Culling Norway Rats not associated with *Bartonella* Species

[Announcer] This program is presented by the Centers for Disease Control and Prevention.

[Sarah Gregory] Hello, I'm Sarah Gregory, and today I'm talking with Dr. Kaylee Byers. She's the deputy director of the British Columbia Node of the Canadian Wildlife Health Cooperative and a university research associate at Simon Fraser University. We'll be discussing the effects of culling on *Bartonella* bacteria in urban rats in Canada.

Welcome, Dr. Byers.

[Kaylee Byers] Hello. Thank you so much for having me.

[Sarah Gregory] Let's start off with a very basic question. What is *Bartonella*?

[Kaylee Byers] *Bartonella* are bacteria and there are several species which can cause disease in people, which is one of the reasons that we are concerned about them. So when thinking about *Bartonella*, the most well-known is maybe the species that causes cat scratch disease. So listeners may have heard of that before. And they are typically spread among animals and to people by vectors like fleas and lice.

[Sarah Gregory] Are there different species of it?

[Kaylee Byers] Yeah. So I think one estimate actually suggested that there are about 20 known species of *Bartonella*.

[Sarah Gregory] It's always so interesting when there's so many different species. Then you have to track them differently, right?

[Kaylee Byers] I think so, yeah. And I mean, again, that I like to narrow in on the part there that's 20 known species, right? There's also probably many more that we haven't yet discovered and which we may one day discover through things like DNA sequencing technologies.

[Sarah Gregory] What kinds of rats are Urban Norway rats?

[Kaylee Byers] They kind of are just like their name. They are city rats. They're also called brown rats or sewer rats. But they're found in cities all over the world.

[Sarah Gregory] And are they more likely to be disease carriers than any of the other many, many kinds of rats?

[Kaylee Byers] Yeah, exactly. There are many different species of rats. And I should have said Norway rats fall within the genus *Rattus*. You know, this is a really great question and I think it's important that we think about this question in terms of what diseases we care about. So for this question, I assume that we're most interested in zoonotic diseases or those diseases that are transmissible or can be shared between animals and people.

So when thinking about whether or not they're more likely to be disease carriers, I like to think of it along two arms of the question. So the first is, do they have the capacity to carry disease, and can they get infected? And the second is, how likely are they to actually come into contact with those diseases that we care about? And so, in terms of capacity, it's really not clear to me that Norway rats are any more capable of being infected with pathogens. I'm not aware of any comparative studies that look at Norway rats and black rats versus other species of rats. Those

studies may exist, and perhaps your listeners will write in with some really interesting ones. But I'm not aware of any evidence that they're more likely to be infected or to be able to carry these disease-causing pathogens.

But regarding the second arm around likelihood, Norway and black rats are actually quite interesting and exceptional in that they live in such close association with people, that there are many opportunities for them to interact with those diseases that we carry and for us to come into contact with the ones that they do. They're in our backyards, they're in our alleys, they're in our sewers, and sometimes they're even in our homes. And so from that perspective, I would say that they're more likely to acquire those human-associated or people-associated pathogens, acting like a bit of a pathogen sponge. They can move through the environment and their close contact with us provides more opportunities for us to acquire those pathogens from them.

[Sarah Gregory] And are these Norway urban rats the most common type of urban rat? Brown rats? Seems like that's what you hear of mostly.

[Kaylee Byers] Definitely. In cities, Norway rats are the most common. But it really depends on where you are. So black rats or *Rattus rattus* (their Latin name) are also actually really widely distributed, but they have a bit of a different ecology. Those Norway or brown rats tend to be on the ground or, like I called them earlier, sewer rats. Black rats tend to be more likely to be a little bit up high, or they are also called roof rats, where you might see them in trees. So because Norway rats tend to be a bit more aggressive, they can also push those roof rats or black rats out of their range. And so I think that's one of the reasons we tend to see them more often. But depending on where you are, you might be more likely to come into contact with those *Rattus rattus* versus *Rattus norvegicus* rats.

[Sarah Gregory] This is probably a horrifying question, but is there an estimate of how many rats there are in urban areas of Canada?

