Erik Sathe: You're tuned in to 90.7 FM KALX Berkeley. My name is Erik Sathe and this is The Graduates, the interview talk show where we talk to UC graduate students about their work here on campus and around the world today, I'm joined by Nick Spano from the department of integrative biology, who studies conservation, paleo biology. How's it going, Nick?

Nick Spano: Pretty great. Erik.

Sathe: Good. I'm glad to hear it. So how did you first get into research?

Spano: Yeah, I first got into research through really just keeping my nose to the grindstone with classes and really getting involved in that and really finding that as kind of a fun pursuit to learn these things in classes. And what happened was I took an earth history class during undergrad, and I had talked with the professor and I told him, Hey, I am interested in paleo stuff. And this has been earth history class. Are there any opportunities for me to do something like that? And he said, sure, yeah, I run a research facility here on campus. You want to come check it out sometime? And I said, yeah, that sounds great. And so he invited me over to check out this facility and the facility itself is called the large lakes in observatory. And it is a institution at the university of Minnesota Duluth, which is right on the Western tip of Lake superior and being right on the tip of Lake superior. The idea is, okay, this is the biggest Lake in the world. We can effectively treat it as an ocean. And so the people who work there are mainly trained in oceanography, study things about ocean physics, ocean chemistry, plankton, and so forth. But his background was in paleoclimatology and being able to tell how climate has changed through time through sediment records that people have pulled up from the ocean floor. And so he just showed me around this building and at the end of it, he said, yeah, how does it look? How does it sound? I said, yeah, this is all really cool. And he said, great, do you want a job? I said, yes, please. And yeah, that was a really fortunate start for how I got into research. Yeah. It sounds very organic. And it was kind of following your own interests and just sort of happening across someone who could provide an opportunity for you. Yeah. So what can we learn about the climate through paleontology? Yeah, that is a really great question. So I would say the main thing that we can learn about climate through paleontology is a sense of scale about how bad climate change is today. And so, by saying bad, I mean, what is the rate at which climate change is happening? It's speed, it's magnitude. And so there are things for example, where we can look at, okay, climate is warming today has climate warmed in the past. And by looking at the paleontological record, we can say, yes, climate has warmed in the past and we can get into the question of, okay, how quickly did things warm in the past and how quickly are things warming today and how does that compare? And there are a lot of very stark things that pop out from that. And so, for example, when we look at a very extreme warming event that has occurred in earth's history that we see recorded in the history of life. At that time, the paleontological record, it is an event called the Paleocene Eocene, thermal maximum. And this happened about 55 million years ago. And what we see happening then is a change to primates at the time, living in places where they'd never lived before to a lot of species in the ocean becoming extinct. And the rate of warming of that event was something that is the highest we've seen in the past, at least

65 million years. And for the carbon dioxide that was put into the atmosphere and caused a warming at that time, the rate at which that carbon dioxide increase causing that warming compared to the rate of carbon dioxide increase we're seeing right now is tenfold. So we are pumping out CO2 at a rate that is 10 times faster than the fastest rate in the past 65 million years. So that's one thing. And for more recent paleontological history, we can look at the past about two and a half million years of the ice ages and see these trends from things that are really cold during the peak of an ice age, to relatively warm, similar, to more recent temperatures. And we can get a sense for how climate can change on scales and timeframes that are more similar to what we have effectively grown up with that is looking at communities and the paleontological record that include things like wooly mammoths and sabertooth cats and mastodons, but also include things like moose and Canada, geese and raccoons and black bears, and really get a sense for how climate change has affected those animals and those plant communities that are still around today, or at least very similar to those around today and see what happened when climate change then.

Sathe: Okay. And so it seems like you do sort of field paleontology. Do you go out and do field work yourself?

