Video Transcript: Bird Extinctions – Time Travel through Lava Tubes

Voiceover: Vast flocks of passenger pigeons used to darken the skies of North America. Then, they were gone. How did humans trigger the extinction of the passenger pigeon and other birds? Scientists are hunting for evidence in diverse environments to understand bird populations. Join us now, for a conversation with ornithologist Dr. Helen James to analyze what makes birds vulnerable to extinction. Now here's your host, Maggy Benson.

Maggy Benson: Hi. Thanks for joining us. I'm Maggy Benson, host of Smithsonian Science How. We're so happy that you're here joining us for another episode. And we're really excited to bring to you today, ornithologist and paleontologist from the Smithsonian's national Museum of Natural History, Dr. Helen James. Thanks for joining us Helen.

Helen James: Very happy to be here Maggy, and glad to know the students have tuned in today too.

Maggy Benson: Absolutely. So Helen, you're a paleontologist and an ornithologist. Can you tell us how those two relate?

Helen James: Well, and ornithologist is someone who studies birds. Very simple. And I think most people know what a paleontologist is. That's someone who studies fossils. So I study fossil birds.

Maggy Benson: And how do those two go hand in hand? Are you looking at birds that are obviously very old?

Helen James: There are some very famous really ancient fossil birds that go back to the age of dinosaurs. Those aren't the ones that I focus my research on. I actually study fossils of modern type birds. So, I'm studying birds in what we call the Quaternary period of time, which-

Maggy Benson: How long ago does that go?

Helen James: Well it starts with the Pleistocene about two and a half million years ago and then comes up through the Holocene which is about the last 10,000 years. And honestly, most of the extinctions of birds that I study, have happened very recently in that period of time. So they've happened in the time since people have been present in the world's ecosystems.

Maggy Benson: So you're looking at the extinction of birds and how does that better help you understand bird populations today?

Helen James: Well, I'm studying the history of extinction of modern birds in relation to human ecological impacts, especially on islands but also on continents.

Helen James: And by studying extinctions that have happened because of ecological change caused by humans in the recent past, we may be able to better protect species going forward from further extinctions.

Maggy Benson: Interesting. So I know that there was a big anniversary, the extinction of the passenger pigeon just marked 100 years. Do you do any research on that, or is that an example of a human-influenced extinction?

Helen James: This is a prime example this year, and a lot of people are thinking about bird extinctions because this is the 100 year anniversary of the passenger pigeon. We have the actual last individual to have lived with a passenger pigeon; it's a mounted specimen that belongs to the Smithsonian. She's on exhibit this year, you can see her in the lobby of the Natural History Museum.

Maggy Benson: And that's Martha.

Helen James: And that's Martha. She died in the Cincinnati Zoo on September 1, 1914. She was a celebrity at that time, because she was the last living member of what had been the most abundant species of North American bird, if not the most abundant species of bird in the world.

Maggy Benson: The most abundant bird in the world?

Helen James: Only 50 to 100 years before that.

Maggy Benson: So if that was the most abundant bird in the world, can you tell us a little bit about their life history, their natural history? What kind of birds were they?

Helen James: Absolutely. And I just want to mention too, that we have an example of a passenger pigeon here, so you can see what they looked like. This is a male, he has this rusty iridescence, and the female was duller.

Helen James: But these birds traveled, they were perhaps the most social species of bird ever. They traveled in enormous flocks, they migrated in incredible flocks. They roosted in big congregations, and they nested colonially, in these huge nesting colonies.

Helen James: Their flocks could have had a billion or two billion birds in a single flock.

Maggy Benson: Wow. That's incredible. As we're seeing in this re-creation here, the sky must have gotten very dark when they passed by.

Helen James: People who witnessed these flocks, colonial and pioneer Americans, said that they could hear the thunder of the wings before they even saw the migrating flock. And they would fly over, it could take over a day, or up to three days for one migrating flock to cross the sky. It was just a river of birds.

Helen James: John James Audubon said it was like an eclipse of the midday sun when these birds flew over.

Maggy Benson: So it's astonishing to me that a bird that was perhaps the most abundant on Earth, could go extinct in such a short period of time.

Helen James: It is astonishing. And it was astonishing to Americans living at the time that this happened. They had experienced this very abundant species in their lifetimes, and then they witnessed its extinction.