[Kaylee Byers] I like that you opened that with "horrifying". This is a really great question, and I get asked it a lot. And short and sweet, it is no, we don't have an estimate of how many rats there are in urban areas in Canada. And that's just because we aren't tracking them. So in order to estimate the number of rats in an area, we actually need established surveillance systems that can track rat populations across space and over time. A lot of the information we get right now is much more anecdotal, right? We might get calls in to pest control companies which can tell us whether or not we're seeing an increase in rat calls or where they are. But whether or not people call in to a pest control company or to a city to report rats is going to vary a lot, and it is not really a reliable source to tell us how many rats there are in an area. And so, we don't know. But this is an area of research that I think we need. I think we need these systems to be able to track rat populations so we can get some estimates (some abundance estimates) and have an idea of not just how many there are, but where they are and how that's changing with time, especially in response to things like climate change.

[Sarah Gregory] I have got to say that I find that incredibly surprising. Rats have been a vector—pretty much as we know of—since the dawn of time. So there hasn't been surveillance systems set up yet?

[Kaylee Byers] So we have varying types, right? But the actual on-the-ground, counting the rats is not something we really have and it's not something we have at a city level. You might have something maybe on a neighborhood level (it's a little bit easier), but there's a few really good

reasons. I mean, rats...as someone who has trapped over 700 rats themselves, I can tell you they are quite difficult to trap. They're quite elusive. So just even being in the spaces that they are, to get a good estimate is really difficult. So you can use proxies, right? You can look for gnaw marks, you can look for rat holes, you can look for sebum marks—so evidence of where rats have been. But again, that won't give you a full estimate of numbers, but I think there's a huge advancement now in tracking technologies for rats and camera traps and stuff. So I think we have more capacity to do that work now than we did before.

[Sarah Gregory] Okay. So back to the disease, is there a season for *Bartonella* in rats?

[Kaylee Byers] So when it comes down to seasonality, we're actually looking at something more complex than just some variables like temperature. We're thinking about how the environment and changes in season impact not just the rat and its survival, but also the things that vector the *Bartonella*, like the fleas that live on the rats and their survival. So it's a complex web, really, of intersections that will vary across the year and vary by years. But at least in Vancouver, we've seen that *Bartonella* is more common in rats in the fall, and that could be because the weather has been warm and humid enough to promote flea populations to survive. So at least in our area, we can say that the risk for maybe *Bartonella* infection for rats would be greater in the fall, but that could change year to year, depending on all these various seasonal variables.

[Sarah Gregory] How is the pathogen spread from rats to people? Fleas? Bites? Kisses from pets?

[Kaylee Byers] Adorable, kisses from pets. For the *Bartonella* species associated with rats, it's primarily transmitted by fleas. But it's actually not the way you might think. So the flea bites the rat, and as it's feeding, it actually defecates. And the bacteria is actually in the feces of the flea. So how does that bacteria get into the animal? Well, it can enter the wound where the flea has bitten the rat, or it can maybe get into another open wound that you happen to have. So you can imagine you get bitten by a flea, it's itchy, you scratch it, you introduce some of that flea feces into the wound. I know that sounds particularly delightful, but that's how you can get it.

[Sarah Gregory] How is *Bartonella* manifested in people? What kind of symptoms do people get from it?

[Kaylee Byers] Several of the diseases that are acquired by people...the symptoms are actually generally pretty nonspecific. And what I mean by that is that there aren't any clear symptoms, really, that would make you think, "Oh, that's *Bartonella*", right, that's a clear sign that you've got *Bartonella*. It actually is much more nonspecific. So it can present with things like fatigue, fever, muscle, and joint aches. So it's sort of a combination of all these symptoms that could appear to be something else as well. So flu-like symptoms, really.

[Sarah Gregory] So it doesn't lead to fatal illnesses or organ failure or meningitis or the various other horrifying things so many of the diseases lead to?