Spano: Yeah, so I have only done a couple field related things in my research so far, my current research focuses on a experimental approach to testing a fossil that people use as a tool to get at environmental reconstructions. And what I'm doing now with the experimental work is to try it and see how good of a tool it really is. But the field work that I've done has included going to the Island of The Bahamas that is San Salvador Island. And this is the Island that Christopher Columbus first landed on in 1492. And what we were looking for there is evidence of how the ecological community had changed when those first Europeans arrived on the Island. And so that was a very cool experience to do some field work that involve Lake sediment, coring. And the idea with that is to take effectively a big plastic straw and put it into the middle of the Lake and just like a straw in your milkshake, you put your finger on top of it to plug it, and then you pull it up and you pull stuff out of it. And what we do that is not delicious ice cream and milk is pull the mud out from the bottom of the Lake. And the idea with that is we have this tube and at the bottom of the tube, we have the oldest stuff in the mud. And at the top of the tube, we have the youngest stuff in the mud. And so we can go through time and look at how the environment has been changing in terms of water quality, in terms of plants that were living around that Lake and sprinkling their pollen into the Lake. And the pollen are very useful because they preserve really well. And they are very diagnostic to be able to tell what kinds of plants were around the community. And so you can get this whole really interesting environmental picture of what was going on through time. And especially with the case of lakes, because lakes are relatively common across the landscape in a lot of different places, you can get a lot of interesting environmental history. For example, with Christopher Columbus, how things happen there, how different domesticated plants have spread around the world and so forth. So that's one example of field work that I've done. Some other field work that I've done earlier in my graduate career was some work that I did in Africa. So I got to go to a whirlwind tour spending two weeks total in Kenya, Botswana and Mozambique. And that was pretty wild. And yeah, that

involved collecting some dung samples to try to get at some ecology of large animals and collect.

Sathe: Dung samples of what?

Spano: Yeah. So I was collecting dung samples from pretty much anything I could find. Okay. Elephants and zebra and some antelope. And there's a lot of poop lying around in some places of the Bush in Africa. It turns out. So how did you know what kind of poop you got? Yeah. So I had a, both a guidebook that I had with me and a local guide, especially when I was in Mozambique. Crews were really helpful in being able to identify who's poo was who's for elephant poo in particular. It is very easy to identify because it's about the size on the ground as a dinner plate. And each ball of poo is about the size of your fist. And the interesting thing about elephant poo in particular is that most of it goes pretty much undigested. And so about 75% of the dry mass of an elephant poo is just grass and other plant material that just pass right through.

Sathe: And so how did you use these samples in your research?

Spano: Yeah, so I use them to try to get at getting back to what I was talking about earlier with this experimental work that I'm doing now is trying to see if the poo had this dung, fungus that I'm interested in. And so I'm interested in a dung fungus because we find spores of this young fungus in the sediment records at Washington lakes that washed into swamps that wash into wet patches on Meadows and so forth. And people in the paleontology community have been using the spores. Those are the little reproductive cells of these fungi as an indicator for how many animals were walking around landscape, especially large mammalian herbivores. And what people have found through looking at these spores that are incorporated into sediment records. There's some interesting things about being able to time the extinction of a lot of ice age animals. So the idea is less spores means less poo means less wooly mammoths, for example, and associated with that. People have been able to tie those changes in the amount of spores in a given record and those extinctions to cascading ecological consequences. So one idea for North AmErika, as an example is that when we lost things like wooly mammoths and mastodons and giant ground slots that were about the size of an elephant, which is pretty wild slough, the size of the slots, the size of an elephant, some of them ones in South AmErika were actually about one and a half times the size of an elephant. And we have some reason to believe or suggest from their pelvic bones that they could have supported their weight on their hind legs, at least for some time. So it's pretty wild.

Sathe: So, these things probably weren't hanging upside down and trees like the fluff that we know today?

