, well they do. One of them is a scientist, a mathematician, the lady, and the other one is in finance, but both of them really love nature. And both of them really are balanced and understanding the value of having this education.

Nate Hagens (00:21:26):

Well, building on that. And I want to make sure I have a lot of questions for you about your research and your prognosis, but is it possible that we, growing up in affluent countries, are privileged to care about the environment like we do, and that most recent generations and many places on the earth today are just concerned with making a living and how they're going to feed their families this weekend. And they don't see the environment from a bird's eye view, the way that you and I are discussing it. So is environmental concern the way that you and I see it, is that a privilege of this fossil fuel bonanza period that we're going through?

Gerardo Ceballos (00:22:11):

Well, it is a privilege, but it's not a privilege only of the people who is more affluent. I work a lot with people, local people here in Mexico. Sometimes they are the owners of a track of forest, tropical forests in Southern Mexico. And what I find is incredible, they obviously are not rich at all. They really sometimes have difficult times to feed. And most of the time when we go there and help them to find ways so they can protect the forest while making some money or by protecting, it is incredible how much love, how much pride, how much attachment they have to nature. So I mean, we're having people, for instance, calling me say, "okay, we have two cows and they were killed by a jaguar." And I said, "I'm so sorry." And I said, "what you want to do?" He said, "well, we don't want to kill the jaguar. Is there any way you can help us to pay a little bit of something for those animals that we can recover a little bit of our losses?"

Gerardo Ceballos (00:23:10):

And I said, "you don't want to kill the jaguar?" He said, "no, no, we don't want to kill the jaguar. We basically are invading their land." And this is a story that happens time, after time, after time, what we are lacking the planet is the people poor or richer or in between who has the possibilities to enjoy nature for whatever reason. In some cases it's because they live next door to nature, although they don't have a lot of money. And sometimes people more affluent with us who can maybe live far away from nature, but we can go rather often because we have the means. So this takes me to the point that it's not determined if you are going to care for nature or not, if you have a lot of money or not.

Nate Hagens (00:23:56):

Do you think that we have some sort of evolutionary relationship with nature in affinity like E.O. Wilson referred to it as biophilia? Is there something that is irrespective of our current modern consumer culture that is ingrained with us, our relationship to nature? What do you think about that?

Gerardo Ceballos (00:24:16):

I think definitely we have some ingrained, this relationship with nature, with animals, and it can be for instance, when small children are afraid of darkness, and I think this is a manifestation of our recent past, where if you were not afraid of darkness, you will go crawl out of your house and you will be eaten

by a hyena or bite by a snake or whatever. And I mean, most of the people that I know, even if they have living in the city, once you take them to a park or once you take them to a forest, I would say probably 99% of them, they will enjoy it and they will feel so quiet, so calm.

Gerardo Ceballos (00:25:03):

So definitely we have evolved in nature and the forest, the lakes, the animals, the plants, well, plants and animals are part of our evolution. Many human beings are still part of that. I mean, I don't know of the eight billion people, but I don't know, maybe two, three billion, but probably more are still in close contact to nature. This is on the one hand, on the other hand, being bombarded by these ideas that having wealth is what counts is causing a lot of problems . But if we think that we have this link, that's something that we need to exploit towards trying to get conscience at the global scale for saving the biodiversity.

Nate Hagens (00:25:43):

Well, like you, I'm a scientist and I have a scientific mind. So I can't explain what I'm about to tell you. But my first time in Africa, I went with my dad, he was on a hunting trip and I just went when I was 21 years old to take pictures. I felt this affinity, like I was coming home or something like that. It was this primal feeling of connectedness, that first couple days in Botswana at that time. It was a really odd sensation, but I just so loved it, I will never forget it.

Gerardo Ceballos (00:26:16):

Oh, that's very interesting because my kids and us, when they were the first time in Africa, we were crossing the Serengeti and we spent 15 days there. I remember, I don't know which one of them say one afternoon, " Wow, this is so beautiful and it feels like home." I mean, exactly in the same feeling that you described because he was sitting down on the Jeep, looking at the horizon as it feels like home. It's our home, it's where we come from. Definitely, there is that affinity.

Nate Hagens (00:26:50):

Okay. So with that entrée, let's get into your work, sir. You recently co-wrote a paper Underestimating the Challenges of Avoiding a Ghastly Future, which cataloged a lot of risks to biodiversity, species, ecosystems. Could you just give us an overview of your general findings either in that paper or generally, what percent of natural ecosystems have been lost in the last 50 years, animals, et cetera?

Gerardo Ceballos (00:27:21):

Well, I think one of the most important contributions I have done in science has been to try to understand what is the magnitude of extinction crisis. I was fortunate to go to Stanford to do a sabbatical and meet Paul Ehrlich. Talking to him, I developed these ideas, and I wrote the first paper on species extinction in Mexico in 1992, something like that, when there was the first president in Mexico who was very neoliberal. At that time, I thought I wrote that being so neoliberal could be really good if we will take care of the important thing of the environment, but also could be the tipping point to make humanity in really bad shape. Then I went to Stanford and I got to spoke to so many people and so many ideas, and then one of the first question that I wanted to answer is at that time, many people would think that extinction was bad, but it was part of evolution.

Gerardo Ceballos (00:28:25):

Let's remember that evolution work with extinctions and speciation and that's one of the basic processes of evolution. Working there, first of all, I one day listened to Paul Ehrlich talking about populations extinction, and it occurred to me that was one of the critical points. We were not understanding the magnitude of extinction because we were looking at the species that become extinct. It's like, if you go and see the problem of a big pandemic like we're having now, just counting the people who died, obviously this is just the final and a tiny part of the whole problem. So at that time, I wrote a paper

with Paul Ehrlich on what we called, we evaluate for the first time, what was the extinction? The magnitude of population extinctions in a whole group in the planet. In this case, mammals.

Gerardo Ceballos (00:29:20):

We were able to gather a database with the distributions of a species in the 1900s and the current distribution, that was around 2000. What we saw is a brutal, literally a brutal destruction of populations of many species. The range was a very big range. 100% was contracted to 2015, 50%. So the range contraction obviously implicates the losing populations. That was the first time I could see that the magnitude for what we were doing to the planet in biodiversity in terms of the extinction was really big.

Nate Hagens (00:30:03):

So you're saying that if you just count the extinctions, like the dodo bird or the Tasmanian tiger, that you're actually underestimating the magnitude, because there's a difference between population extinction and species extinction.

Gerardo Ceballos (00:30:18):

Definitely. That's definitely very important. Let me give you an example. If we have jaguars in Mexico, it doesn't matter if they become extinct here, if there are jaguars in Brazil, in terms of the role and function they play in ecosystems and in the provision of environmental services. That is all the benefit we will get from nature. So disappearance of populations are basically like extinctions, called extinction.

Nate Hagens (00:30:48):

Is that what's called an ecological extinction?

