

Video Transcript – Island Biodiversity – Tracking Human Influences

- Announcer: Today, we are tracking our impact on the planet, and working to restore ecosystems to their natural condition, but how do we decide what is natural? Archaeologists have detected human impacts on biodiversity, even thousands of years ago. Native Americans and other early inhabitants of North America left a record of their resource [00:00:30] use and artifacts and animal and plant remains. Join us now for a conversation with archaeologist Dr. Torben Rick to find out how studying ancient people from islands and coastlines is helping carve a path for future natural resource management.
- Torben Rick: Now, here's your host, Maggy Benson.
- Maggy Benson: Hi everyone, thanks for joining us for another episode of Smithsonian Science How? I'm Maggy Benson. Today we have with us Smithsonian archaeologist, Dr. Torry [00:01:00] Rick. Hi Torry, thanks for joining us.
- Torben Rick: Hi, thanks Maggy. It's great to be here. I'm looking forward to talking to you and all the students.
- Maggy Benson: Wonderful. Can we start by you telling us what an archaeologist is and what kind of data you have and what it reveals?
- Torben Rick: I'm sure you know archaeologists study the human past, and we do this in kind of a unique way. We focus on material remains or objects, all of the things that people over thousands of years have left behind that preserves through time, we use that to reconstruct what was going on. And archaeologists have long been focused [00:01:30] or interested in some of the very core questions, questions that center around what it means to be human, what it means to be us, so where did written languages come from? How did they start? Or social inequality, where did that come from? Or the origins of domestication, and the type of work that I do though, it's a little more mundane than that. I focus on human diet and what people ate, but as we're learning, even basic things about human daily life, they have a lot to tell us about past environments and then the present day [00:02:00] and the future too.
- Maggy Benson: How? I mean how is learning about people of the past relevant for today and the future?
- Torben Rick: Right, that's something we're really working on. In archaeology, although we address these really central questions it's only been relatively recently that we've started to address broad societal issues. One of the ways we can do that is to look back at the long record of the human past. We can look back 100, 500, 1,000, 10,000 years in a particular place, and this gives us what we call, or one of my mentors called, postcards [00:02:30] from the past.

Maggy Benson: I like that.

Torben Rick: Yeah, they're like snapshots. It's, "Hey, we were here, we lived here at this spot and we ate this food and we made these artifacts." And we can stack up all these postcards through time, and then use them to provide us baselines or perspectives of what was going on in the past.

Maggy Benson: Does that help us better understand the time period that we're in now? I've often heard that right now we're in the period of man.

Torben Rick: Right, it does. Archaeologists, we often deal with geological time periods like the Pleistocene [00:03:00] or the Holocene and that's about 2.5 million years ago or the Holocene is the last 10,000 years. And now what we've seen is people are arguing we're living in the Anthropocene, and there's a debate going on among scientists and even policy makers about whether we are.

Maggy Benson: And that's the Age of Man.

Torben Rick: Exactly. It's the Age of Humanity, the Age of Us. It's really recognizing that what we're doing now and the types of things we're doing have a really big impact or influence on the world around us.

Maggy Benson: I can understand how that makes it tricky to better understand what [00:03:30] our ecosystems have looked like through time and what constitutes them as natural.

Torben Rick: Right, exactly. A way to think about this really quickly though is to think about what we have today, what we would have around us. So industrial, things that we leave behind might show up for a future archaeologist, and then some of the stuff we look at in the past is kind of similar. We'll get to that in a second, but when we think about baselines and what's natural, it can be a tricky thing to think about where that fits [00:04:00] in.

Maggy Benson: I think we should ask our students what they think about this topic, what do you think?

Torben Rick: Yeah, I think that's a great idea. Why don't we ask the students?

Maggy Benson: All right, great. So we have a poll on your video screen for you. When did natural ecosystems last exist? Before the 21st century technology revolution? Before the early 1800s industrial revolution? Before farming began 10,000 years ago? or Before humans arrived in an area? You can respond using the poll that appears to the right of your video screen, [00:04:30] and remember that this is the same place that you can post questions for Dr. Torry Rick to answer during today's program.

Maggy Benson: [00:05:00] So Torry, the results are still coming in and it looks like they're split between farming and when humans arrived. What do you think?