Spano: Probably not as far as we know, but yeah, so people have been able to find that based on the timing of these extinctions inferred from the spores of the stung fungus in these records, you see really interesting changes in the rest of the environment that are happening, where you see an increase in the amount of pollen from Ash trees that takes

off right at the same time. And you see a increasing the amount of tiny itty bitty little pieces of charcoal that wash in these sentiment records as well. And people use the charcoal to infer what the fire patterns look like on landscape through time. And what we see happening is this landscape ecosystem, radical change that was occurring in the context of warming that happened as we were coming out of the most recent ice age. And along with the warming, we see these ecological changes that were caused by the loss of these giant herbivores. And so that has some pretty big implications for the last giant or Varsa. We have left today, for example, African elephants and how they change the vegetation in savannas and grasslands or hippos and how they can act as what's called ecosystem engineers in Subsaharan Africa as well, and what it means to conserve those animals and conserve those landscapes that they literally create, especially for being able to support a really big Safari industry and tourism and the intrinsic value of those animals themselves too

Sathe: That's amazing. So it's really interesting that you're sort of using a resource that people might not think of as very valuable, you know, dung samples to make very well-informed assumptions or guesses about what these ecosystems were like in the past.

Spano: Yeah. And so it's something that, it seems like the last place you might look for information like that. And I think that's a pretty fun pattern that pops up a lot of times in ecology and science and natural history is somebody is curious about something in its own. Right. And it turns out to be important for all sorts of other things.

Sathe: Are you pretty unique in studying dung samples in paleontology and conservation biology or is the sort of a common thing?

Spano: I'd say, I know some people who do that kind of work, but we are few and far between.

Sathe: Makes sense. Yeah.

Spano: Yeah. It's not the most charismatic of approaches to these things, but it can tell you a lot of really interesting information.

Sathe: Definitely. So you said you did feel to work in Africa and I'm wondering if you have any crazy stories from your experience.

Spano: Yeah. I have at least one crazy story, which is the first country that I visited. And the first place that I visited on my trip to Africa was a field site in Kenya. And what I was interested in doing first day was to go to a bunch of watering holes that were at this research station in Kenya and see what kinds of animals were around the watering holes. Maybe get a sense of where they were pooping and to really think of that as a comparison to wear animals during the most recent ice age. And before that might've been concentrating around lakes that we now use for the sediment records and the stung fungus. So we get up to this watering hole and there is a herd of elephants that's drinking right at the edge of the watering hole. And it's beautiful and their mom, elephants and auntie elephants and baby elephants. And there's a bunch of baby

elephants, which is great. But next thing we know, and I have a photo of this very moment. You see mom, elephants raising their ears up, pointing them at us, trying to look big and they start walking towards us and speeding up and we realize, Oh my gosh. So we are booking it out of there trying to get away from this herd of elephants. And we're driving around trying to get away from the watering hole. And we come around this Bush and there was a mama elephant who bellows at us. And she is probably I'd say no more than six feet away from trampling us. So that was my first day of field work in Africa. It's a good start. Yeah. And I'm still here. I'm so glad to hear it. Yeah. Yeah. Me too.

Sathe: You have talked a little bit about the, the coring method for the samples that you take. What's sort of the timescale on these cores. How far back can you go?

Spano: Yeah, that's a great question. So it depends on the course itself. In some cases we can get back up to the scale of millions of years in some settings, especially cases where the Lake bed itself has long since dried up, but people take a drilling rig just like people use for oil rigs, but drill into these dried up Lake sediments and get back down very, very, very far back in time. And especially with big lakes and deep lakes, we can get to these scales of hundreds of thousands, if not millions of years. And really cool thing that happens with some lakes is that based on the seasonal changes in what kind of plankton are present in the Lake and how the water chemistry is changing in the Lake throughout a year, you have these layers that form in the Lake sediments that correspond to one year each just like tree rings. And so we can get down to that level of being able to tell a year by year how this environment has been changing through time.

Sathe: That's amazing. So you're from Minnesota, I'm from Minnesota, Minnesota has over 10,000 lakes.

Spano: You betcha.

Sathe: Have you done any coring in Minnesota?