Gerardo Ceballos (00:30:51):

Yeah, it's an ecological extinction. It is similar. Ecological extinction is when you have species in an area, let's say. First of all, population extinction, all the species are made up by several populations. When the species become extinct, we have lost all the populations. But those populations at the local and regional levels are so important, but then when you lose them, you lose the value and it's like, it was a whole extinction.

Nate Hagens (00:31:22):

Can you give an example of one of those species and that that happened?

Gerardo Ceballos (00:31:27):

Well, just as I said, the elephants. If you see the distribution of the elephants, they were just at the beginning of this century, almost one million elephants.

Nate Hagens (00:31:35):

20 years ago.

Gerardo Ceballos (00:31:39):

30 years ago, there were probably one million. Now, there are 250,000 elephants.

Nate Hagens (00:31:43):

In the whole world.

Gerardo Ceballos (00:31:44):

In the whole world, in whole Africa. So if you see the map of the distribution, you will see an area, most of Africa will be covered why the distribution of elephants. Now you will see just dots in the continent. A small population dispersed throughout the continent. So it means that we have lost elephant in most of Africa. By losing them, we have lost the role where they do. There are many roles that the elephants have. Let me give you two examples. On the one hand, for instance, they disperse lots of plants that they eat, and then maintain the Savanna because they destroy trees to eat the bark. So the Savannas, when you lose the elephants are invaded by crops and trees, and eventually you lose the Savanna and you lose the grasslands with so many animals. So the elephants are critical to maintain the Savanna.

Gerardo Ceballos (00:32:37):

But recently, other scientists have shown that when you lose the elephants and other ungulates and other species of a larger mammals that feed on plants, the grasses grow much layer. On those grasses, the populations of many rodents exploit become very abundant. Those rodents has many diseases that affect humans. So by losing the elephants, you are losing the composition of the plants, and then this is causing a massive increase of rodents, and those rodents transmit diseases to humans, to domestic animals and to wildlife. So who will think that the elephant, the presence of the elephant will be linked to the presence and the abundance of rodents in Africa.

Nate Hagens (00:33:27):

A conservation biologist might think that, but you're right. We don't normally think in terms of systems. There is that story, I don't know how true it is, about the elk and the wolves and the ecosystems in the Yellowstone similar sort of thing.

Gerardo Ceballos (00:33:41):

It's very similar, but it is basically correct.

Nate Hagens (00:33:44):

So in the case of the elephants, just to highlight that, what are the main reasons that we've gone from a million down to 250,000 in the last 25 years?

Gerardo Ceballos (00:33:55):

Well, basically, it's poaching, and we're losing habitat. As there are more human population, we need more food. So more habitat of the elephant is being destroyed to plant crops. But basically, the main problem is we're still killing elephants for their ivory. Just to give you an idea, 15 years ago, an elephant was being killed every 15 minutes, an elephant was illegally killed. Even now, an elephant is being killed every 40 minutes illegally to take their tusks to the markets, especially in China. What is really incredibly surprising is that the tusk are useless. They use them for ornament and for some crafts, but we're killing the elephants because this huge appetites for ivory. Now the mafias in China and in Africa and Mexico, everywhere, in the US, the mafias dealing with the trade of animals, and in this specific case of African elephants have more power, more money, more guns than the guards, and many times than the local governments. It's a real bad problem.

Nate Hagens (00:35:18):

I had another guest, I don't know if you know paleobiologist Peter Ward, and he told me that there are some alternatives to ivory, and now all of a sudden, deep coral reefs are being unearthed because they're taking giant clams as a replacement for ivory. That there's a big demand for giant clams, because they're starting to change the demand away from ivory a little bit. I don't know the details of the story, but...

Gerardo Ceballos (00:35:49):

Well, the problem is who needs ivory? I mean, who can't live without ivory and the -.

Nate Hagens (00:35:55):

Well, who needs three houses?

Gerardo Ceballos (00:35:57):

Exactly. I mean, the pandemic is related to the trade of animals in China and it's organization.

Nate Hagens (00:36:04):

The pangolins.

Gerardo Ceballos (00:36:05):

The pangolins, the bats, if you put wet market in Google, you will see horrendous photographs and videos of the way the domestic and wild animals are in cages in these market in very unsanitary conditions. So it's very easy from the wild animal, a disease jumped to a domestic animal, so to humans. So to be honest, it is now the right time to try to stop the illegal trade of animals. Although, saying it's easy, but the illegal trade of wildlife and plants, it is so big that is in terms of money, it's almost as big as the drug trade.

Nate Hagens (00:36:50):

Well, it's akin to changing GDP as our cultural goal.

Gerardo Ceballos (00:36:55):

Yeah.

Nate Hagens (00:36:55):

Do we change the taxes and the rules, or do we change people's aspirations? In other words, do you devote all your money to anti-poaching people with rifles and night goggles and things like that, or do you change the cultural demand for ivory and pangolin and all that other crazy stuff? I mean, which is the answer?

Gerardo Ceballos (00:37:19):

Well, I think the answer is simple in the sense that it's impossible to have just one answer. The answer is we need to have all of these. We need to have right now goggles and people, I mean, fighting to save the wildlife, and we need to try to change corporations and countries and the GDP. In other words, this is a complex issue of a complex society of a complex humanity. So what I'm saying is like, there is not simple answers, but the more answers and the more solutions we have, I think the easy will be eventually to reach a society, that for me, it's very easy. The new society coming from COVID, and coming from this massive destruction that were happening, will have to have two simple elements.

Gerardo Ceballos (00:38:13):

It should be socially more just, and it will be sustainable. If you think it sounds so simple, but obviously it conveys the complexity of this moment of humanity, but who will in his right mind, not think that having less poor people and having more equitable, more equal, be more just with the poorest will be good? Who wouldn't be thinking that protecting more forests and protecting more animals and having more, better, less pollution and so on, we will be in better shape.

Nate Hagens (00:38:51):

It wasn't that long ago that black humans were treated and considered subhuman. It wasn't that long ago that women didn't have rights and couldn't vote. Is it possible that our culture will recognize what we're doing and extend some of these recognitions to other species, especially conscious, self-aware species like dolphins and bonobos and things like that? I mean, culturally, do you think that's possible?

Gerardo Ceballos (00:39:24):

Oh, definitely, it is possible. It is very possible. As you say, just in the 1970, we have the minority revolution, the racial revolution, the women revolution, we have the sexual revolution, we have the non-traditional sex preference revolution, and it happens, and it happened incredibly quickly. I tried to think like in the '70s or the late 1900s, in the late 1900s, the whole planet suddenly has all these new paradigms that would change completely the way we were. Marxism with Marx, and we have evolution with Darwin. We have psychological changes with Freud, and we have [inaudible 00:40:08] sociology and so on. It took many years to catch up. Now, with the technology that we have, with the spread in the social network, and the instant distribution of information, I think we have a great opportunity if we can use those resources with these new ideas. I see many philosophers, many scientists, many politicians, a lot of an important group of people talking about the right things. So I don't know if we will have enough time before we collapse civilization, because the damage we have done to the planet, like climate change, species extinction, toxification and so on. But what I think, and probably I may be wrong, but what I think is what we're experiencing right now is one of those times in the history of humanity, where many things start to change and suddenly they will change enough, and they will change to the right direction.