Torben Rick: Wow, that's great. I think that's really interesting. Really the key for this question is there is no right or wrong answer. It's one of those questions where everybody is correct and it kind of gets to the core of what we're trying to deal with. That question is kind of a career-long problem that I and other researchers I work with are trying to address. And it gets us back to an issue of baselines. [00:05:30] We mentioned these long postcards from the past that we have to deal with, and, in this case, what we're also looking at are reference points. One of the things when we hear today that our ecosystems are degraded or there's problems with them, we want to restore them and bring them back to a "natural state," one of the things we need to realize is well what is that state? Archaeology provides us a great lens to see that, and it also can challenge us to think about a really big issue today, or one that we've dealt with for a long time, and that's what is [00:06:00] natural and what is cultural?

Torben Rick: Where do we fit in to the natural world? Are we part of it or separate from it? And that's a question for all of us to debate I think.

Maggy Benson: I think I've seen the example before where fish have provided baseline examples. Can you tell us a little bit about that?

Torben Rick: Right, so yes, definitely. There's an example of a study that was done. You can see it up here on the screen right now. This is a study that was done at a trophy fishing competition in Florida, and it's a couple decades-long look at this one spot, this one competition [00:06:30] held at the same time every year. What it does is give us those snapshots. A different vantage point, those postcards of this place. We can see changes in the types of fish that were caught and the sizes of the fish. One of the things we always joke about is that the size of the fish goes down through time and the size of the people goes up.

Maggy Benson: The clothes change, too.

Torben Rick: And the clothes change too. (Laughter)(Maggy: That's a baseline.) Exactly, yeah it is.

Maggy Benson: So it's pretty interesting that all through these decades there's such drastic [00:07:00] changes in these baselines, but it sounds like 10 years ago, 20 years ago, 100, 1,000, people have always impacted their environments, even maybe Native Americans who we sometimes think lived in perfect harmony with nature.

Torben Rick: Right, so archaeology can add on to a study like that by adding that longer time series. Instead of going back a couple decades, we can go back hundreds or thousands of years. And then what it does is it shows us that pretty much everyone, all of us, no matter who you are, where you live or when you lived in

the past had an influence on the environment around [00:07:30] you. And that's from basic Native American hunter-gatherers to subsistence-level agriculturalists to major industrial societies. We all influence the environment around us in both positive and negative ways, and we kind of see it as a continuum with all sorts of shades of gray in between.

Maggy Benson: So it's very tricky to be able to really understand what the natural state of an ecosystem is, but how do you go back and use these baselines, use your research to be able to better understand the environments and maybe even managing them?

Torben Rick: Yeah, it is really tricky. And [00:08:00] one of the things I should say is that we're providing parts of a larger picture, right? We're not giving all the answers, we're providing a component that can help us better understand today. We think that by looking backwards at that long lens, we can better project forward. And the ways we do that are traditional archaeological analysis, analyzing the stuff that we find, the shellfish we find in an archaeological site, the bones that people left behind from things that they were eating. By analyzing and quantifying and understanding how this changed [00:08:30] through time and across space we can really contextualize what the ecosystem was like, where people fit into that. And then we can start to apply it to problems that we have today.

Torben Rick: So we could look back and say, "Well what was going on a thousand years ago? Is that what we want it to look like in the future?" And it gets us from a baseline to something a little more complicated that we call a desired future condition. That means that all of us, scientists, policymakers, all of the students out there, we're all stakeholders in the world around us, and we should all be helping and be proactive towards [00:09:00] what we want it to look like.

Maggy Benson: There's a question from Xena that actually aligns with this. She wants to know "In the pictures you can see the size of fish changing, do you think later on, maybe in the future, the fish populations will have massive growth?"

Torben Rick: Xena that's a fantastic question. Yeah, it's possible that they might have rapid growth. I can't say for sure, but one thing you might be getting at is that in some cases we get what's called eutrophication where nutrient levels go really up. Sometimes that can have negative effects in declining [00:09:30] animal population, but in some cases it can have actually short-time big growth implications. So it's possible in the future we might see some larger fish. We're also seeing one thing called marine protected areas, areas that are protected where people can't harvest from today. The fish in those areas are really doing well and getting bigger and bigger, and we see a rebound.

Maggy Benson: Thanks for the great question Xena.

Torben Rick: Yeah, it was a good one.

Maggy Benson: So Torry, what kind of archaeological data do you actually use to better understand these baselines?