[Kaylee Byers] That's a really good question, and I'm not as familiar with, really, the morbidity and mortality in people that is associated with *Bartonella*. I mean, as a bacterial pathogen, I believe you can generally treat it with antibiotics. But what the consequences are if you have a *Bartonella* infection and haven't treated it, I'm not entirely sure. When we're thinking about diseases associated with rats that do have significant morbidity and mortality for people, one of the ones that's actually quite considerable is *Leptospira*, which is a different bacterial pathogen

transmitted in rat urine. And for that, many people get sick worldwide and can have some pretty significant consequences in terms of mortality and morbidity.

[Sarah Gregory] And plague, of course.

[Kaylee Byers] Yeah. I mean, we often do associate plague with rats, and I do believe we still have some outbreaks today. The science around that is a really interesting area and is often changing as how much of previous outbreaks were rat-associated. Again, it's really the fleas there that are doing some of the damage, that are jumping from the rat to the people. And the rats don't do well with the plague, either. But there's some research in the last decade that was looking at human-associated lice, and I'm not entirely sure where we've settled on that and how much of the past outbreaks were actually related to human ectoparasites.

[Sarah Gregory] Oh, that's interesting. I just want to say here, I am inordinately fond of rats. I have had pet rats and I just find them delightful.

[Kaylee Byers] They are. And you can train them, right? They're really interesting pets. And even just the work that I've done where we were trapping rats and we were trapping and releasing rats, you can really see all their different personalities, which I found really interesting. You can really tell when you're working with all the different animals. Yeah, I have a fondness for them, too.

[Sarah Gregory] Have you had any pet rats?

[Kaylee Byers] I haven't, but I've had other pet rodents. But I have never had pet rets.

[Sarah Gregory] Your study was...actually involved some culling of the rats to stop the spread of diseases, but apparently there was some concern that the process would backfire. There seem to be some pretty significant aspects to this. Tell us what happened or what your concerns were about the culling.

[Kaylee Byers] When we're thinking of managing rats, the approach that we tend to take is this 'seek and destroy' approach. And that's partly because the idea that we can catch the animal, we can kill the animal, somehow we can remove those diseases that are associated with them, right? And especially these zoonotic diseases that can be transmitted between animal and the person. But several studies have actually shown that this approach can have some unintended consequences that can alter normal disease transmission patterns in really unanticipated ways. And that, again, is because we're actually operating in a really complex system. So for example, in a previous study that we did in the same rat population with *Leptospira interrogans*, which I had mentioned earlier, we looked at whether or not culling rats as you would through standard pest control practices impacted *Leptospira*—so were rats more likely to carry *Leptospira* before or after we had done this culling campaign? And we actually published the findings of that study in this journal as well (in *Emerging Infectious Diseases*). And what we found is that culling the rats actually increased the number of rats or the prevalence of *Leptospira* among the remaining rats in the areas where the culling had occurred. So only in the blocks where we had removed rats did we see that more rats were actually carrying *Leptospira* after the culling. And so it seemed actually to have the opposite effect on what you would think. We actually saw an increase in disease among rats when that pest control had happened. So there was some precedence here for why we expected we might see some kind of impact in maybe a way we didn't expect.

[Sarah Gregory] Why did you do this study and what were you looking for?

[Kaylee Byers] Well, because we'd already done this previous study on *Leptospira*, we were really interested in looking at this impact on another pathogen carried by rats but has a very different ecology. So I was just telling you about *Leptospira*, and in that case, the bacteria are transmitted in the urine of rats. So the urine goes splashing into city streets, they can get it from close contact, the bacteria might get in the wound. And so, they can get it that way. But as we discussed, *Bartonella* is transmitted by rat fleas. So you're dealing with a whole different ecology, and you've got not just the ecology of the rats, but the ecology of the fleas (the vectors) which result in a very unique transmission system that requires close contact among the rats for the fleas to be spread or maybe the rats sharing nests, and that's where many of the fleas are. So we were really curious, would we see the same thing? Would we see that culling increased the number of rats carrying *Bartonella*? And so that's why we did this study.

[Sarah Gregory] You mentioned releasing some of the rats, which is different than culling. So you want to tell us how you conducted the study? What exactly went on here?