Nate Hagens (00:41:09):

I hope you're right about that, obviously. Let me ask you this question. David Attenborough is very popular and famous for his narration of wildlife-centered shows, planet earth, and some of these shows are so stunningly beautiful. I grew up, I used to watch religiously Marlin Perkins and the Mutual of Omaha's Wild Kingdom. It was a rite of passage for my family. We would watch it, I think Sunday nights, I would just so look forward to it. I can't watch those shows anymore, Gerardo. I can't watch planet earth. Every once in a while, I live on a farm here and I walk out in nature every day, and I have to do it for my mental health, but sometimes I look at the nature and I'm just struck by this dual lightning bolts.

Nate Hagens (00:42:02):

Part of it is just the awe and the beauty and the wonder of nature, but it's a bittersweet feeling because I also glimpse, fast forward ahead at what's going to happen in the next century to the nature, and I feel this overwhelming sadness. So as much as I care about these things and talking to scientists like you and getting the word out, sometimes it's too painful to be directly in it. Do you know what I mean? You must know what I mean.

Gerardo Ceballos (00:42:31):

Well, I am kind of weird in that sense because I have been working with extinction and we changed the paradigm, and we were the first to show that the species we lost in 100 years would have been lost in 10,000 or more years in normal times. I have been able to be, like I said, the chronicles of depth in where we say how many species are becoming extinct and so on, and the population extinctions, and we called one of our terms, we call it the biological annihilation because when I was at the high school, extinction was still selected. Like your animal or very restricted range animals and so on.

Gerardo Ceballos (00:43:17):

But now, it's a biological annihilation, because basically a small or big, largely distributed or small distributed, beneficial or non-beneficial and so on, all kind of characteristics that you may have, all of

those species are becoming extinct because of us. In other words, the characteristics that will make more species more prone to extinction has been wiped out by the massive assault that we have in nature. So we call it biological annihilation. I get sad, and I get sometimes really down, but I really think that I have visibility and I'm glad I have it because the more I feel the heat, the more I push harder to try to change the whole thing.

Nate Hagens (00:44:02):

Yeah, I totally agree, and that's what I'm dedicating my time on this planet to doing. The biological annihilation of our planet species, let's be honest, yes, it's reaching crescendo level, but it's been happening for hundreds and hundreds of years. Every human alive in the last 500 years has witnessed part of this or it's happened during their time. So since you and I have been on the planet in the late '60s, what percentage of wild animals have been lost since around 1970?

Gerardo Ceballos (00:44:34):

This is exactly what is mind-blowing. Since the 1970s, we have lost around 80% of all the animals.

Nate Hagens (00:44:44):

What?

Gerardo Ceballos (00:44:44):

80% of all the animals that used to be in this planet have been lost since 1970.

Nate Hagens (00:44:51):

So not the species, but the numbers of animals.

Gerardo Ceballos (00:44:54):

Not the species, the individuals animals. 80% of individual animals has been lost. Individuals who were part of populations, and population who were part of a species. Some of these species have become extinct. Some are on the brink of species. Some of those species are still more or less abandoned, and some of those species are abandoned. But in general, all of those have lost so many individuals. Just to give you other examples. In the 2000-something, they published a really well researched paper, where they chose that. At that time, only 2% of the large fishes on the planets remain compared to 1960s. 2% of the sharks, 2% of the tuna, 2% of any of the big fishes that were still present in the ocean. We have wiped out at that time, 98% of the large fishes in the planet.

Gerardo Ceballos (00:45:54):

Another example is not only the big animals and the vertebrates and so on. This example are rather good and amazing, good scientist from Argentina, he used to live in Mexico, his last name was Rappaport. Rappaport, one day, he wrote a really nice book in Spanish where he mentioned that the changes that we're making in the planet, you could see them while driving your car. It's that example that when you used to drive your car, there will be so many insects splash on your windscreen. Now, you can drive for areas having just one or two.

Gerardo Ceballos (00:46:39):

I remember, not so long ago, I was still like 20 years old, in Mexico, the gas station, you will stop and there will be one guy coming to clean up your windscreen and also the radiator, because the radiator will have so many animals stopped by, that the car wouldn't cool down properly the engine and anyway. So they clean up the radiator and they clean up everything. There was this person specifically doing that as part of the service of the gas station, that is gone because insects are gone.

Nate Hagens (00:47:10):

So I had, another one of my guests is Daniel Pauly who came up with the scientific concept of shifting baselines, which is that we can remember 50 years ago what the windshields were full of insects, but we can't look at really yesterday or the day before yesterday, every day kind of blends into the next day. So we assume that what's happening is normal because it's happening so slowly on a day to day basis, but on a decade to decade basis, it's tragic.

Gerardo Ceballos (00:47:39):

But this is also part of our culture, is part of our evolution. Remember that until very recently, we didn't have to worry about what was going to happen in three months or one year. We didn't have ways to store food. So we were worried about what was going to happen the following day. If you were in a cave, living in a cave and suddenly you will see a smoke in the horizon, you will have to pack up your stuff because you know the other tribe or group will come in, and you will have to run. So basically, we are very well developed, I mean, we have very well evolved to perceive things at the normal, at every day. Oh, it's going to rain, but our rain hasn't have the capability to understand this long term, a small changes on the one hand, but also remember that until 1970-something, when we saw the first photograph of the planet on this massive black void, we understood it was the first time that we could see what the whole planet it is.

Gerardo Ceballos (00:48:46):

So now for us, it is kind of easy to try to imagine what the world is, but in terms of our evolution, this kind of understanding of what's going in the planet, and that we're changing the whole planet is incredibly new. So it is incredibly difficult for us to try to first understand and then to grasp the consequences of what we're doing here in my garden in Mexico, how this is affecting the rest. It is not that because we're stupid, is simply a mixture of cultural and biological factors.

Nate Hagens (00:49:20):

I'm realizing Gerardo, that I could probably talk to you for four hours and not cover half of what I want to ask you. So let's just cover as much as we can, because I have so many questions for you. Let's drill down on what you just said earlier. You said that elephants, the problem was the number of humans were encroaching on their habitat and poaching, but what about insects? What has caused the drop in insects from the people at the gas station clearing them out of your radiator and windshield to today?

