

Video Transcript - Ecosystem Change – Plotting with Plant Collections

Announcer: Wherever we go, we alter the planet. In our wake, some living things thrive and others disappear. How can we measure our impacts on natural ecosystems over time to reveal what we have lost? For centuries, botanists have collected and documented a treasure trove of plants creating vast collections that [00:00:30] offer a portal to the past. Join us now for a conversation with plant expert, Rusty Russell, to learn how scientists today are retracing their footsteps to reveal the stories of our changing landscapes. Now, here's your host, Maggy Benson.

Maggy Benson: Welcome everyone. Thanks for joining us. I'm Maggy Benson, host of Live from Q?rius, Smithsonian Science How? We're so happy you're here with us today and we're also so happy to [00:01:00] have Rusty Russell with us as our special guest. Thanks for joining us Rusty.

Rusty Russell: Thanks for having me Maggy.

Maggy Benson: So Rusty, you are the botany Collections Manager of the National Herbarium that's housed here at this Smithsonian National Museum of Natural History.

Rusty Russell: That's right.

Maggy Benson: Can we start by learning what the National Herbarium is and what you do as its manager.

Rusty Russell: Well, a herbarium is simply a collection of dried pressed plants not unlike those that you might have prepared if you went out in your backyard and collected flowers and leaves and so forth [00:01:30] to preserve them. The difference is, these have been assembled over a long period of time globally and they represent a research collection that we have been working on at this museum for 100 years.

Maggy Benson: How big is the collection?

Rusty Russell: 5 million specimens.

Maggy Benson: 5 million specimens?

Rusty Russell: Yeah.

Maggy Benson: Why would you need such a ... Why would you need 5 million? That's huge.

Rusty Russell: Well, that's a good question. Historically, we have used the collections to do the kind of research [00:02:00] that we're involved in, studying species, species evolution and that sort of thing. But more recently over the last couple of

decades, we have been using these data to apply to other more modern questions that really have an impact done a lot of the population.

Maggy Benson: So you have some objects on the table here today, are these part of the National Collection?

Rusty Russell: They are. And I mentioned the pressed specimens but there's a wide variety of object types that we maintain. Starting at the far end of the table, micro slides [00:02:30] that are microorganisms like algae and diatoms; the bulky bamboo samples here; and a specimen that is liquid preserved. This is a cactus actually in that jar. Some bulky fruits including this double coconut from the Seychelles Islands; woods and pine cones; and some coral and algae on this side.

Maggy Benson: That's a great diversity.

Rusty Russell: Enormous, yeah.

Maggy Benson: Wonderful. So what does the National Herbarium tell you [00:03:00] as the manager of it, what can you use the National Herbarium to learn about?

Rusty Russell: As I said, historically, we have used it for our own sort of Ivory Tower exercises but recently we can use them to study endangered species and threatened species and maybe provide suggestions or advice for restoration. Advise land managers on how to steward their natural resources and also to monitor and track invasive species.

Maggy Benson: How would you use a collection to better understand invasive [00:03:30] species?

Rusty Russell: Well, invasive species have an entry point into a non-native area. Some of our collections are quite old and may in fact provide that information, what the entry point was, how the individual species spread through the area.

Maggy Benson: So what I'm really curious about is I still can't get over this 5 million number. I'm really curious how you find anything to be able to find out this cool information about invasive species-

Rusty Russell: It's extremely well organized.

Maggy Benson: [00:04:00] How is it organized?

Rusty Russell: How do you think it's organized?

Maggy Benson: I think this is actually a good question for our viewers, what do you think?

Rusty Russell: Sounds good.

Maggy Benson: All right. Now's your chance to tell us what you think. You can respond using the poll that appears to the right of your video screen. Let us know how you would organize a plant collection. By collector? By species? By date of collection? Collection location? Or by expedition? Take a moment to think about it and put [00:04:30] your answer in the window to the right of your video screen. Rusty, the results are rolling in and so far 80% of our viewers think that they would organize their collection by species. What do you think?

Rusty Russell: Brilliant. That's exactly the way we do it and the majority of herbaria around the world do it that way. Because [00:05:00] as I said we do a lot of species related research. So in the collection, we have all the members of a family together, genera within a family, species within a genus and that makes it possible for us to go out and actually locate specimens in the collection. However, this posed a problem if you're looking for specimens collected by an individual or specimens collected from a specific geographical area, and that's where digitization has come in handy.

Maggy Benson: What have you done to be able to make them more accessible and easily found with digitization?