Spano: I have, yes. So there are quite a few lakes around the twin cities area and a lot of work that people at the university of Minnesota are really interested in is this approach to try to use these techniques from paleontology and geology of Lake sediment, coring to get at more recent history and more recent environmental change that's been going on in Minnesota. And so for example, people have been looking at the history of plant domestication within native American cultures and how the signal of that is preserved in these like sediment records and how pollution can be recorded by heavy metals and other things at Washington Lake sediment records, and even the development of suburbs and urbanization can be observed by the different things that Washington to these lakes. And that's a really cool thing about it is we can use these techniques to get at all of that information and have those records and have those archives and really measure the effects of say both how bad pollution has been in the past and see conversely how different policies had been enacted to, to lessen that pollution have really made a difference.

Sathe: Okay. So we've been talking about North America now and sort of the paleontology conservation Paleobiology that you've been doing here a little bit. I'd like to hear a little bit more about the landscape of North America and sort of what the ecosystem was like at this time that you're studying.

Spano: Well, I'm always happy to chat about that. And so for Minnesota, in particular, as many people know, most of it was covered in ice sheet that was in some places up to a mile thick. And so a lot of Minnesota is Rocky from rocks that washed out from the melting ice sheet, but there is a chunk of Minnesota that was actually missed by the waves of ice sheets that have been coming across to the North American landscape for the past couple million years. And so that is very ecologically interesting. It's called the Driftless Area because we see both a less flat landscape in that part of the world and also a relative Leigh higher number of different species, especially of amphibians and reptiles in that area. And the idea of that was, well, they weren't hit by the glacier, so to speak. And so they were able to hang out there while these changes were happening, which is really cool, but more locally within the Bay Area. I think there's some really cool things going on with the landscape and who is around and what was happening, where if we go back to the peak of the most recent ice age, if you're going to build giant ice sheets and glaciers that characterize the ice ages, as we know them, all that ice has to come from somewhere. And so that somewhere is the oceans. And when all of that ocean water was locked up in these ice sheets, it dropped down sea level significantly such that Indonesia, as we know it today was mainly just a large landmass connected to the rest of Asia and in the Bay area, we see not the San Francisco Bay, but we see really the San Francisco Valley, which the Sacramento river was cutting out. And if you look out on a clear day, past the Golden Gate, you can see the Fairlawn islands right on the horizon. And during the peak of the most recent ice age, the California coast extended 20 miles out all the way to those islands. Wow. And so we had this giant plane with grasses and all of this really cool stuff going on in California. And at that time we had things like mammoths and mastodons and giant ground slots and even camels that were living in the Bay Area. For example, when the downtown Berkeley Bart station was being built, people were pulling camel bones out from the rocks and the sediment that was there. So they were walking around Shattuck. And we also see things like a, what is called the American line, which is a cousin to African lions, but looked pretty much the same as African lions, as far as we can tell, but about 30% bigger. And we saw things like caribou and moose and deer and bears and all these other animals that are still around today. But then with this whole other half of the cast that is now extinct, which is pretty wild to think about.

Sathe: Why do we think that those other half of the cast is extinct?

Spano: Yeah, that is the killer question that people have been trying to get at for the past 60 years now. And so one of the first people to really try to get at this and the reason for why we see so few large animals today compared to the ice ages is this guy, Paul Martin, who he was a paleontologist at the university of Arizona. And the story goes that he was a PhD student and he got his PhD studying peat and swamps and coring them and getting at the paleontology of that. And he finished up with it and he was trying to figure