[Kaylee Byers] So it was really an urban experimental design. What we did was identify a number of city blocks in this downtown area of Vancouver, Canada, where we were going to trap rats. So in total, we had 36 individual city blocks. And those were divided into groups of three. So we effectively had twelve study sites, and each of those had three blocks. And then we designated seven of those sites as control sites where we didn't do any culling and five of those as the intervention sites where we did do some culling (where we trapped and removed rats). And so, in all of those blocks, we trapped rats and we took them back to our mobile laboratory van, we put them to sleep while we took samples like blood and urine and feces to test for pathogens, and an ear punch for genetic information. And we collected the fleas from the rats as well to test them for *Bartonella*, and we gave each rat a unique ear tag identifier so we can identify them again because as you mentioned, we were actually trapping and releasing rats for most of the study. So we would trap rats and release them in all of these blocks for two weeks, and then we would try to catch them again, essentially.

So for the first two weeks, we trapped and released in all those blocks. And then the next two weeks in the intervention blocks, we trapped and humanely euthanized rats in those central blocks to enact the culling intervention. And we did that in the center of the three blocks in an intervention site. And then, we trapped and released rats in all the other blocks during that time. So we continued to trap rats, take samples, and put them back exactly where we had caught them from. So in the control sites, as I mentioned, that's what we did. And then we came back to all the sites about three to six weeks later, and we trapped and sampled and released those rats again. And so the aims were really to see whether the number of rats and rat fleas carrying *Bartonella* had changed from before the culling intervention and afterwards, and whether that changed whether or not you were in a control block or you were in an intervention block.

[Sarah Gregory] Well, that's how it worked with the rats. What about people? What did you find in people? Did the culling actually improve things for people getting the disease?

[Kaylee Byers] So we actually didn't look at people. So what we found in the rats (which was quite surprising), we found that throughout the study, the number of rats with *Bartonella* increased in the second half of trapping in all the blocks except in the ones where we did the culling (the intervention). And so, it actually seemed to suggest that in this case, removing rats reduced *Bartonella* carried by rats, which is sort of the opposite of what we

saw with *Leptospira*. In terms of improving things for people, it's difficult to know. There has been some previous work in this area that suggests that people do come into contact with *Bartonella*. It's hard to know whether or not that's acquired through rats or not. But a lower number of rats carrying *Bartonella* in an area could be beneficial for people. There are just fewer rats with that disease for you to come into contact with. But I would say there's so many other things that go into this, right? It's beyond just, is the disease present? It's also, are people coming into contact with rats? How frequently? How closely? That's just, again, just such a dynamic system.

[Sarah Gregory] You've mentioned fleas many times here, because they're actually the real culprit. What about the fleas? If culling impacted the rat population, then the fleas just jump to the remaining rats, right?

[Kaylee Byers] You know, we actually didn't find that there was any impact of the culling on the number of fleas we collected per rat. Rats were just as flea-infested before as they were after. We also didn't find any significant difference in the number of fleas that were carrying *Bartonella* before versus after. So where we saw that difference for rats, we didn't see that difference for fleas. And that could be because generally, most fleas actually don't live on the rats. So many fleas, especially earlier in that developmental stage, are actually in the nest. And so, removing a few rats and the fleas that happened to be on them probably didn't significantly impact the flea population at all. So it would actually be really interesting to do a similar study that actually looked at the impact of removing the fleas from rat burrows on *Bartonella* prevalence. For example, to actually go in and scrape those fleas out of the nest. And you know what? The rats would probably not be too upset with that either.

[Sarah Gregory] Ultimately then, what do you think about the practice of culling to prevent disease? Is there any point to it, from a disease standpoint?