Rusty Russell: The [00:05:30] U.S. National Herbarium, the Department of Botany here has been a pioneer beginning in 1970 when we created the first online database for any Natural History Collection. In 1983, we implemented barcodes, the first unit to actually stick a barcode on something and we've gone on to providing millions of records online and images online as well.

Maggy Benson: Very cool. Are you continuing to lead the field in digitization and creating modern access [00:06:00] with computers and other tools available now?

Rusty Russell: Well, we're certainly a player. Later this year, we're going to implement a program that involves using a conveyor belt to take the specimens under a camera, and by doing so we're going to generate images in a day as fast as it took us two weeks to do previously.

Maggy Benson: That's incredible. How many are you actually planning to digitize with this effort specifically?

Rusty Russell: We have 5 million specimens. I anticipate 5 million records.

Maggy Benson: [00:06:30] A specimen record includes information like the plant's name, maybe where it was collected, who collected it, where does all that information come from originally? What's the original source?

Rusty Russell: Well, the most important thing is that each individual specimen represents a record of this thing being in this place at this time. I call it the three dimensions of biodiversity. It allows you to study changes over time, changes over distance and the changes [00:07:00] in the biodiversity. The individual records create a

point in space, a point in time. But when you start adding up 5 million records, you start to get a very rich picture of biodiversity on the planet.

Maggy Benson: So that information, the place, the time, is that coming from where? Is it your personal knowledge or?

Rusty Russell: On these specimens, you'll see that there are labels and this is one of the advantages we have in botany that we can intimately [00:07:30] associate the label with a particular specimen. It includes information about the who, what, where, and when that we were just talking about. But historically, that information has come from the field notes or the field books of the individual collectors. A good example of there being a whole lot more information in a field book than there is in what gets translated to the label is this particular specimen of horsetail here. This was collected by Martin Gorman in Alaska 1902. [00:08:00] It includes the basic information on the label. But you'll see here in his actual field book that it reports information on how the plant was used and provides common names in two different languages.

Maggy Benson: That's his actual field book from 1902.

Rusty Russell: This is his actual field book.

Maggy Benson: So how do you make sure that that information isn't lost? There's probably so much rich data in there for each individual record.

Rusty Russell: In the same way that we're digitally imaging [00:08:30] specimens. We started the field book project five years ago to catalog and begin to digitize every single page in every single field book. And then we are committing them to a site we call the transcription center so people can, from the reading of the handwriting, enter the data for us.

Maggy Benson: What kind of people are actually doing the transcribing? So taking those written pages and retying them online.

Rusty Russell: Volunteers [00:09:00] all over the world. It's basically a site that you can go to and enter data, assisting us in collecting data to provide this kind of information associated with specimens.

Maggy Benson: So you can go to transcription.si.edu, the site that we see there right now; somebody viewing can actually start their work.

Rusty Russell: Exactly. Everybody who's watching now. In fact, that includes active transcribers in our in the transcription center watching this webcast [00:09:30] can go in, set yourself up, start reading. You can digitize labels off specimens; you can digitize pages out of field books. There's a wide variety of content.

Maggy Benson: Wonderful. So volunteers are very important part of your team.

Rusty Russell: They always have been, they're becoming more important.

Maggy Benson: So we have some student questions. Are you ready to go to them?

Rusty Russell: Shoot.

Maggy Benson: Wonderful. So this one comes from Paul from Tulsa. When did people first start keeping field books?

Rusty Russell: I would suspect that as long as [00:10:00] they have been going into the field recording data. Field books are the notes that you take; they become the record that you refer back to because our memories sometimes fail. The early Greeks, the early Romans were collecting plants as well. During the Renaissance, we had herbals that were created that included real plants in the pages. Making notes and recording [00:10:30] has always happened. These field books that we have only go back 150 years.

Maggy Benson: But it's still a very rich collection.

Rusty Russell: Incredibly rich. Yeah.

Maggy Benson: So this question comes from Mona. What is your favorite part of your job?

Rusty Russell: The favorite part of my job is what I call maintaining order amidst chaos. It's a huge collection, it's a very active collection. Things need to be in the right place at the right time, there's a lot of transaction work going on [00:11:00] and managing that aspect of it is certainly challenging. But I also enjoy getting out into the field to do the kinds of things that we're going to talk about.

Maggy Benson: Wonderful. This question comes from Eagles18. How can we become citizen scientists?

Rusty Russell: That is the big question, isn't it?

Maggy Benson: I think so.

Rusty Russell: There are sites you can visit that give you ideas on projects that are actually recruiting volunteers. You can go to our transcription center [00:11:30] and assist us with that particular exercise. There's an incredible a number of things that you could help with, but you could simply go to your extension agents. Simply go to your local nature center or a local natural history museum and offer to help out.