out what he was going to do next. And he was just curious and open on a weekend. And he thought, you know, people have been playing around with this radioactive carbon dating method on a lot of archeological sites. And ice age paleontology size. I wonder if we look at those dates, if we see any patterns pop up and what he saw was a very clear pattern of which animals became extinct, namely disproportionately large animals, and that the timing of those extinctions really seem to match up really well with the first appearance of humans in different areas. And so, for example, when we look at places like Europe, we see a wave of extinctions around 40 to 50,000 years ago, right around the same time that humans show up. When we look at North America, wave extinctions from roughly 13 to 10,000 years ago, right around the same time human showed up South America, same thing about 14, 13, 12,000 years ago to 10,000 years ago, right around the same time human showed up. And so we thought, huh, that is quite the coincidence. I wonder what's going on. And so he proposed this idea that people came in at, if not through, what's called the Blitzkrieg model of people just wiping out the animals as quickly as possible. Maybe through some combination of habitat modification and hunting and other human pressures. Humans had caused these extinctions that we think about human caused extinction today, but maybe this was even happening tens of thousands of years ago. And so he proposed this idea and the people in the paleoclimatology community kind of looked at it and said, wait, you're trying to tell me that a bunch of people with sticks and spheres came in and wiped out entire species that had been living in these areas for tens of millions of years before that. No, that's crazy. We know that things were getting warmer when these extinctions were happening too. And so it was probably global warming that caused these ice age animals so disappear. And so there had been this back and forth debate and battle in science over whether it was humans that caused the extinction or climate change that caused the extinction and people have been butting heads about it for the longest time. And now we're finally getting into a space in paleontology where we can say, well, wait, why not both? And so now people are getting at the potential for a synergistic effect. That is when you add climate change with human impacts together, you get this multiplication of the two that causes species to become extinct. People are really with refinements in how radioactive carbon dating works have been getting at more precise stories of who became extinct when, how quickly those extinctions happened, how they occurred in the context of how climate was changing and how human populations might have been increasing at different times. And so we're getting a much more interesting story. That's much more complicated, but at the same time, much more comparable to what we see today with a whole combination of factors that is causing population declines. And the implications for modern conservation biology are huge to say that this has happened before. It's entirely possible that this couldn't happen again.

Sathe: Do you have a favorite large animal that you sort of wish was still around?

Spano: Yeah. Oh, well, that's kind of a two part question. I'll start with the favorite animal in paleontology. And my go-to at this point is what's called the Colombian mammoth. And so it was a cousin of wooly mammoth. But interestingly, when we think of a Woolly Mammoths we tend to think of really, really, really cold places. But if we look at where Colombian mammoth fossils have been found, we see them in places like Arizona and

New Mexico and Texas and Mexico proper. And even during the peak of the most recent ice age, those places were colder than they are now, but not ice sheets, Tundra cold. And the really cool thing about that is that we infer that Colombian mammoths were probably not that woolly. And they were probably very similar in their ecology and their behaviors to living elephants that live in warmer areas. And so the Colombian mammoth exemplifies this idea that, okay, maybe not all, mammas have to be Woolly or associated with very cold conditions and can be comparable conceptually to elephants that we think about today. And so the second part of that question about whether I wish they were still around today gets at a very interesting field of animal ethics and conservation. That is the idea of de-extinction and people have been talking for some time about kind of a Jurassic Park style story of, well, what if we could bring woolly mammoth back? And then the question again, related to Jurassic Park is, well, should we bring them back? And although, I love ice age giant animals and thinking about them and learning about them. I think that if we were to really bring back a Colombian mammoth from the perspective of animal ethics, if they are so comparable to elephants, as we know them, I mean, elephants are very social and sociable animals. And so those first Colombian Mammoths, I mean, thinking if this was actually a real thing, might be really sad and whether we should really pump all that money into the genetic engineering and trying to get all that down, when there are much more pressing conservation issues, if we were to sell it as a conservation thing to bring back, these mammoths is something that I don't think it was very warranted. And so I do love seeing large animals still in the world and being able to experience a world in which that's part of the story of how life works and how the universe does things. But yeah, whether I would actually want that back is a very tough question.

Sathe: Definitely. So that's about all we have time for. Is there anything else you want to say nothing?

Spano: Yeah, not that I can think of right now other than, yeah. Just thank you for having me here.

Sathe: Of course. Thanks for coming in. You're listening to the graduates on KALX Berkeley. My name is Erik Sathe and I was joined today on the show by Nick Spano, from the department of integrative biology, talking about his research on a conservation paleo biology. We will be back in two weeks.