[Kaylee Byers] This is such a good question. And I think ultimately, it's just a bit misguided to assume that a really simple response to a complex problem will have a straightforward and universally beneficial effect. So when we're dealing with these complex systems that involves animals like rats and vectors like fleas and people, the environment as well and, as we talked about earlier, seasonality, altering one part in that system has implications that are very difficult to anticipate. And so, in this case, we saw that removing rats might be beneficial, right? We might reduce *Bartonella* prevalence. But in another study with the exact same population of rats, we found that it could actually increase risk for *Leptospira*. And so, I think what these comparisons show us is that we really need to be thinking about rat management (and especially rat disease management) differently, beyond just this seek-destroy method. How can we address disease risk that account for that complexity? I think that means looking beyond just the culling (the removing wildlife), to ways that actually create healthier, living environments for all of us (people and wildlife in the cities), and that reduce negative contacts between animals and people (that human-wildlife conflict). For example, if we are most at risk of coming into contact with rats and their diseases in our homes, what kinds of policies and programs can we implement at the city level to address those risks? Could we prioritize approaches that ensure people have clean living environments, free from rats, or that hold landlords accountable for rat infestations in a building, that ensure that buildings have strong infrastructures that reduce rat infestations, right, ultimately keeping rats out of the building in the first place? None of those measures deal with the rats themselves. They recognize where rats and people are most likely to interact and address that interface. And I think that, to me, is much more exciting and sustainable. Mind you,

it has to be an iterative approach to rats than just this really narrow focused approach that we tend to have, which is the seek and destroy approach.

[Sarah Gregory] Among that same them, I've been reading these articles about birth control for rats, which seems brilliant to me. So I'd like your opinion on that, as well as if you're going to feed them some kind of birth control, couldn't there be like a multipurpose vaccine in there, where you give them birth control as well as rabies vaccine like we do with raccoons, as well as Leptospirosis vaccine? I believe there is one, right? What do you think about all that?

[Kaylee Byers] So this is a really interesting question. So maybe let's start on the vaccine side. To my knowledge, rats have not been associated with rabies at all, but we tend to think of them as potentially carrying rabies. So to my knowledge, they don't. And I'm not aware of any other vaccines that could be right now targeted to rats that would reduce things, say, like *Leptospira*. Although, I think maybe the vaccine you're talking about might be in dogs. But certainly, I mean, what you're talking about with rabies and raccoons, those have been really exciting campaigns and I think have made some significant difference for those types of diseases. So in areas where we had large Leptospirosis outbreaks, could we formulate something that would reduce Leptospirosis in rats? That is a very exciting area of research and something I know nothing about but would be excited to learn more about.

In terms of rat birth control, again, I think this is an interesting area. It's something that has gotten a lot of attention. I think some of the issues with something like a birth control approach are...feasibility is part of it, and there's also the aspect of uptake. So on the feasibility front, how often do rats need to eat the bait in order to reduce their numbers? So reducing numbers generally through something like birth control is interesting because really what you want to do is reduce the number of rats there are, but ultimately you also want to reduce the carrying capacity of an area. So you want to reduce the number of rats that can survive in an area. We typically do that through environmental control—you have better waste management, you have less areas for them to burrow. So in this case, you're just looking to reduce the total number of rats that they can have. So you've got that part. So if they need to eat it every single day and there is a lot of other food in the environment, how much of an effect is that really going to have? Will it have significant decrease in rat populations that we might like to see? I haven't seen any data to suggest out in the city, that that would have much of an effect because there's so much other food available to them.

The other issue is if you go in and you say...say you're a pest control manager and you say to a client, "I'd like to use this birth control to reduce rats", someone might say, "Oh, that seems like a more humane approach, I'd prefer that". But then it actually will take more time, right, than just going in and trapping and culling rats. So how likely are people to actually engage with it? And that's something else that I don't think we have a really good understanding of. So I would say this rat birth control could be another aspect to our control, although I would also be hesitant a little bit about the long term effects on other wildlife. We certainly see that with poison baits, right? It gets into non-target wildlife, and that's a significant problem. I doubt it would be the only approach, and I think, again, we need to really be thinking about environmental management and we need to be thinking about these interface areas to reduce the risks associated with rats.

[Sarah Gregory] Do you think what you found is particular to Canada or can we extrapolate to other countries? I'm thinking particularly the US, since we have this border and it goes a long way.