Maggy Benson: Curiosity sparks it all, right?

Rusty Russell: It helps a lot.

Maggy Benson: Wonderful. Rusty, you have done a lot of your collection work here at the National [00:12:00] Herbarium but you've done some specific work in Southern California.

Rusty Russell: That's right.

Maggy Benson: Can you tell us a little bit about that project?

Rusty Russell: Well, about 10 years ago, a good friend of mine and colleague James Bryant from the Riverside Metropolitan Museum (and I suspect they're out there watching right now), we were sitting down talking, brainstorming about ways that we could take collection data and use it to map change over time. He's very familiar with this particular mountain range in Southern California so that's where we [00:12:30] focused.

Maggy Benson: What's that mountain range like and where is it?

Rusty Russell: The San Jacinto and Santa Rosa Mountains are in Riverside County and it has an incredible diversity of habitat. You can see the location down here just northwest of the Salton Sea. It includes desert canyons facing the Colorado Desert, it includes high elevation grasslands, and it includes the 9,000+ peak of Mt. San Jacinto.

Maggy Benson: [00:13:00] So what did you do with your collection study at that location?

Rusty Russell: Well, the idea was to take all of our existing specimen data, map it out over time and see if the species composition in that location has changed over that time. A 100-year period, the 20th century. So we went to a lot of herbaria, collected over 22,000 individual records of plants that existed that have these data on it: the species, the place and the time. Then we mapped it in a way that allowed [00:13:30] us to start analyzing, during one decade, what does it look like, during the next decade, what does it look like.

Rusty Russell: What we found is that a particular species would appear and then disappear as it relates to the record. Appear, disappear. So we broke it up into two parts. Everything that occurred before 1940 and everything that occurred after 1960 to see what we got and we got an incredible difference.

Maggy Benson: So it's really interesting because you're pulling historical [00:14:00] records to be able to make these observations. So you have to wonder. I mean, when you were doing this study, you probably said, I really wish we could go back and see what we could collect.

Rusty Russell: Right. All of this was done from the comfort of my chair in my office because we were only pulling on existing digital content in herbaria. So then the next step was to hit the ground. Get out, start collecting, see how we could compare what

exists now with the way things appeared to [00:14:30] change given the herbarium record.

Maggy Benson: I'm really curious about how you actually select a plant to collect. I think we should ask our students.

Rusty Russell: That sounds a good idea.

Maggy Benson: All right. If you're just joining us, here's another opportunity for you to participate in a live poll. Tell us which plant would you collect. A, the palm. B, the cactus. C, the flower. Or D, the dandelion. Put your answer in the window that [00:15:00] appears to the right of your video screen. Rusty, the results are coming in and the majority [00:15:30] of our students say C, the flower. What do you think?

Rusty Russell: Not really a surprise. One of the things that we find in the history of collecting is what we call collecting bias. That is that you don't necessarily go into the field to collect everything because things like the palm, which are very difficult to collect, the cactus which is very dangerous to collect sometimes or something is common and weedy as a dandelion oftentimes get overlooked. So we don't always have [00:16:00] really good records of some of those things.

Maggy Benson: So did you have to fill gaps to be able to look at what was collected?

Rusty Russell: We had to identify the gaps and we were seeing where things appeared to disappear or appeared to appear in these two time windows that we were working with. So when we went into the field, it was the data that dictated where we were going and what we wanted to collect.

Maggy Benson: So can you tell us again specifically [00:16:30] exactly what time frames you were comparing.

Rusty Russell: Well, within the 20th century we compared the 1900 to 1940 block to the 1960 to 2000 block. What we found, and this chart exemplifies it, is that in that first period covered by the red and the yellow, we had a certain percentage of species within that entire range. The yellow and the green represent what we found in the second [00:17:00] half of the 20th century and the sum, therefore, of the red and the green represent the change that occurred over that 100-year period.

Rusty Russell: Things that appeared to disappear or appeared to appear. I say that, that way because it is only from the material that was collected that we're working on making that assumption. That's why going back into the field to test whether those gaps are really true or not, sometimes addressing the collecting bias [00:17:30] that occurred, that was the purpose of going back into the field.

Maggy Benson: Interesting. I saw 111 new species on that graph. Why so many new ones? Are they all new species to that area?

Rusty Russell: Well, in that case, they were species that showed up in the record for that period. But what we found, and this is probably not a terrible surprise, is that a large number of those that appeared in the latter part of the 20th century are non-native plants to California.