Gerardo Ceballos (00:49:51):

Well, let's put it in a larger framework, if you want to. I see humans and your guests have talked about this, is population, the growth of human population, consumption, technology and so on, has caused major environmental problems, and those problems are global. When I grew up and was studying biology, there was only one global environmental problem, was relation of the O-zone layer, that fortunately we were able to solve. But then, climate change, pollution, toxification, invasive species, emerging diseases, over exploitation, habitat encroachment, habitat destruction, over killing and so on, all these massive impacts of our activities both directly and indirectly is what is causing the destruction of plants, animals and microorganisms. In terms of the insects, there are several theories, and I think that what is happening is it changes regionally. In some regions it's pesticides, in other regions it's more climate change and so on. But what is clear is that this is happening.

Gerardo Ceballos (00:50:58):

So for instance, in many places, the massive use of pesticides, like in central US, have destroyed so many species. For instance, just recently, we heard that the monarch butterfly was declining, and after several studies and so on, they found different reason for the decline, but one of them was the use of herbicides to kill a plant, this invasive plants and crops. And one of these plants is the food plant for the butterflies. So, we kill the plants not because we want to kill those plants because it's just a part of

the plant that you want to kill if you want to have your crop free of herbs, but those particular plants are the unique food for the monarch butterflies, and when it was done at a continental scale, then the populations collapses.

Gerardo Ceballos (00:51:52):

Aside from that, we have in Mexico the places where they are, where basically we're talking about no more than maybe 200 acres, where those million butterflies come every year. Just imagine how fragile is the area that these 200 acres dispersed in a few million other acres can be easily be wipe out by fires, by illegal logging and by climate change. So, insects are a good example to talk about how different factors, human factors are causing the destruction of species in different scales, in different parts of the planet. For elephants, hunting could be really bad. For other species like prairie dogs in Mexico is poisoning them because they compete with cattle and so on.

Nate Hagens (00:52:39):

It just says an aside, how many jaguars are there left in the world and how many are in Mexico, roughly?

Gerardo Ceballos (00:52:45):

Well, roughly the jaguar is the most abundant of the six larger cats. Fortunately, there are still around 60,000 jaguars left, but 60,000 is just a fraction of the 150,000 that are estimated that there were at the beginning of the 1900s or more. In Mexico, let me tell you, this is one of the things that gave me a lot of hopes. In Mexico, I organized a group called, The Alliance for Jaguar Conservation in 2005. And we are something like 60 people from 30, 40 different institutions and scientists and lawyers and so on, very different people. Between 2008 and 2010, we did the first national jaguar census in any country. So, we designed a way to census the jaguars in Mexico and we come out with 4,000 jaguars. And 4,000 jaguars was very good because at that time we thought that there were 100... 1000 jaguars no more in Mexico. So 4,000 jaguars was a good, good news.

Gerardo Ceballos (00:53:57):

But then, we repeat the census in 2019 and bingo, because we have been working so hard with the government and the local communities and so on, the population grew up to 4,800 in only around 10 years. Now, we're going to do the next year, the same, the third jaguar census. So in general, we have 60, 70,000 jaguars in the whole continent, and in Mexico we have around 5,000 and those are good news.

Nate Hagens (00:54:26):

So, if species is really decimated in the population, you mentioned the large predatory fish are at 2%, I'm sure there's some mammals that have that level or worse, but there's still a viable population. Is there a level where they get to where the genetic diversity is so small that if they interbreed with each other, there are problems? So even though there's enough animals to breed, there is that problem. I think I read something that's happening with cheetahs to some extent.

Gerardo Ceballos (00:54:58):

That's a very good question. What you've read about cheetahs, it was the idea in the 1990s or something, understanding of genetics has become so good that fortunately there is not a single rule. For instance the vaquita, is it a porpoise found in Mexico, only in the Gulf of Mexico, there are probably 10 to 12, and there was a new recent study showing that this 10 to 12 have enough variability if they recover to live properly. And there are some cases like the marine elephants, who at one point they were 100 only left, and now there are more than 300,000.

Nate Hagens (00:55:40):
Which the elephant?

Gerardo Ceballos (00:55:41):
How do you call it, the marine elephant?

Nate Hagens (00:55:44):
Oh, the manatee.

Gerardo Ceballos (00:55:45):
No, no. The elephant seal. How do you call this?

Nate Hagens (00:55:47):
Oh, yeah elephant seal. Okay.

Gerardo Ceballos (00:55:49):
So, it's like the elephant seal. At what point, there were only 100 left protected in Mexico. This is a really interesting story. In 1920, a Mexican president declared Mexico a haven for marine animals, and that saved the great whale, saved elephant seal, saved a lot of marine mammals. But anyway, the elephant seal, there were only 100. Now, there are more than 300,000. Those are the ones who goes to the coast of California and in the annual naval reserve, this is the only one... two columns. Now, they go to the continent. Most of the time they go to island because they were free of predators. But anyway, there are 300 animals and they have not much variability, but with the variability they have, they are doing fine. As a rule, we say that 500 animals is very critical. If you have less than 500 animals of any species, you are reaching the point where genetics and demographic factors and other factors are putting you to in really big problem. Although, as I mentioned, there is a lot of variability on that.

Gerardo Ceballos (00:57:02):
And we just published a paper in 2000 to 2020, where we look at, we call this species who are at the brink of extinction, and this is coming back to what you mentioned on a functional extinction. We call them zombies, because those species are living dead. They are still alive, but if you have 500 individuals, 100 individuals divided in several populations, basically the ecological role that you have that you used to play is gone, but also you're facing so many demographic genetic population problems that are almost zoomed to extinction unless there is an iteration over humans.

Nate Hagens (00:57:43):
So, this is a factoid that I know well and I think more people are becoming aware of it, but you know it cold. If you compare the approximately 8 billion humans and all of our livestock, our cows and pigs and goats and sheep, how does that compare to the number of wild animals on the planet?

Gerardo Ceballos (00:58:06):
Well, that's a very good question. There have been some paper published that when I read it just made me really, really, almost faint because they have estimate that when you took all the vertebrates of the planet, mammals, birds, reptiles, amphibians and you compare them to domestic animals its 30% of the volume mass of the planet is made up by the 8 billion human beings, 36%. 4% is made up by all the thousands of species of vertebrates and the rest are domestic animals, mostly cattle and poultry. So just imagine, only 4% of the total biomass of the planet is made up by wild animals. And the rest, the 96% is made up by humans and the domestic animals. So, we have been able to displaced them. We occupied most of the land and we have been able to take off the energy that those species use.

Gerardo Ceballos (00:59:14):

This is why it's not surprising that we have lost 80% of all individual animals since 1970, because we basically are occupying their land and we're using the energy that they used to use. And if you look at the birds, it's even more dramatic. If you look at the 11,000 species of birds and the domestic poultry, 70% of all the biomass is made up by domestic animals. And 30% is made up by the 11,000 wild species of birds. So, it's not surprising then that we have lost 80% of all the individual animals in 1970, because we're co-opting their land and we are co-opting the energy they use.

Nate Hagens (01:00:03):

So, 70% of the weight of all the birds on the planet is two species?

Gerardo Ceballos (01:00:09):

Exactly.