Maggy Benson: I think we should ask our students what led to their extinction and maybe their vulnerabilities.

Helen James: Let's find out.

Maggy Benson: Alright.

Maggy Benson: Here's your chance to answer a poll with us today. What made the passenger pigeon vulnerable to extinction?

Maggy Benson: Was it migrating in large groups, nesting in colonies, eating acorns and other tree nuts, raising only one chick per year, or having tasty flesh?

Maggy Benson: Take a moment to think about it and put your answer in the window to the right of your video screen.

Maggy Benson: So Helen, the results are coming in, and it looks like we have an even spread across all answers. What do you think?

Helen James: That's showing that the students have very accurate opinions on this, because in fact this was a trick question. Each of those answers has truth in it. And the birds indeed migrating in these large groups, nesting and roosting in these large groups, in particular, made it easy to locate the birds, especially once we had the telegraph to let people know where the flocks were deciding to nest.

Helen James: And then, professional hunters could harvest them in great numbers. And you know, back in those days, we didn't have the chicken farms established that we have now. You couldn't just walk into a grocery store and buy a chicken as easily as you can now.

Helen James: So people relied on wild game to quite an extent. And these birds were just piled into railway cars and brought back to the eastern cities in our country to feed people.

Maggy Benson: So they were a primary staple.

Helen James: They were a very primary staple. And you can find recipes for passenger pigeons in old recipe books.

Maggy Benson: Wow. That's interesting.

Helen James: In addition, they raised as far as we know, only one chick per year. So if you did harvest them, it could be hard for the population to recover, if you harvested them very heavily. And the reason they were able to nest in such huge congregations is that they fed on nut crops. They fed on acorns, chestnuts, and beech nuts during that breeding period. And those tend to be very concentrated when they have a phenomenon called mast.

Helen James: So across this continuous eastern deciduous forest, only in certain regions would you have a tremendous nut crop, and that's what the birds used for their food. So as we cut down the forest and converted land for agriculture, those continuous forests also were broken up.

Maggy Benson: So it sounds like there were multiple factors that went into the extinction of the passenger pigeon. Is this extinction event unique, or are there other birds that have similar stories?

Helen James: You know, we don't really think about it every day, but there are a number of North American birds that colonial, pioneer and earlier Americans experienced as part of the wilderness experience that have indeed gone extinct. Many of these were abundant birds in our native ecosystems.

Helen James: For example, while we spoke of the passenger pigeon, but did you know that just in our area, in Washington, D.C., where we're sitting today, when we go in the forest now, we don't really think of encountering a tropical-looking parrot, but this is the Carolina parakeet that used to be in the eastern deciduous forest.

Maggy Benson: It's beautiful.

Helen James: This amazing bird was native to our forests and fields. And it became extinct. The heath hen that we have here last occurred on Martha's Vineyard and it was a popular bird for hunting here in the east.

Maggy Benson: Again, a staple in a diet.

Helen James: Yep. Another case. And here we have the ivory-billed woodpecker. There's debate about whether this woodpecker is finally extinct or not, but this was the largest woodpecker in our North American fauna and apparently it is extinct.

Maggy Benson: So for these birds to go extinct, is there ever just one reason, or is it a variety of impacts that causes them to go extinct?

Helen James: You know, that to me is a really compelling question that as a scientist I want to address, it's one of the things that drives my research, because we know that a lot of global change is taking place in the world today that there is high rate of extinction, and there are high number of birds that are threatened with extinction.

Helen James: So what I want to study is, what really caused the extinctions that have led up to this in the past? What really does cause birds to finally go extinct? And usually you're right, Maggy, there are a number of forces that could be causing that population decline. And the question for science is to figure out what are the most important ones, what are the most important actions we need to take, then, to preserve species now?

Maggy Benson: So your research is very important.

Maggy Benson: So we have a student question, are you ready to take it?

Helen James: Sure, let's take a question.

Maggy Benson: This one comes from Jeff from Jacksonville. He wants to know, why does it matter if we don't have any passenger pigeons?

Helen James: One of the reasons it matters is that plants and animals have what we call ecological roles, and the ecological role could be what the bird eats, and what ecosystem it lives in, and how it interacts with other animals. And if you have an extinction that had been extremely abundant become extinct, then that very major ecological role is missing. And there's no real effective way to restore it. You can try, you can decide that the ecosystem is not functioning the way it used to because of this extinction, you could try to introduce into the ecosystem something with a similar ecological role, but consider the passenger pigeon.