Maggy Benson: So [00:18:00] was this research project successful in helping you better understand change over time? So maybe those new species that came and the others that were lost?

Rusty Russell: Yes and no.

Maggy Benson: Please explain.

Rusty Russell: The yes part is we got good data and we were able to create a result of the analysis of herbarium data as it relates to these changes. The no part is we knew going into it that we weren't going to have all of the data. The problem is that not all specimens [00:18:30] have been digitized. So even in pulling data from the California herbaria area and others, there was a lot of data that we were missing. So we know that there are gaps that way, but at least we've demonstrated the utility of a historic collection of a herbarium to at some level document that change is occurring. We may fill in some of those gaps, but it's only going to change percentage by 3 to 5 percent most likely. [00:19:00] The difference is still an enormous change over what is by our standards a fairly short period of time, 100 years.

Maggy Benson: Interesting. We have a student question. Are you ready to take it?

Rusty Russell: Yeah.

Maggy Benson: This one actually comes from a group of students watching in our Q&A Lab here at the Natural History Museum.

Rusty Russell: Great.

Maggy Benson: They want to know, how do you define a weed?

Rusty Russell: Good question. A weed isn't really a technical term and my mother used to say a weed is just a nice wild [00:19:30] flower where you don't want it to be. The terms that we use generally are non-native where something actually came from somewhere else. The dandelion is actually a European species. We also hear (the word) "invasives." That's where species have come in and they're actually dominating the existing flora and overtaking it. So the answer is a weed, non-native, exotic or invasive.

Maggy Benson: So non-native species, [00:20:00] you must have found a lot of those as we saw in your research in Southern California. What are some of the ones that you found?

Rusty Russell: We did. Two really good examples of that are the fountain grass, which is a beautiful organism but it is a water-

Maggy Benson: Seen here, right?

Rusty Russell: Right. It's a water hog in the desert canyons and is the Bureau of Land Management is making a concerted effort to remove that as much as they can. Sahara mustard is another one that you will find along roadsides [00:20:30] completely enveloping the land along different ... I'll answer the question again, weedy areas of the landscape.

Maggy Benson: Great. So getting back to your research project, who was deployed into the field to be able to collect these new specimens that you used as a comparison?

Rusty Russell: Well, it could have been simply James and myself. But what we were able to do, with the [00:21:00] significant help from Earthwatch Institute, his museum (Riverside Metropolitan Museum), the University of California Riverside, Bureau of Land Management and the Forest Service, was to bring teams in the spring, summer and fall. We actually had adults through the Earthwatch Institute in the spring and the fall, and in the summer, we had a great program where we employed high school students from all over the country to come in for two weeks. We based them at the James Reserve and went all over the region collecting [00:21:30] plants during that period.

Maggy Benson: What an awesome opportunity.

Rusty Russell: it really was.

Maggy Benson: Is this one of your field-

Rusty Russell: This is Julie Myers. Yes. Julie was my project manager for almost the entire time. A brilliant person, (she) learned a lot about plants at the time. Here's Tony and Katy collecting plants, pressing them. Shannon it is definitely pressing it, laying down on the thing. A number of these students, by the way, they weren't necessarily science tracked [00:22:00] but I'm very proud to say that a number of them have gone into plant science and biology in college and a couple of them are moving on to grad school. So it was a great experience for them as well.

Maggy Benson: You said that they weren't science tracked. So does that mean that any student could be a citizen scientist?

Rusty Russell: Absolutely. You're already a scientist. You're asking questions, you're observing, you're curious and you're asking more questions and those are the same things that we do as scientists. So [00:22:30] whether you go into science or not, those are the qualities that are going to allow you to be good advocates for science. Of course, we hope that you all become scientists.

Maggy Benson: Rusty, there's actually a class of students from Gage Middle School watching the program here today with us.

Rusty Russell: Right outside Riverside County, Riverside California.

Maggy Benson: Yeah, absolutely. I think they're watching with the Riverside Metropolitan Museum.

Rusty Russell: I hope so.

Maggy Benson: They have submitted a question for you. Let's see it.

Karina: Hi. my name is Karina from Gage [00:23:00] Middle School watching with the Riverside Metropolitan Museum and my group was wondering why you focus your research in Southern California.

Rusty Russell: Thanks, Karina. That's a very good question. James Bryant, who you've probably met there, and I are close friends for a number of years and it was our brainstorming session that came to define the project that we are conducting there in Southern California. James was the one that suggested that it was the San Jacinto and Santa Rosa Mountains [00:23:30] because of the tremendous diversity of species there that was a good location to apply our ideas.