Nate Hagens (01:00:09):

Chickens and turkeys. And the other 11,000, comprised the other 30%.

Gerardo Ceballos (01:00:15):

Exactly. That's exactly.

Nate Hagens (01:00:16):

So, I was fortunate to do an Earthwatch expedition in Ecuador. Ecuador is not much bigger than Minnesota and Wisconsin where I live, but they have, if I recall 2000 - mas o menos - species of birds and the entire continental United States only has 800. So, this tiny country, there are 2000 species of birds, including 250 species of hummingbirds.

Gerardo Ceballos (01:00:42):

That's amazing.

Nate Hagens (01:00:42):

In the United States, we only have eight.

Gerardo Ceballos (01:00:45):

That's amazing.

Nate Hagens (01:00:45):

Yeah. Some of these places are amazing.

Gerardo Ceballos (01:00:48):

So, you were talking about the 60 minutes and so on?

Nate Hagens (01:00:51):

Well, I'll get back to that.

Gerardo Ceballos (01:00:52):

Yeah.

Nate Hagens (01:00:53):

But I just wanted to say one other thing. We consume 70 billion chickens and turkeys per year, and then they're not all alive at one time because it's only 10 or 11 weeks old when they... because they breed them to get so fat that they can't walk and they harvest them early. It's overwhelming.

Gerardo Ceballos (01:01:11):

Just insane. It's overwhelming, yeah. It is overwhelming, especially when we understand, and it's now much more widely know that this is taking us to a trajectory that unless we change it will cause the collapse of civilization and it's going to cause the collapse of civilization not by the end of the century, not in 2100, it will cause the collapse of civilization in the next 50 to 20 years, or if you are optimistic, 30 years. The good news is the window of opportunity there is still a window of opportunity, but it's rapidly closing and we don't have decades to put our act together. We have very, very few years, and that's what this becomes rather difficult for people to grasp and this is why I think so many people prefer not to think about it and just get distracted with something else because-

Nate Hagens (01:02:15):

Why did you say that we're going to have a collapse of civilization possibly in the next 15 to 20 years, for what reason?

Gerardo Ceballos (01:02:21):

Because most of the status in terms of species extinction on climate change, on pollution and so on is getting us to a tipping point where pandemics like COVID, like loss of ecosystem services, and so on are becoming so big and the rate of change is much, much faster than we anticipated.

Nate Hagens (01:02:44):

So, this is on top of oil depletion and economic overshoot and finance and all that agricultural problems?

Gerardo Ceballos (01:02:53):

Exactly. This is a side we can have a collapse similar, a collapse related to economic issues or to political issues or to social issues. Talking about the environmental issues, there is the probability that in the next few decades, there will be a collapse of civilization. But when people say this, the people say, "Gerardo, that sounds ridiculous." You think about it.

Gerardo Ceballos (01:03:19):

We have now a pandemic that has put us basically on our knees and it wasn't the worst virus and the worst emerging disease that we have faced in the last 50 years. Ebola is much worse. The Marburg virus is worse, the Lassa fever is worse. Anyway, right now there are more than 2 billion people who don't have clean water. There are almost 2 billion or more than 2 billion people who don't have enough to eat next day or in the next few weeks. There are 100 or 150 million ecological refugees, environmental refugees. So, if you go to Kinshasa or so many of these places, and you see the conditions that millions and millions of people are living right now. This is collapse, this is the definition of collapse.

Nate Hagens (01:04:07):

Well, if you're an elephant or an insect, you've also undergone a collapse.

Gerardo Ceballos (01:04:11):

Exactly. So, so obviously all these species who are being driven to extinction by your activity are part of this collapse. That's a very important point that you mentioned. We're looking at the collapse of the

natural systems that are essential for human survival. The animals that are being disappearing are part of this collapse. The plants that are disappearing are part of this collapse. The massive losses of ecosystems are part of this collapse. And then, the reflection of what I said of these problems on billions of people already, for me, this is already that we are entering in the collapse that just will become massive and global if we don't do something in the next few decades. But what I'm trying to say is that we cannot predict exactly when, but to say that it will be at the end of the century is probably responsible in the sense that it giving us a false sense of security because it's still 80 years.

Nate Hagens (01:05:22):

So, I want to come back to this, but I had a thought while we were talking about chickens. I think there's a paradox in the human brain, I have chickens only for the eggs and for the companionship. I have 17 chickens and I love going out and sitting with them and every night there's two of them, a rooster Floyd and Blanch this hen that I stroke before I shut them in at night and I go on, 'chrp-chrp-chrp', they're my friends and they're so interesting. They're dinosaurs.

Gerardo Ceballos (01:05:52):

Yeah, dinosaur. Yes.

Nate Hagens (01:05:52):

And yet I eat chicken. I don't eat pork at all and I rarely eat beef, but I do eat chicken. So, I'm just processing this in my brain, talking about the 70 billion chickens that humanity consumes. I consume some of those chickens and yet I love my chickens and I don't eat them. So, what's going on there? Why are these two things happening in my brain? And what does that suggest for greater consciousness? I don't know. I'll just ask you.

Gerardo Ceballos (01:06:25):

Well, I don't know, but what I know it is basically excess and behaviors. It is perfectly right. I think will be perfectly balance if we eat a meat once a month or once every month, but when you eat every day meat, or as we say the excess on what we do is what causes the problem. If I have a house, you have a car. That's fine. If for instance, I have to travel a lot and use planes and I don't feel remorse because I know I am causing pollution, but I think it is much more important that I travel to save jaguars and big chunks of habitat than to stay in my home without flying. So, basically the balance is that. We have to balance our act and what you are doing with your chickens and eating chicken, basically, I'm sure you are balancing that. You're not eating-

Nate Hagens (01:07:22):

Well, it's what I teach my students and we wrote in our book that the time now isn't to minimize your impact and be a smaller part of 1/8 billionth of the planet, it's to maximize your impact and do whatever you have to do and have a good moral, ethical environmental hygiene and make good decisions, but try to be impactful at larger scales like you're doing with your work.

Gerardo Ceballos (01:07:50):

That's what I was trying to say. For instance, if I stay home, I will reduce my impact, but I won't have any big impact.

Nate Hagens (01:07:58):

Exactly.

Gerardo Ceballos (01:07:59):

In Mexico, there is a project right now that is called, the Maya train. It's a project pushed by the government. And this government has been the most anti-environment ever in Mexico, since I was at high school. And regardless of that, I helped the project, once was approved part of the project, I helped them to design in such a way that we created wildlife passes, because the project will be done. First of all, it was done and follows the law. So, you may say philosophically, I don't like trains, or you may say politically I hate this government, I don't like the train, but if it was done properly with the law and that's the right, they have the right to do it. And train has much less impact than more highways and cars and so on.