Helen James: There was no other bird on earth that was like the passenger pigeon. There's nothing we can introduce to restore that role. So that's one reason that losing species is harmful to our ability to keep ecosystems healthy going forward.

Maggy Benson: Great question, Jeff, thank you. So Helen, I know that you do a lot of your research in Hawaii. Why are the Hawaiian Islands the unique landscape for you to do your work?

Helen James: The Hawaiian Islands are a volcanic archipelago, and they're out in the middle of the world's largest ocean. This is an incredible barrier to animal dispersal, for animals that live on the continents; they have a very hard time arriving in Hawaii across all that salt water.

Helen James: The islands are volcanic. They're lava that is pushed up through the lithosphere of the earth's crust, and is poured out onto the surface of the crust. And finally this mound of lava breaks the surface of the ocean and it builds an island.

Helen James: On the big island of Hawaii, those volcanoes stretch even three miles almost, above the surface of the ocean. So they're this very rich ecosystem that is nevertheless separated from other terrestrial or ground ecosystems, by a vast ocean barrier.

Maggy Benson: So how do you find fossils, if that's what you study, out in this volcanic landscape?

Helen James: You know, paleontologists didn't turn their attention toward looking for fossils in the Hawaiian Islands for a long time. In fact, it was in the 1970s that I started looking there with Storrs Olson and some other important contributors in the Hawaiian Islands. And that was really because, who would go look for fossils in volcanoes? What's gonna preserve a fossil there?

Helen James: So the first thing we did is, we went around the edges of the islands, because there you'd have marine sediments accumulated, old sand dunes. Coral reefs that become elevated above sea level. And these are calcium carbonate based sediments, which are very good for preserving bones; bones have a lot of calcium in them.

Helen James: So we looked around the edges of the islands. And then we had an insight, and we began going up the slopes of the younger islands, where there are lava tube caves, and we found fossils in there. We were able to sample the whole spectrum of habitat types in the islands, by looking in these lava caves.

Maggy Benson: So these lava tubes, what are they like? How are you finding fossils in these tubes that carry hot lava throughout the island?

Helen James: That's right. The lava tubes are basically the plumbing system of a lava flow. And if you can imagine, there's a volcanic vent up on the slope of the volcano. And lava is coming down, and there's a river, and you see in these films a river of lava, and molten lava is red. But you also see that some places on the river, there's a little crest where lava is starting to cool, and it crusts over, it's already forming rock, and that's black.

Helen James: Well, this pipe brings the lava all the way down to the front of the flow, where it spreads out. The vent stops putting out lava, red stuff drains out of the pipe, and you've got this empty tube.

Maggy Benson: So how do birds, if you're finding fossils in these empty tubes, how do birds get into them? They're not in lava flows.

Helen James: Right. So sometimes, there are openings into the flow. For instance, where you saw in the video that there is red lava, there's no crust over that, that lava can just drain out and you've got this vertical opening into the tube.

Helen James: Birds like an ibis; we'll show you an ibis that we found in a lava tube cave. Let's say this ibis was wandering around in the woods, it was very much like a kiwi in its habits, wandering around looking for snails in the woods. It falls into this trap.

Maggy Benson: Like this.

Helen James: Exactly. This is an artist depiction of how the ibis could have become preserved in the cave.

Helen James: So the ibis falls in. It's flightless, it's unable to fly. So it wanders in the cave's darkness, and it passes away there. So thousands of years later, the paleontologists that come along can use ropes to carefully and gently lower themselves into the cave. And then we find those bones still preserved in the darkness, thousands of years later, and actually they can be remarkably preserved. We actually find biological molecules that were part of the living organism still preserved in those bones, like DNA and collagen proteins.

Maggy Benson: Wow. That's incredible. So how do you picture what this animal looked like if it could be thousands of years old and since extinct? How do you go from knowing from the bones, what it looks like?

Helen James: Well, we study the bones very closely, and for example, you can look at this skull. This is the fossil skull of an ibis from a lava cave. The bill shape, you can pick it out, if you know the ibis has this big curved beak, you can really quickly pick out that this must be an ibis skull.

Helen James: But in other cases it's not so evident what the bird is. So we have a comparative collection here at the Smithsonian of the skeletons of modern birds, which are all identified. And we make very close comparisons of the skeletons of these fossil birds with the modern birds, in order to understand what their body forms were like.