Maggy Benson: Great question. Thanks Karina. We have another question.

Rusty Russell: Okay.

Maggy Benson: All right. Let's roll it.

Tony: Hi. My name is Tony. I'm from Gage Middle School watching with the Riverside Metropolitan Museum. We were wondering what you studied in college.

Rusty Russell: Thanks, Tony. It turns out that I studied botany. When I was a kid, 10 years old, I started collecting plants. It was just [00:24:00] a passion of mine based on what I mentioned before about just being plain curious. As I went into college, I followed a place where I could actually study botany and great mentors to work with and I was a botany major. So thanks Tony for the question.

Maggy Benson: Wonderful. All right. This one comes from Priscilla from Seattle. How did you get interested in plants and botany?

Rusty Russell: Priscilla, I'm not really sure. I think what happens to you as a young person is that [00:24:30] you become exposed to different ideas or different disciplines and one just sticks with you. I just remember that as a youngster, I was just absolutely fascinated with plants, asking the questions that we talked about earlier. Why were they there? What they really are? And it just became my passion.

Maggy Benson: Beetman wants to know, when did you get your job?

Rusty Russell: The job here?

Maggy Benson: Yep, as Collections Manager.

Rusty Russell: The joke is that I've been here 40 years [00:25:00] but I started when I was six. The reality is, I've been here since 1975 and just celebrated my 40th anniversary in the museum.

Maggy Benson: Congratulations.

Rusty Russell: Thank you very much.

Maggy Benson: We're lucky to have you.

Rusty Russell: Well, I'm glad to be here of course.

Maggy Benson: This one comes from Sam. What is your favorite plant that have collected?

Rusty Russell: There are so many, I have to say. There's a beautiful lily that grows up in the high elevation meadows of the San Jacinto [00:25:30] Mountains and I have to say that, that may be one of those on the top of the list.

Maggy Benson: This one comes from Eagles18 again, another job question. They want to know why your job is important and what happens if you mess up. Maybe what a mess up is.

Rusty Russell: I don't mess up of course.

Maggy Benson: None of us do.

Rusty Russell: The reason this is important is because as we described earlier, we're managing a collection [00:26:00] of records and being able to revisit the specimens is critical. Oftentimes, the identification of a specimen changes and you need to be able to go back and confirm that. There is something extractive about data and images that doesn't replace the actual plant. So as a manager of a herbarium, you don't throw them away. You have to maintain them in perpetuity and that means caring for them while at the same time, [00:26:30] making them fully accessible. It's sort of a tug-of-war.

Maggy Benson: This question comes from the viewers in the Q&A lab and I'm combining it with one from kids.gov. People in the lab want to know what this object is. And kids.gov is wondering, how do you store these if they don't flatten?

Rusty Russell: This is called *Lodoicea maldivica* and it is otherwise called the double coconut. It is it turns out the largest single seed in the world. Not necessarily this individual but [00:27:00] this species. Everything that you see inside here is part of a single seed. Double coconut because it has a sort of a double nature to it. It grows in the Seychelles Islands, it's an endangered species there but we have been able to obtain a number of them to be part of our collection. Because you don't press them, because you can't commit them to the mounting paper, we have storage cases that are designed specifically to hold large objects like this, like the bamboo root system, and others.

Maggy Benson: [00:27:30] Great. Rusty, it's been so wonderful having you and learning more about the work you do here at the Smithsonian.

Rusty Russell: It's been my pleasure.

Maggy Benson: Thank you all for all of your wonderful questions. Rusty, we're actually all out of time already. But thank you so much for sharing your work with us and helping us better understand why the National Herbarium is so important.

Rusty Russell: I'm glad to do it.

Maggy Benson: Can you tell our viewers where they can learn more about this work?

Rusty Russell: Well, we mentioned the transcription center and that's actually a good place to see the kind of objects, specimens, [00:28:00] and field books and other kinds of content that you can go to and help us transcribe that information. There's also a site called citsci.org, which is a sort of clearinghouse for citizen science projects and that's a good place to start as well. But don't forget you can initiate your own. Go to your extension agent, go to your natural history museum, your local nature center and offer to help. I guarantee you that they need it.

Maggy Benson: Wonderful. Thank you so much.

Announcer: [00:28:30] Thanks for watching. You can explore more Smithsonian Science How shows on our website, qrius.si.edu. Join us on February 12th for a conversation with paleo biologist, Brian Huber, to learn how small life forms can tell big stories about climate change on earth millions of years ago and today. Register [00:29:00] now at qrius.si.edu.