Torben Rick: We use a variety of different things, [00:10:00] some of which are positioned out on the table here in front of us. The ways we do that, you can see on the screen some of our excavation techniques. The way we generally go about it is by getting into the field and doing some excavations like we're doing here in this Arroyo cut. Sometimes we're in precarious spots, because if we're looking at 1,000 or 10,000 years ago, sometimes these deposits are deeply buried. So we generally go in and excavate a site and try to recover all of the things that were there, the artifacts people made to the bones and the shells and the things that are from what they were eating. All [00:10:30] of that adds up to a great understanding of what that environment was like and how people played a role in it.

Maggy Benson: A really nice treasure trove of information to help us understand the past.

Torben Rick: Yeah, it really is a treasure trove.

Maggy Benson: So Torry, you work at different research sites around the country, and one of the sites that you study at is in the Channel Islands, can you tell us about why this spot is unique? Maybe about its biodiversity.

Torben Rick: Sure, the Channel Islands are a remarkable spot. I've been lucky to work there for a number of years. There're eight islands situated off the coast of Southern [00:11:00] California. They're actually as close as 20 miles from the dense urban centers in Los Angeles. The Channel Islands though, even though they're that close, the ocean gap makes them worlds apart. There are no really big permanent cities out there or anything like that. Five of the eight islands are actually managed by Channel Islands National Park, and because of that you get these really distinct ecosystems. Then you add on top of that, the fact that the archaeological record there goes back some 13,000 years. [00:11:30] You get this really long Native American archaeological record on top of these unique environments.

Torben Rick: We're seeing aerial shots of what the Channel Islands look like right here. You can see those environments and really rich sea bird habitats, really rich seal and sea lion habitats and then of course distinct terrestrial ecosystems. Because they were separated from the mainland, you also don't get many of the species that you see on the mainland. (They) don't occur on the Channel Islands - deer or carnivores or anything like that.

Maggy Benson: It looks so beautiful, especially [00:12:00] if you're just across the water from LA. Is what we're looking at natural?

Torben Rick: Right, that's the key question. We've already hit on the point that natural is sort of one term you might want to put in quotes or have a caveat whenever you say

that. It's a mix. It's a mixed bag when you look at that. Some things are natural and are native to the landscape out there, and other things are pretty obvious that they're not. Actually, the primary restoration goal of the Park Service is to get rid of some of those invasives; the big ones are things that were introduced in the last 200 years from the ranching era. [.00:12:30] You can also see a picture, like this one that's up on the screen, sort of typifies what I'm talking about. You might look at this and say, "Wow, that's totally natural. It's fantastic. The seabirds there, the seals and sea lions on the beach," but what's lying underneath your feet that you don't even know about is a massive archaeological site that's about 600 years old, a big village site.

Torben Rick: You can imagine 600 years ago, which isn't that long ago.

Maggy Benson: No, especially in geologic time.

Torben Rick: Exactly, 600 years ago there might have been 25, 50 or even 100 people living there. It would have been very different. Then (this) gets us [00:13:00] back to what is the baseline? What do we want this to look like? And what should it be for the future?

Maggy Benson: So you have a lot of objects here on the table, and I'm really drawn to this fox, and I know you have some skeletons here. Are they an example of a naturally occurring animal on the Channel Islands?

Torben Rick: Right, exactly. So that gets us back to what we've been talking about again. There's a series of foxes we have laid out here. This is a pelt from a Gray Fox, and Gray Foxes occur throughout Western and the Eastern [00:13:30] U.S. Then we've got a Red Fox skull here, a dog skull for scale. A Gray Fox skull there. And then we've got an Island Fox; this is what we've been working on. Island Foxes are close relatives to Gray Foxes found on the mainland. You can see a big difference between the two though, if you look at these guys, is the size. Gray Foxes from the mainland are about 30 percent larger than Island Foxes, and you can see some of the pictures on the screen here just how beautiful they are.

Maggy Benson: They are very beautiful.

Torben Rick: Yeah, and they're considered an endemic species. This is their [00:14:00] native homeland. This is where they occur.

Maggy Benson: Do they occur beyond the Channel Islands?

Torben Rick: No, they only occur out there on the six of the eight Channel Islands. They're kind of a hallmark of the Channel Islands. There are something that any visitor, I hope, who goes to the Channel Islands gets a chance to see them in their natural habitat. They're a key predator because there aren't the large carnivores from the mainland. These guys are really a dominant predator there, even though they're only about the size of the cat. In our work, we've been really

interested in understanding, "Well okay, how long have they been out there? When did they get [00:14:30] there? How did they arrive? And then knowing that people have been there for 13,000 years ago, how did their interactions with Native Americans and then ranchers and then the general public today, how did that influence their history? And how can we use that to better understand where they might be going in the future?"