Helen James: Another good example is the skull of this bird, this is related to ducks, but it's a big goose-like skull, it had undergone a lot of evolution in the islands, and it had become basically this big, heavy-bodied herbivore, like the native sheep of the islands.

Maggy Benson: Was this bird also flightless?

Helen James: This bird was also flightless. And I think we have a skeleton of this bird that we can show you. So an artist that I worked with illustrated each bone very carefully, and then rearticulated them in Photoshop to show us what the skeleton looked like. And then afterwards she put feathers on the bird so that you could get a concept of what this animal might have looked like walking around in the woods.

Maggy Benson: Interesting. So you've shown us two birds that you've reconstructed that are both flightless. Is there a connection there with flightlessness and extinction on the Hawaiian Islands?

Helen James: Well, thank you for asking me, because I want to talk about flightlessness. You know, the birds that colonized the Hawaiian Islands had to fly there, across several thousand kilometers of ocean, in order to arrive there on these volcanoes.

Helen James: But at least 22 different species in the islands, that we've found fossils of, became unable to fly through evolution. So their wings became very small, and if you look at that skeleton, the reconstruction that we had of the moa-nalo, you see it has its tiny little wings.

Helen James: I also want to talk about the sternum. This is the sternum of a goose.

Maggy Benson: So the breastbone.

Helen James: Yep. This is the breastbone of a goose. And if we look at this, everybody has seen this bone in a chicken. You know this big keel here supports all that wonderful breast muscle that we love to eat. And that breast muscle is what allows the bird to fly; it's the very heavy breast muscle that powers the flapping of the wings.

Helen James: But if we look at the sternum of the moa-nalo, which is actually a relative of geese, look, the keel is completely missing from this sternum. So this bird had only a thin sheet of breast muscle, and it had tiny little wings, and a great big, heavy body, and it was completely unable to get off the ground and fly.

Helen James: So they basically evolved to fill a mammal-like niche, and they become a terrestrial bird.

Maggy Benson: That's interesting that you can tell if a bird is flightless or not by the sternum. But I'm still really curious about this flightless question and the vulnerabilities that may have come with that. What do you think? I think we should ask our students this question.

Helen James: Let's ask them.

Maggy Benson: Alright, wonderful.

Maggy Benson: Why do flightless birds tend to go extinct?

Maggy Benson: They fall into lava tubes, they can't find food on the ground, they can't fly away from predators, their nests are easy targets for predators, or all of the above?

Maggy Benson: So Helen, we had mixed results. What do you think the correct answer was there?

Helen James: There were some answers and some incorrect ones. So the birds didn't go extinct from falling into lava tubes. It was actually very rare for them to do that, and I can assure you, the paleontologist has to look far and wide to find a bird that fell into a lava tube.

Helen James: But avoiding predators is one of the main ones. Because when people arrive on islands, they often bring mammals, other mammals with them. Mammals like even a small rat that is introduced can be a predator for birds that are nesting on the ground. They can chew through the eggs, for example. So the predation rate from things like mongoose and rats, and cats, can be quite high compared with when these birds evolved flightlessness.

Maggy Benson: So when humans arrived on the Hawaiian Islands, they brought predators that these animals weren't used to.

Helen James: That's right.

Maggy Benson: so did you find any other remains during your research in Hawaii other than flightless birds?

Helen James: We found an amazing variety of birds, perhaps 60 extinct species of birds in this research. And many of them were flightless birds, they were also raptorial birds like an owl and a hawk that was specially adapted for feeding on birds.

Helen James: Then there were a whole variety of colorful forest birds that became extinct, such as relatives of these Hawaiian honey creepers.

Maggy Benson: These are beautiful.

Helen James: Yeah.

Maggy Benson: So can you always tell what kind of bird you're finding based on just the bones?

Helen James: Well, we can tell a lot from the bones, but there's a lot more we can learn from looking at those ancient biomolecules I mentioned, that are preserved inside some of these bones.

Maggy Benson: How do you get to them?

Helen James: Well, I have wonderful collaborators who work in stabile isotope labs, or ancient DNA labs, or radio carbon labs, who are able to get amazing information out of the bones. We had to sacrifice a bit of bone for this, and powder it up. And it goes through a long laboratory procedure.