Gerardo Ceballos (01:08:49):

Anyway, we worked with them and we create the largest project on the planet with wildlife passes. In 700 kilometers, we manage to put 300 wildlife passes, massive thing. And then, they change the director and with a new one, he's a really bad guy. He's really bad. He's messing this up. So, we're not working anymore with them, but I didn't close up my work for saving the forest in the Yucatan Peninsula because it's happening. So, I go there often and we design a project where we are benefiting, I don't know, probably 20,000 families and we're saving right now almost 700,000 acres directly by paying ecosystem services to the owners of the forest. And these are the ones I tell you that they are so proud and when they have a little money that they are have enough to live, they will be the first to defend their forest.

Gerardo Ceballos (01:09:45):

And not only that, it occurred to me, how can we create a series of protected areas that we end up? We will end up with 3 million acres protected with the local people with the help or without the help of the government. So, this is exactly what you said, while I have to work with the government and everybody was... the people close to in favor the government say I was in favor of the train, the people against the train say, I was betraying nature and all kind of things. I was guided by science and what was right, we did a really great impact. But as you say, this has to be guided by ethics and in terms, when you're a scientist, by the scientific knowledge, that will help to minimize the impact of those projects and maximize what we can say.

Nate Hagens (01:10:39):

Excellent. I'm going to ask you more about your work in a minute, but I have a core question that I wanted to get to on this conversation. Gerardo, what is a mass extinction? And is a sixth mass extinction now inevitable?

Gerardo Ceballos (01:10:53):

Well, in the last 700 million years, we have a good fossil record to be able to see three things in the history of biodiversity of life on earth. One is that the balance between extinction and expectation has been positive, so we have more species now than ever, as I say before, this is the first thing. Second, we have seen in this fossil record that there has been five times where suddenly the extinction rates become much, much higher than the despeciation rates causing the loss of most plants and animals on the planet.

Nate Hagens (01:11:32):

And that's not a population extinction, that's the species itself goes extinct.

Gerardo Ceballos (01:11:36):

That's the species. This massive loss of a species, 70% of all the species in the planet or more have become extinct. And then, we know that it was caused by a catastrophe, natural catastrophe, like the meteorite that impacted the planet 66 million years ago. So, we call them mass extinction. Then a mass extinction has three characteristic. One is geologically speaking, really fast, hundreds of thousands or

few million years. Second, is this wipe out, 70% or more of all the plants and animals in the planet. And third, it was caused by a natural catastrophe.

Gerardo Ceballos (01:12:15):

When we started to do our studies on extinction, that was exactly what I wanted to see, that if the rate of extinction that we're looking at now was similar to the rate of extinction in the last few million years or normal extinction, or it was elevated. Fortunately for us, we saw that Tony Barnosky, a colleague of mine from Berkeley, they publish a paper where they gather data from thousands and thousands and thousands of fossil, any fossil mammals, and they managed to determine that in the last few million years, the normal extinction rate was basically, you will expect one extinction for every 5,000 species in a century. In those million years, you will pick up a century. Another century, you have 10,000 species, you will expect two extinctions. If you have 40,000 species, you will expect eight extinction. You have only 5,000 species, you will expect one extinction. So, that was-

Nate Hagens (01:13:16):

The background rate. That was the background rate.

Gerardo Ceballos (01:13:18):

The background or normal rate. Exactly. But for us, it was like gold because basically we have something to compare what's going on. So, we look at what's happened in the last 500 years in terms of extinction of vertebrates and then what happened in the last 100 years, we're expecting things to be bad, but not as bad as we found it. As I say, we found that the species lost in the last 100 year, we have lost in 10,000 years or more. So, when we published this paper, it was published in Science Advances, we thought that we would get a lot of criticism. And surprisingly, it wasn't actually, people did agreed. And one of the criticisms that we have, it wasn't a criticism, but say, well, this is happening in vertebrates and it's correct. Everything seems to be fine, but it's not happening in other groups.

Gerardo Ceballos (01:14:09):

And then after our paper was published, there start to be papers published in other invertebrates, plants and even microorganisms. And now, it's clearly being shown that we have entered the sixth max extinction. And you say that it's inevitable, it is probably inevitable if we really put our act together and we slow down the loss of populations and the loss of species, and we can restore a lot of the populations and the species who are on the brink extinction, but this has to be at a global scale. It's impossible to be done by actively protecting the places. It has to be done reducing the use of carbon and fossil fuels and reduce... basically reducing the magnitude of the human enterprise so we can reduce pollution, toxification, habitat destruction, over-killing, and so on.

Nate Hagens (01:15:09):

So as far as the inevitability of a sixth mass extinction, and I know you'll have to give me a speculative answer on this because no one knows, but what percentage of the risk of an actual mass extinction -- and what was the exact definition? 70%, or is there a threshold to be called a mass extinction?

Gerardo Ceballos (01:15:31):

Yes. Well, this is kind of a standard, but yes, 70% of all the species has to become extinct.

Nate Hagens (01:15:40):

Okay. And do you think that the biggest risk of that happening is climate change? Or is it 10 things all together? Or is climate change the real granddaddy of that risk?

Gerardo Ceballos (01:15:52):

No, I think species extinction, it's as bad as climate change, but it hasn't been understood. Just by itself, we take out climate change and we continue with the problems of habitat destruction, over-killing, diseases and so on-

Nate Hagens (01:16:09):

Pesticides, herbicides. All that.

Gerardo Ceballos (01:16:10):

Pesticides, herbicides. We will face a sixth mass extinction. If, unfortunately, on top of that, we put climate change, that will mean that we will affect many more species much more rapidly. And there will be synergic and additive impacts, effects among all these issues. So this is why it's so complicated, so complex, and so overwhelming, because it basically involves all the human enterprise.

Nate Hagens (01:16:39):

Okay. Here's a tough question, Gerardo. Do you think a collapse of human civilization would be good for animal and other species population? Some people think definitely so, and others I've talked to think absolutely not. What do you think?

Gerardo Ceballos (01:16:56):

Well, I would say in a different way. First of all, what we have learned from all the past extinction, mass extinction, is that life has recovered. Completely different things, completely different species. There are no more dinosaur or there are no more trilobite. But life recovered. But it took 15 to 20 to more million years. So in other words, I feel somehow a little bit less stress when I think that unless there is a nuclear holocaust or something like that, life will prevail. Okay?

Gerardo Ceballos (01:17:33):

Now, if a collapse of civilization is good or bad, it could be tremendously bad, in a sense, and equally speed up the extinction crisis. Just imagine that suddenly there is not enough food in the US, and people has gone. What will happen with the wildlife? They [People] will go and kill deer or kill whatever to feed. And it will happen throughout the world. If you are in a place in Africa, and suddenly there is no more food, and you will go and kill the last elephant with no problem. So in that sense, could be really, really bad.