Maggy Benson: Great, so Jessie C. has a question. Jesse wants to know, did you figure out any native activities that people don't do today? It's a little behavior question about the native people.

Torben Rick: Right, well Jessie that's another good question. There were lots of different things [00:15:00] that people did in the past that they don't necessarily do today. One of the biggest ones for me, since I keep saying I'm interested in diet, is the types of things that people ate. One of the things is today we go to a supermarket and a grocery store to get all of our food but just imagine living off the land as a hunter-gatherer. Every meal that you're eating you have to get and maintain for yourself. You're not growing the food as a hunter-gatherer, either. That's one of the big differences is just the basics of getting your food, and then using all the natural things around you to make your artifacts too I think is another [00:15:30] difference.

Maggy Benson: Great question. So back to the fox, how do you actually know how old these fox skulls are? And how do you know that they've been cohabiting with humans for that long on the Channel Islands?

Torben Rick: Right. We've been doing a variety of different things, and this again shows us that archaeology is kind of a team sport. We've been collaborating with a lot of different researchers around the country at San Diego State University and the University of New Mexico, Santa Barbara Museum of Natural History, and then, of [00:16:00] course, the Smithsonian's National Zoo is one of our biggest partners. What we've been doing with foxes is we've been one, putting them in space, so looking at all of the archaeological sites, all of the fossil sites that contain their bones, and then we radiocarbon date them, meaning like this one here. This one is actually archaeological. It's about 6,000 years old

Torben Rick: What we do is we take a small sample of bone, we submit it to a lab and we get a date back on how old it is. Then what we do is we take it another step further and one of our [00:16:30] collaborators does what's called stable isotope analysis on that, and he gets an idea of what they were eating. And then, most importantly, what we've been doing lately is ancient DNA analysis. We work with our colleagues at the zoo to extract material about their genetics that we can then compare and understand how they're related to foxes on the other islands, on the mainland, where they might have come from ultimately too.

Maggy Benson: So part of your work is comparing these ancient foxes to modern-day foxes, and I see right next to that 6,000 year-old Island Fox, something that we're all

familiar [00:17:00] with, but maybe a little embarrassed about, why is that there?

Torben Rick: Right, well you can't go anywhere without bringing a little fox poop with you. This is a gift from my collaborator and colleague. (Laughter)

Maggy Benson: A gift?

Torben Rick: A gift.

Maggy Benson: I want to be friends with this person.

Torben Rick: Yeah exactly. It's from my colleague and collaborator, Jesus Maldonado, out at the National Zoo, and then Courtney Hoffman our student there who are doing most of the genetics work with us. One of the great things is (that) to understand the past you've got to look at the present. So you want to know the genetic makeup of the present-day [00:17:30] foxes that are there, and to do this you need a blood sample or a tissue sample. Although we have ways to do that without causing any harm to the foxes it's still invasive. One of Jesus' great contributions is that he's a master at non-invasive techniques, and he can do DNA analysis on the poop that can give us similar information. We've done this on Channel Island Deer Mice and other species too. So it's a really exciting way to, I think, think about linking the present and the past.

Maggy Benson: Very fun.

Torben Rick: Or a unique way, maybe is a better way [00:18:00] to put it.

Maggy Benson: So this is very long history between Island Foxes and humans on the Channel Islands, and your data is helping better understand them through time. How is that helping the management of them now?

Torben Rick: Yeah, that's key. I think we're just starting to figure out how it can help management. And one of the things about the Island Foxes, they were a Critically Endangered species back in the '90s - the populations were so low. Yeah, you can see pictures of it right here. The Park Service did really an amazing success [00:18:30] story with their partners at the Nature Conservancy and elsewhere to bring these fox populations into captivity, do a captive breeding program, get their populations up and then re-release them. Now, the populations are doing really well. So that's an amazing success story. But, the question is where are they headed in the next 10, 100, 1,000 years.

Torben Rick: One of the things we can do with our data is understand when did foxes first arrive? And we have kind of clued in on it looking like they arrived about 9,000 years ago. So they've been there, they came in maybe later than [00:19:00] people at this point. We don't know exactly how, if it was a natural rafting event

that happened or if people brought them out on a boat from the mainland. We're not really sure, we're still trying to investigate that.