Helen James: But then, we can use a radio carbon date to find out when in time that individual bird died. We can use stable isotopes, for instance carbon and nitrogen, to find out something about its ecology, its habitat, what it ate. And we can use ancient DNA sequences to find out about its evolutionary relationships and also about its past populations.

Maggy Benson: And don't you use something else that some kids might find very amazing today?

Helen James: Oh yes. You know, in one of my excavations, we actually found coprolites. Coprolites are a polite way for saying we found ancient turds from this big waterfowl species. So this is an illustration you're looking at that shows the actual fossil coprolite next to turds of a Canada goose, which everyone has seen.

Helen James: And we were able to look at plant microfossils inside the turd and find out these birds indeed were herbivores and they were eating green leafy material, especially ferns. They were probably actually doing hindgut fermentation. Like a sheep, in order to live on such a diet.

Maggy Benson: So your research involves finding these fossils around the Hawaiian Islands and doing analysis on them using museum collections and laboratory techniques. What has this told you about bird populations in the past on the Hawaiian Islands?

Helen James: Well, it's a bit of a sad story, Maggy. Tremendous amount of extinction has taken place. And the extinction, based on the radio carbon dates, apparently took place only after people first arrived in the Hawaiian Islands.

Helen James: We're looking here at a chart that summarizes the number of endemic species, species that lived only in the Hawaiian Islands and lived there all year round, of birds that were in that record when people arrived about a thousand years ago. And the ones that you see only the white profiles of, those have all become extinct in the human era, only the past 1,000 years.

Helen James: The ones you saw in gray are now actually endangered with extinction. And only those few that have the black outline are still considered safe.

Maggy Benson: That's a huge amount of extinction.

Helen James: Yes.

Maggy Benson: What are some of the direct impacts on these populations that may have caused them to go extinct?

Helen James: We know of a number of forces of change. There's obviously direct harvesting by people. For example, this beautiful feather cloak was made by native Hawaiian people, and the birds that produced the yellow and the black feathers

are in fact extinct. So we know there was direct harvesting by people of these birds.

Helen James: But that wasn't the main cause of extinction of so many species. It's just hard to drive so many species of birds to extinction. So we also think that introduced predators, that landscape conversion for agriculture, and the introduction later of diseases, all these factors have contributed to the extinctions.

Maggy Benson: So again, it's a variety of factors that are causing declines in bird populations and ultimately extinctions.

Helen James: And the big question for science, when we see a massive extinction like this, is to really figure out what the major forces were and try to control for those going forward.

Maggy Benson: So we're still living in the Hawaiian Islands as humans, and there are still bird populations. Is there any hope for the birds?

Helen James: There is hope for the birds. Conservation biology is a field that has really grown since the extinction of the passenger pigeon and these other North American species that we spoke of, and it's a very serious science now.

Helen James: For example, we could use the Hawaii state bird, the Nene.

Maggy Benson: That is what we're seeing here.

Helen James: Yes. And this species had a very close brush with extinction, and it was only because conservation biologists brought the birds into captivity, figured out how to propagate them, released them back into the wild, that this species has probably escaped extinction.

Helen James: So conservation takes commitment, and it takes effort. But it can happen if possible.

Maggy Benson: And it must also depend on knowing the life histories of these birds, and the populations throughout time, which your research is shedding light on.

Helen James: Bringing forth these records of what the ecosystem had been like before people were in it, and really studying how the ecosystem used to function, before now, we're hoping that we can inform conservation efforts and stem the tide of extinctions going forward.

Maggy Benson: It's been so wonderful learning about your work. Can you tell our viewers where they can learn a little bit more about your work, and the Hawaiian birds that we talked about today?

Helen James: Sure. There are some resources on the web. There's passengerpigeon.org, which I really recommend for passenger pigeons. The Q?rius Website at the Smithsonian, and other natural history websites also are helpful. And the Bishop Museum in Honolulu is a good resource.

Maggy Benson: Helen, we are all out of time. Thank you so much for all of your wonderful questions. It's been a real treat learning more about your work as an ornithologist here at the Smithsonian today.

Helen James: Alright, well it's been a pleasure for me.

Maggy Benson: If you missed part of this broadcast or want to see it again, it'll be archived later this evening at qrius.si.edu.

Maggy Benson: We hope to see you next time, on Smithsonian Science How?

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