Nate Hagens (01:18:08):

Yeah. And in the sense, if there's 100-plus nuclear missiles and then there's nuclear winter, and there's no photosynthetic productivity in the oceans... I mean, there's all kinds of scenarios like that, which is I'm trying to work on what I refer to as a bend, not break scenario. And I don't know exactly how that looks. Clearly, the sooner that we stop emitting carbon, the better certain populations will be of organisms in the ocean, for one thing. But yeah, it's a heavy question to even think about. So you do some work on endangered species. Maybe talk a little bit about some of your biggest challenges and biggest successes on your own work.

Gerardo Ceballos (01:18:55):

Yeah, well, what we do in my lab is basically basic science. And we do basic science, really powerful science, but this is different from many labs in the planet, scientific labs, is that we do a lot of conservation in situ. So we go and work to save a species, but also to save habitats, ecosystems. We have created... Almost 2% of the Mexico land mass is protected because of our work that we have been proposed to go over in new areas, as national parks or bio-reserves and so on. And the other part is, we work with endangered species. For instance, we reintroduced bisons in Mexico. Working with all our colleagues, we created a reserve in other Mexico in the US border, and this is, it's called kind of reserve.

And in that we introduce bison, we're protecting the black-footed ferret. And the Mexican home government has re-introduced the wolf. So, and in Southern Mexico, we work with jaguar, we work with tapirs, monkeys, and so on, trying to save them.

Nate Hagens (01:20:05):

Are you connected with a lot of grassroots eco-teams around the world that are working on issues because of your center node nature in this topic?

Gerardo Ceballos (01:20:16):

With some, not with many, but some, yes. Because we are so unique in the sense that we do science, and we also do this work. So we're not as well-connected in that sense with other groups. Simply we don't have enough time to do it. But yes, we are part of some networks. And then, the other thing we do, so we propose and protect areas as nature reserves. We work with endangered species, but we also do what we call public policy. We propose the first Endangered Species Act in Mexico that now protects 3000 species.

Gerardo Ceballos (01:20:51):

And we propose also, we help to create the National Commission on Protected Areas and so on. We create the first program for recovery of prairie dogs and jaguars. So we go for, and then, we do a lot of outreach. We do a lot of working with the local government, so local people and schools and so on, trying to talk about these issues. But also talking many times about the successes that we have. We have got a lot of success. And although it is small for the magnitude of problem that they have in Mexico or in the planet, those successes are very important to talk about, because gives hopes to people, and guidance.

Nate Hagens (01:21:35):

Well, we just need orders of magnitude more people working, or at least devoting some time and resources and effort and passion towards this issue. What are some ways that people listening to this program who care about other species in the natural world can make an impact globally, or especially in their local ecosystems to help other creatures make it through the coming bottlenecks of this century?

Gerardo Ceballos (01:22:01):

Well, first of all, if they are listening to this program to your podcast, they are already doing something that is good. They are getting good information. I would say that anything that can reduce our impact locally at home. For instance, if we are more affluent and we can buy better soaps or better foods or use less plastic and some, that's all good. If you go into the internet and put 50 ways to help the environment, you will find literally hundreds of pages that will guide you on what you can do. But for instance, never buy wildlife as pets, never eat wildlife for food. Try to reduce your impact of eating meat, for instance. I like meat and already eat meat probably once every two weeks or something like that. And before, I used to eat it two, three days a week. And nothing changes. Actually, probably my health is a bit better in some senses, but I haven't lost my pleasure of sometimes eating meat.

Gerardo Ceballos (01:23:04):

I just have to be most responsible how to eat it. We buy things here at home, local thing. People, for instance, every Wednesday, a guy comes and sells us their fruits and the vegetables that they grow from here. And in the ranch that we have, we do exactly the same. We grow a lot of our own legumes and fruits and so on. The other thing is to get involved locally and regionally, for instance. It's very important at this point, the people that you bought for has to have the right ideas in terms of protecting the environment.

Gerardo Ceballos (01:23:40):

In terms of putting the proper loss and the proper norms to reduce our impact. And the other part, it is incredibly easier now, if you're interested, for instance, in saving species, to become volunteer. Or to donate funds, or to do something to help the species that you're interested. Basically what I said, because there are not recipes, there are so many ways to do it. Basically what we have to do is to become actors instead of being spectators, really. And now with the social media and with the internet, we can really become actors in a big way, locally, regionally, and globally.

Nate Hagens (01:24:24):

I think my sense, and of course it could be my network, and so I'm biased, is a lot of people understand this. A lot of people care about it, but the barrier to entry is so high that they don't know what to do. They want to do something. And I think sometimes, you know my work about the Superorganism and the energy-hungry entity that humanity en masse has created. It's hard to fight that, but I think there are watersheds and communities and ecosystems around the world where people listening to this show live, and you can get a start right there. It's just, how do you get started? I wish there was some international network with a how-to guide on protecting your local creatures and ecosystems. Does that exist? What do you recommend on that?

Gerardo Ceballos (01:25:18):

Well, it does exist and, as I said in the internet in YouTube and so on, there are many ways, many examples where you could do. But probably, I mean, get closer to people like me or you or to people, or some of organizations who are doing good work. It is hard, but it's not impossible. And the examples are now replicating, but you just give me a good idea that maybe it will be good to have a-

Nate Hagens (01:25:46):

A clearinghouse.

Gerardo Ceballos (01:25:47):

A clearinghouse for that. And let me tell you something. I have been working with a new project. We call it First Stop Extinction, and I would call it Creatures United. That if it works and everything seems to be going in the right direction, it will be basically that. It will be a massive moment. We'll try to get the idea of a species extinction to 2 billion people in the next five years. Specifically, what is the problem? What is magnitude, what I can do. And then to direct the effort to basically four things, what needs to.

Gerardo Ceballos (01:26:25):

I mean, projects who are already working, saving a species and ecosystems. Then a database who have already been built, where you can click in your neighborhood and see what are the species and what species are in danger. And basically, and the third part that we will be develop is we will be the clinic, as you say, okay, I am in Oaxaca, Mexico. I like to find out what are the groups who are working in endangered species. And you can click it, and it will give you all the groups working there. And then you can go and search and decide which one you want to support

Nate Hagens (01:26:59):

Creatures United.

Gerardo Ceballos (01:27:00):

Creatures United. And the idea, it is very ambitious. It will be to help to save 100 million hectares, 1 million species, and to reach probably between 2, 3 billion people in the next 10 years.

Nate Hagens (01:27:14):

And not only would that help those species and ecosystems, but it also gives a sense of the sacred to those humans working on those things that we're lacking in our lives right now.

Gerardo Ceballos (01:27:27):

That's exactly right. And it also will be a solid ground to avoid many of the dangers of possible collapse. It's very ambitious. It's going, it's coming along well.

Nate Hagens (01:27:41):

It has to be ambitious. So let me know if I can help you with that, Gerardo.

Gerardo Ceballos (01:27:44):

I will. And we will launch on November. And just to give you an idea, the idea is that we call it Creatures United because these are animals dressed like humans. And it would say, for instance, "Hey you, I am the white elephant, the white rhino. I'm becoming extinct. I need your help. I'm talking on the name of all these endangered species. We need your help. Please help us." Something like that. And then it will be show, we want it to be for two days, on the walls of the United Nation. You know that at night they put their colors of flag sometimes. We want to put the creatures there, showing how many they are and where they are, and why are they becoming extinct?