[Kaylee Byers] I certainly think that the overarching finding of this work that culling animals can have unpredictable impacts on disease dynamics in wildlife and their vectors, I think that can be applied to other settings, for sure. But again, because each of these systems is really nuanced, each environment will influence these systems differently. And that's not just the physical environment (like green space and standing water and buildings) but also the social environment—so how do people interact with wildlife in their environment, how do management approaches of a city differ. All of these things will come together to mean that we...or what we found about *Bartonella* in Vancouver—and again, in a specific area of Vancouver—is not a universal truth. But I think this broader picture about how human actions can have unanticipated impacts on a wildlife disease and disease spread will be true across numerous contexts.

[Sarah Gregory] Were there surprises? You mentioned the difference between Leptospirosis and *Bartonella*. Is there anything else or was that the main one?

[Kaylee Byers] I'm not sure even that we were particularly surprised by the findings. It was certainly interesting that we found that the same approach had different impacts on the disease ecology of rats for these two different pathogens. But I think that knowing what we do about how dynamic all of these disease systems are that it actually was maybe a bit expected, or it wasn't such a surprise when we found something different. I think maybe a good motto when you're dealing with these kinds of systems is 'expect the unexpected', really.

[Sarah Gregory] What were the challenges in gathering up these rats? As we've said, rats are very intelligent and crafty little guys.

[Kaylee Byers] Yeah. Rats can be quite difficult to catch. They're very wary of new things in the environment, which is probably a good idea. So that makes it really hard, actually, to get them into your traps in the first place. That's a really significant challenge when it comes to doing this kind of rat work, and I also think it's one of the reasons we don't have more urban rat research. So to manage that specific challenge, one of the things that we do is called 'prebaiting', and that's where you actually put bait in traps and keep the traps open for a week or so before you actually start trapping to get them acclimatized to traps. You get them used to it being there, the traps get a little bit dirtier while they're sitting outside. And then even once you get them into a trap, they can be really difficult to wrangle. The first rat we ever trapped immediately escaped into our rat van. So there are a few levels that make it difficult to deal with rats.

[Sarah Gregory] I don't know if you ever read it, but a book called Rats written by....

[Kaylee Byers] Sullivan, was it? I think?

[Sarah Gregory] Yeah, that sounds maybe right. But anyway, there's only one book I think called Rats that's non-fiction. Absolutely fascinating and goes a lot...talks a lot about how intelligent they are and how hard it is to do anything with them because they just outsmart you every step of the way.

[Kaylee Byers] Yeah, I think I did read that. I think the person who used to deliver my mail actually lent me a copy for a bit, and I found it really interesting. And actually, if I can, I'd love to plug just momentarily that the story of the rat that got lost in the rat van is actually a chapter in a children's book that a colleague of mine wrote (Dr. Cylita Guy), and that book is for kids about

urban ecology. It's called Chasing Bats and Tracking Rats: Urban Wildlife and Ecology and How We Share Our Cities. So that's the little book chapter where folks could learn more about Harold the Rat and other urban wildlife stories.

[Sarah Gregory] Oh, that's wonderful. I am going to find that immediately.

Are there further studies you want to do to better understand the relationship between animal disease and people?

[Kaylee Byers] I'm actually really interested in people's relationship to wildlife, generally, and how our perceptions of wildlife and their diseases impact mental health in people. So this is some work that I did as part of my PhD with rats, and actually looking at the experiences of people living with rats and how that impacted them day to day. And I think this kind of information is really important because it helps us understand how wildlife impact people differently across cities, and it can help us to build better, healthier human wildlife relationships. And so that's actually an area of research that I'm really interested in.

[Sarah Gregory] What would you say is the most important aspect of your study, public health wise, and what future researchers need to pay attention to?

[Kaylee Byers] I think the most important aspect of this study is really taking a broader view beyond the particular findings of this one project, and that's just to recognize how complex these One Health issues are. And when I say, "One Health", I'm talking about a perspective that recognizes how interconnected the health of animals, people, and the environments are. So we really need to be thinking broadly about how all of these components of these systems intersect and recognize the incredible value of bringing together diverse perspectives in trying to address those issues. Folks working, in my case, in pest control and ecology and vector biology, right? There's so much information there that needs to be integrated in order to understand these systems better, and to promote wildlife or human and wildlife health, generally.