Maggy Benson: So the marine, I mean people coming out there on boats, there has to be an impact that's similar to the fox story for a marine species on the Channel Islands.

Torben Rick: Exactly. We can get snapshots of all of the foxes through time that we can then use to manage them in the future and give us ideas what things might look like at different climate regimes. We can also do that for the marine environment. These are [00:19:30] islands, so all around the Channel Islands are surrounded by water, and so we've been looking at shellfish remains and fish remains and trying to do similar stuff that we've done with foxes. On the table here you can see some of the shellfish that we brought that represent our work. These are red abalone shells.

Maggy Benson: These right here?

Torben Rick: Yeah exactly. Right in front of us. These particular shells are about 6,000 years old and they occur in archaeological sites all over the Channel Islands. Today their populations are really doing poorly. [00:20:00] There's a moratorium on it, there's no fishery on these anymore.

Maggy Benson: So people used to consume these, eat them?

Torben Rick: People used to consume them a lot. They were very popular, but what we've done is quantify them, measure them and look at how they've changed over 10,000 years on the Channel Island, and then compare that to modern and historical commercial fisheries records and then try to make predictions for the future about where the best places might be for restoration of abalones.

Maggy Benson: Where do you find these shells? Are they just laying on the beach? Do you have to dig far inland? How do you get [00:20:30] them?

Torben Rick: Once you know how to find an archaeological site, they're there, and they're usually right along the shore. We go in, they're a protected resource too, so you don't want to do any excavation without a proper permit. Once we find these sites we usually have to excavate small units; we focus on what we call midden sites or trash pits. Midden is a word that just kind of rolls off my tongue all the time but middens are where we generally work, in these shale piles or refuse piles of people's ancient trash.

Maggy Benson: So really you're an archaeologist that looks through garbage [00:21:00] of the people of past times.

Torben Rick: Yeah, thanks for pointing that out. (Laughter), I really appreciate it. I basically am a glorified ancient trash digger and that's what we're doing but-

Maggy Benson: So it's true, one person's trash is another man's treasure.

Torben Rick: It is and I guess the trash is truly my treasure. One of the things though is, if you think about it, you can learn a lot about people from their trash. You can learn a lot about their environments, and you can just think about what we have in our trash today and these archaeological sites are the same way.

Maggy Benson: Is this part of an archaeological site of a trash pit?

Torben Rick: [00:21:30] Yeah it is.

Torben Rick: What we're looking at is a soil monolith, which is basically a 3D pullout of the soils that were on a particular archaeological site. This part here on the left of the screen, this is the top where the midden is actually located. These are all oyster shells, so this is from the East Coast in the Chesapeake Bay, and as you scroll down you're going deeper into the earth and down into sterile sediments that have no archaeological material. This particular one, that's a big sand dune. So people came in, this [00:22:00] is about a thousand years ago, lived on top of a sand dune, deposited their trash there and then we come along and find it. You can even see in here there's some artifacts, there's a piece of pottery sticking out and then oyster shells are really the big standout.

Maggy Benson: So you have oysters here, do they have a similar story to the abalone and the Island Fox of the Channel Islands?

Torben Rick: They do, and we've gone bi-coastal. Just like we've been working out on the Pacific coast, we're now working on the Atlantic coast on oysters. Just like the abalones, the oysters went through a [00:22:30] major amount of decline. They were a really important commercial fishery, but today in Maryland we often see less than 1 percent of what they were 100 years ago. What we're trying to do is go in, measure them, we do stable isotope analysis just like we do on the foxes to give us environmental conditions. Then we develop those snapshots or postcards through time of what oyster abundance was like. Then, hopefully, that can help us better manage them into the future.

Maggy Benson: So for managing, you have to understand the impacts that have happened to them. And I think this [00:23:00] is another great opportunity to ask our students what happened to those oysters populations.

Torben Rick: That sounds great.

Maggy Benson: All right, so here's your opportunity to take another poll. Why have oysters declined in the Chesapeake Bay and along the East Coast? Was it harvest by Native Americans? Harvest by later colonists? Climate change? Changing water salinity levels? Or all of the above? Take a moment to think about it and put your answer in the window to the right of your video screen.

Maggy Benson: [00:23:30] So Torry right now about 57 percent of people say all of the above. What do you think?