Nate Hagens (01:28:28):

Good luck with that. I sense that people already feel that this is happening, and it's too painful to go there. So it has to be coupled with direct action steps that people can immediately do. Otherwise, it's too sad and overwhelming, I think.

Gerardo Ceballos (01:28:45):

But you are right. I mean, here, you can donate to projects who are already working and saving the species. You can participate in our project. It will tell you what kind of thing you can do, for instance, what product you can buy, reducing your impact. It will tell you what is the problem of trade, wildlife trade, and what can you do to avoid it and so on.

Nate Hagens (01:29:06):

I think that's really important. I also do think we need people to find each other in communities in Topeka, Kansas, and Red Wing, Minnesota and Toluca, Mexico that find each other, and actually try to restore the ecology and protect the species in their own watershed within five miles of their house. And to have a toolkit for that. And I don't know how possible that is.

Gerardo Ceballos (01:29:29):

Well, I think about it. I read that somebody said that we need $400 billion to invest in conservation, and it will be enough to tip off the point. $400 billion a year is nothing in a trillion-dollar economy. And what I say is just, if you lucky that you have $1,000 in your pocket and they say, "Oh, sir, I'm sorry. You have to spend $4. Otherwise you're going to die." We will get it immediately. You know what I'm saying?

Nate Hagens (01:29:56):

I mean, well, that's why I'm so impressed and thankful for people like you and Daniel Pauly and Peter Ward and others who are -- because there's not a lot of funding to learn about all the other species that we're sharing the planet with. So thank you. I have some questions that are a little personal that I ask to all my guests, if you don't mind. So Gerardo, you were an animal researcher expert, but you're also a college professor. So what do you tell your students after hearing about species extinction and future risk? Do you have any recommendations, specifically for young humans listening to this show who are becoming aware of the economic environmental risks and challenges we face?

Gerardo Ceballos (01:30:39):

Well, what I say first of all, that there is a still time and there is still, we have a lot of responsibility, but also it's a great time of opportunity. So I say to them that they the most open mind they are, and the better academically prepared they are, the less focused on one thing and more broad their knowledge, they will be better. What I tell my students and the people that take my classes is that they have to spend time understanding the market, understanding what are the places where the society will need specialized people, and that they have to think how to put their heart and their passion towards those places.

Gerardo Ceballos (01:31:28):

So they can have a decent job to do that. And I put myself as an example. When I was studying ecology, the ecology, the word wasn't even understood. And probably I was one of the first, probably 20 ecologists in the country, maybe less. I mean, and here I am, I'm well-off and I'm happy. And I do what I wanted to do. At that time, everybody would say, "What I do, Gerardo, you're intelligent, why don't you study lawyer or accountant or something with money. And then you'll be this as your hobby." And my father was very good and he says, "Send them to hell, do what you want to do."

Nate Hagens (01:32:06):

You took the right path, my friend.

Gerardo Ceballos (01:32:08):

I think so.

Nate Hagens (01:32:09):

So what do you care most about in the world, Gerardo?

Gerardo Ceballos (01:32:13):

To be honest, I care most species that are becoming extinct. I'm obsessed to save species. I mean, obviously my family first. But aside from my family, the most important thing for me is what I do. Trying to save things from extinction and make, in terms of my science, the kind of thing I haven't done to be aware and really understand the magnitude of the problems. And then to expose them to as many people as I can, saving species. Saving habitat. It give me so much happiness. For instance, recently, we signed the deal that we're saving this 700,000 acres of forest. Just incredibly, I'm very happy for the people who own that land. But I'm happy for the species who will be saved there.

Nate Hagens (01:33:03):

That's excellent. What are you most concerned about, of all the things we've talked about in the coming decade or so in our world?

Gerardo Ceballos (01:33:11):

Main concern is we don't do the changes that we need to do quickly enough, so we can really stop the problem and avoid a collapse of civilization. And this is both personally, I'm already enough that I have lived a plentiful life, but I'm worried about my children. I mean, they're only 30 years old. And if things go bad, they will be younger than I when they will feel the heat of the whole problem. So that's my main concern. And my main concern, sometimes I wonder, I mean, have we been so... I feel like we have been failing humanity, the people like me who are working on this, and we haven't been able to turn the tide. So I know this is not, it will be very superb or very bad to think that we can have the power to change it. But sometimes I feel worried that we haven't been able to have a better impact, a much higher impact to change the tide.

Nate Hagens (01:34:09):

I feel it every day, Gerardo, that we're not doing enough. But we're trying, and we have to keep trying. So in contrast to that, what are you most hopeful for in the coming decade or so?

Gerardo Ceballos (01:34:21):

I'm very hopeful because I'm seeing changes, right changes. I think that there is so many people interested in what we do, even what I do, or in the environment and corporations, government, TV series, talking about this. I think I'm hopeful. And at least in my mind, I imagine that we are, as I say, like in the '70s with all these revolutions. The minority, the women, the revolution. Or in the late 1900s with evolution, geology, psychology, and economics. And so on. That really shape up the following decade. And for many decades, were perfectly fine. I mean, we were really live in a better world from sometimes in the '60s and '70s, and then we lose track.

Nate Hagens (01:35:12):

I agree with everything you just said, except for the revolution in psychology and economics. Perhaps I might disagree with that, but we'll do that on another call.

Gerardo Ceballos (01:35:21):

It was a revolution. It doesn't mean that it was a proper revolution, but it changed things, you know?

Nate Hagens (01:35:26):

Yeah, no, you're right about that. So if you were a benevolent dictator and there was no personal recourse to your decision, what one thing would you do to improve the human and planetary futures?

Gerardo Ceballos (01:35:39):

Well, if I could do it, I will probably get the experts and finance ways, how to reduce our appetite for fossil fuels. And then take the decisions to curb it.

Nate Hagens (01:35:52):

On that note, do you have any other closing thoughts, advice, or wisdom for our listeners? This has been a wide- ranging, very deep, personal conversation. And I thank you. Do you have any other closing thoughts?

Gerardo Ceballos (01:36:06):

Well, what I would say is that I have devote my life to work with animals, to save species and so on. And I feel very grateful, and I'm very hopeful. I'm very hopeful that we together, we will be able to turn the tide. And as I say before, fortunately the window's still open. It's rapidly closing, but still open. Believe it or not, I'm optimistic. I really think that we can keep working hard, and we may change the fate of humanity and the fate of biodiversity.

Nate Hagens (01:36:43):

Thank you so much for this conversation, and for your lifetime of work on these issues. And I hope to see you again soon, my friend.

Gerardo Ceballos (01:36:51):

Thank you very much. It was wonderful.

Nate Hagens (01:36:54):

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