[Sarah Gregory] Well, you mentioned your job. So tell us more about that and what exactly do you do?

[Kaylee Byers] I have a few hats that I wear. I'm the deputy director of the British Columbia Node of the Canadian Wildlife Health Cooperative. And the Canadian Wildlife Health Cooperative is a national collective of wildlife health experts and enthusiasts looking to support healthy wildlife populations in Canada. And so in that role, I work on a number of health programs, from the ones we spoke about today to studies on *Sarcocystis* in bears, to projects that use metagenomics to study bat diets and what they are eating. In that case, we actually collect bat guano and do genomic sequencing to look at what species of insects are there and whether there are any known agricultural pests. So that's one area of work that I'm engaged in. I'm also a university research associate at Simon Fraser University where I work on knowledge translation and health communication research to identify ways to strengthen health communication processes, and then try to better understand how we share information and how we engage with that information, and how to engage communities in it. And so those are the two scopes of research that I work in.

[Sarah Gregory] And as you said, you just recently got your PhD, and tell us what your thesis topic was and going back, why did you choose it?

[Kaylee Byers] I did. I completed my PhD two years ago, and actually my graduation is finally coming up because I think it was in one of the first rounds of pandemic graduations. So my PhD

was in the department of Interdisciplinary Studies at the University of British Columbia, and that's where I worked on urban rats in Vancouver. And this study was really one part of that thesis. It didn't end up in the thesis, but I looked specifically at how rat ecology and human interactions (like this culling study) can impact pathogen spread. I also looked at rat movement patterns, so that's that aspect of rat ecology and how that aligns with what we see in diseases. One interesting thing we found is that diseases carried by rats tend to be clustered. So one city block might have many rats carrying a disease-causing bacteria and the next one might be pathogen-free, and so why is that? And it could be in part because rats don't move all that far. They don't move between blocks. So that was really a lot of the work I did. And then also some of this mental health piece that I had mentioned earlier. So I feel really lucky to have been able to work across disciplines in epidemiology, social science, veterinary science, genomics—all these areas—to really understand these critters better. It has really been incredible, I think. Even though they live in such close association with us, we're still learning so much more about them all the time, and that's really exciting to me.

[Sarah Gregory] And you also do a couple podcasts of your own, I believe. What are they about and why them?

[Kaylee Byers] I do do a couple podcasts, but the first one I started was called Nerdin' About. It actually was a spinoff of an event that I used to run in Vancouver (or co-ran with a colleague) called Nerd Nite. And that event was a science communication event where people would get together and learn about science over a drink in a bar. And then with the pandemic, we had to transition into something different, so we started a podcast. And that was a lot of fun, and I learned a lot about podcasting and how maybe I'm not...my skills don't lie in podcast editing. So to the person editing this, we appreciate you.

And the other podcast that I started on this year with folks of Genome British Columbia is Nice Genes. And that's been a lot of fun. So I host Nice Genes. Nice Genes is a podcast all about genomics and how genomics intersects with our lives from research on environmental DNA, to understanding how genomics can inform healthcare (and we call that pharmacogenomics), to exploring how DNA informs our identities through these take-home tests like 23andMe. So yeah, that has been a lot of fun and I have really appreciated being in the host face for Nice Genes. So we just wrapped up season one, and we're starting on season two now and I'm really excited about it.

[Sarah Gregory] Nice. Well, I hope some of our listeners here at EID will listen to yours.

And thank you so much for taking the time to talk with me today, Dr. Byers. This has been a delight.

[Kaylee Byers] Thank you again for having me on. It's always my distinct pleasure to chat about rats.

[Sarah Gregory] And thanks for joining me out there. You can read the August 2022 article, Culling of Urban Norway Rats and Carriage of *Bartonella* species Bacteria, Vancouver, British Columbia, Canada, online at cdc.gov/eid.

I'm Sarah Gregory for *Emerging Infectious Diseases*.

[Announcer] For the most accurate health information, visit cdc.gov or call 1-800-CDC-INFO.