Torben Rick: Perfect, I think that's the exact right answer is all of the above. What we often [00:24:00] characterize it as that the problems facing Chesapeake oysters are a multi-headed monster, right? So it's salinity which is changes in the salt content in the water that oysters need to live and thrive. It's changes in climate that are affecting oyster populations. It's human over-harvesting and it's disease. And all of those things are really affecting them. So they're exactly correct.

Maggy Benson: So there are impacts that us humans are making to the earth today that probably have an impact on archaeological sites, not just the actual [00:24:30] flora and fauna of the earth. Is sea level rise actually threatening things like your Chesapeake Bay oyster sites?

Torben Rick: Yeah, exactly. We think these sites have a lot of value for understanding present-day environmental issues and future environmental issues. But these sites are also extremely important resources in their own right. They're very fragile, non-renewable resources. Each time we dig a site or each time a wave washes on the shoreline and erodes part of it away, we're losing part of our shared [00:25:00] cultural and human history. And as sea level is predicted to rise with climate change in the next 10 to 100 years and continues to rise, we get more erosion. We're losing parts of these sites every day. And one of the things we're doing is trying to be proactive about it, and try to get in and gather as much information from these as we can before they're permanently lost. So that means dating them, sampling them and then trying to quantify them to help build this bigger story that we're working on.

Maggy Benson: And maybe there's the next generation of scientists watching [00:25:30] today that can help actually excavate these sites in the future.

Torben Rick: Yeah, I think so. I really hope and encourage everyone to get into this field. It's been a great one for me. It's one that I enjoy more than anything. And the other thing is you'll notice that I work out on the Pacific coast and I also work in the Atlantic coast where I live. I grew up in Southern California and that was my home. But now, living here, I work in the Chesapeake that's really close, and that's because the local world around you has a history. And so everybody that's out there [00:26:00] watching right now, you're all part of a shared history, and everywhere you go, underneath your feet, there's a history that's just waiting to be explored.

Maggy Benson: Wonderful. This question comes from Xena. What made you want to become an archaeologist?

Torben Rick: Well Xena, that is a great question too. There's a lot of different things that made me want to be an archaeologist. I came at the field, I didn't really get a hold on archaeology until I was an undergrad at University of California at Santa

Barbara. I was 19. Before that [00:26:30] I had thought I wanted to be a marine biologist. That's what I wanted to do was study the ocean. And then I walked into, just by accident, a class on California archaeology and it changed my life and I've never looked back. Now I see archaeology as a tool to helping us, in a sort of abstract way, but helping us to understand all sorts of contemporary issues and problems.

Maggy Benson: Great, this question comes from Brighton and Mark, what do you do with the trash from the people and the animals?

Torben Rick: All right, well Brighton and Mark that is [00:27:00] great. The archaeological site, we call it trash, but really they're all eco-facts and artifacts, so we give them much fancier, more important sounding names. All of this material, we bring it back to the lab, we carry a lot of stuff, we bring a lot of dirt back, we run it over really fine mesh screens, we bring it back for detailed analysis. For every hour we spend in the field, we spend about 15 in the lab. And then ultimately, we label everything, we keep it all by its provenience, which means the location [00:27:30] information, and then we store it at the museum and hopefully put it up on the web so people know what we've found, we write about it. And then we try to keep it so that new generations in 10, 50, 100 years can come back and relook at what we studied too with new techniques. Great question.

Maggy Benson: Wonderful. And can you tell our viewers where they can learn a little bit more about your work?

Torben Rick: Right. So there's a lot of resources on the web that you can get more information. You'll see on your screen there, at the top, is a link to the Smithsonian's Ocean Portal, which has a lot of information [00:28:00] on the topics we've been discussing today. And then below that is a link to shiftingbaselines.org, which is another resource that has short videos, and all sorts of interesting information on the shifting baselines topic that we covered.

Maggy Benson: Thank you so much for being here with us today Torry.

Torben Rick: Thank you.

Maggy Benson: If you missed part of this broadcast it'll be archived later this evening on qrius.si.edu. See you next time on Smithsonian Science How?

Announcer: Thanks for watching. [00:28:30] You can explore more Smithsonian Science How? shows on our website qrius.si.edu. Join us again on December 11th as we talk to ornithologist Dr. Helen James about her expeditions into Hawaiian lava tubes to look for fossil evidence as to why some bird species survived and others became extinct after the arrival of humans. Register now at qrius.si.edu, [00:29:00] see you then.