Wild Birds and the Urban Ecology of Ticks

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

[Ted Pestorius] Hello, I'm Ted Pestorius and today I'm talking with Dr. Sarah Hamer, Assistant Professor and Veterinary Ecologist with the College of Veterinary Medicine at Texas A&M University. Our conversation is based on her study about wild birds and ticks in Chicago, which appears in CDC's journal, *Emerging Infectious Diseases*. Welcome, Dr. Hamer.

[Sarah Hamer] Hi there. Thank you so much. It's great to be here and I'm just thrilled to share my research with you.

[Ted Pestorius] We're delighted to have you. Dr. Hamer, people have an increasing awareness of West Nile virus being carried by wild birds and are certainly more alarmed than they used to be when they find dead birds in their gardens. Your study seems to imply that we may want to consider birds as a threat for more than just mosquito-borne diseases. Can you tell us what you're looking for in your study?

[Sarah Hamer] Yes, sure. Our research group here is broadly interested in the ways in which wild animals are involved in the ecology of pathogens that have the potential to cause human disease. Often, we're only made aware of the presence of a pathogen in an area once it causes an epidemic of human disease, and at that point, it's too late. But most of the infectious diseases that devastate human populations have their roots in wild species, and many pathogens are maintained silently by local wildlife communities before spillover to humans occurs. So our research group is especially interested in vectorborne pathogens. These are the viruses, the bacteria, the parasites that are transmitted by vectors like mosquitoes, or ticks, or kissing bugs. Our goal is to learn as much as we can from the wildlife and from the vectors, not only to protect animal health, but also to protect human health.

So in our recent study, we were interested in finding out the roles of different species of wild birds that may be involved in the natural maintenance cycle of the Lyme disease ticks and the Lyme disease pathogens. For some disease systems, the wildlife that are reservoirs for the pathogens actually suffer disease and can die as a result of being infected. In West Nile virus in birds like Corvids, such as crows and jays, that's a great example—first the infected crows serve as a source of infection to the mosquitoes, and then, many times, these infected birds will die. But for other agents, like the Lyme disease pathogen that we're studying, we don't observe any disease in these wild critters that are infected. They just go about their normal business, seemingly healthy, and all the time they're able to transmit the pathogen to ticks, and in doing so, they're maintaining this natural cycle of the pathogen. If newly infected ticks next feed on a human or a dog, then Lyme disease can result. So, what I'm trying to say is that by studying the wild species, like wild birds, and the ticks that parasitize them and the degree to which those

ticks are infected, we can learn more about the potential for Lyme disease risk to humans in a given area.

[Ted Pestorius] That's quite interesting. So where did you do this and how did you select the area?

[Sarah Hamer] We conducted our work in and around Chicago. And Chicago was a great place for us to do this bird tick study for a few reasons. First, Chicago is obviously a highly urban zone, and urban zones are often associated with higher burdens of zoonotic diseases. Zoonotic diseases are, of course, those diseases caused by pathogens that are shared by animals and humans. And this urban zone has high rates of zoonotic diseases, not only because there's more people there to come in contact with the wildlife, vectors, and pathogens and not only because there are more doctors there that are aware of these infections, but also because there are key features of the urban habitat that might actually promote infections. For example, urban areas often have a microclimate that is a bit warmer than the surrounding natural areas, and even a couple of degrees of warmth can allow some vectors and pathogens to flourish. Also, we liked to do this study in Chicago because our research team has been actively conducting bird trapping around Chicago for the past seven years, predominantly to study the ecology and epidemiology of West Nile virus, so it was a great place to also understand how these same birds may be important for a different vectorborne disease, which was Lyme disease. And finally, Chicago is an area of recent Lyme disease emergence in the human population. Over the past decade, the Lyme disease pathogen has been increasingly detected in mammals and more blacklegged ticks, often known as deer ticks, have been found, and these are the ticks that are capable of transmitting this pathogen. So for these reasons, we decided to study Lyme disease ecology around Chicago, using wild birds as sentinels.

[Ted Pestorius] Thank you, Doctor. How did you go about tracking and capturing the birds and the ticks?

[Sarah Hamer] Well, in order to learn about the ticks that the birds were carrying, we first needed to get our hands on the birds. For this, we used standard field ornithology tool called the mist net. Mist nets are very fine mesh nets that we string tightly between two tall poles or even two tall trees. When a net is erected, it spans about 36 feet in length and up to nine feet in height. Importantly, these nets are made of very fine thread that's nearly invisible to the birds when they're put up properly. We study the habitat first to identify areas with lots of bird traffic—for example, natural corridors in the small woodlot at an urban cemetery or a cluster of tall bushes in the back of a residential yard where there's active bird feeders. Then, early in the morning, when it's still dark out and birds are on their roosts sleeping, we erect a set of nets, and our team usually puts up six to ten nets, in a given area. We then monitor the nets all morning for bird activity. What happens is the birds fly into the nets and they become tangled: one or both of their wings, or feet, or even their head gets wrapped up into the net and this will immobilize the bird. This does not hurt the bird, and our research team is trained to quickly remove the birds from the

net, and often we do this in less than 60 seconds. With a bird in hand, we can perform a health assessment, determine the species of the bird, the sex, the age of the bird, and attach a leg band. These bands have unique numbers on them, so we can identify the recaptured individuals that we've previously marked as part of our study. The banding data are submitted to the federal bird banding laboratory, where they can be used to address research questions about the movement and distributions of different species of birds. One cool example is that one of the robins we banded in Chicago, way back in the summer of 2006, was recovered in the winter of 2009 in Mississippi. We also take blood samples from the birds. Most importantly, we search the birds for ticks. Ticks are found in areas where it's not easy for the bird to preen them off. Across all of these bird tick studies that I've done, the most common locations on the birds where I've found ticks include around the ears and even down into the ear canals, by the eyes, and around the bill. These ticks are tiny. Birds usually host the immature stages, called the larvae and the nymphs, and even when these larvae and nymphs are engorged with blood due to feeding on the bird for a few days or up to a week, they're often no bigger than a sesame seed, but with legs. After removing the ticks and preserving them so we can bring them back to the laboratory, we release the birds.

I just wanted to mention, real quickly, that the type of hands-on bird field research that our team does requires many permits that span the university, the city, the state, and federal levels. All of these permits are intended to ensure that our research is conducted with human safety and bird safety as top priorities.

[Ted Pestorius] This sounds really cool. What'd you find?

[Sarah Hamer] Yeah, we found that it was certainly a rare event for birds to have ticks. Across our six-year study, less than two percent of over 6,000 birds that we looked at were found to carry ticks. Nonetheless, we have lots of cool stories to tell about the 350 ticks that we found on this small percentage of birds, which included five different tick species that differ in the ways that they are important for public health.

First, we did indeed find the blacklegged tick on birds. It certainly was a rare event, and the percentage of birds with this tick increased over our six-year study period, which probably reflects a true increase in the density of this tick species across the landscape. It was really neat to look at the individual birds that carried this blacklegged tick in our study because we could learn a lot about the tick species. For example, we found the blacklegged tick on hatch-year, resident birds, including American robins and house sparrows, that we know to have hatched onsite at our field sites within a couple weeks prior to us capturing them. They had not yet engaged in large dispersal movements, but they still had this tick species on them. Therefore, we know that this tick is established locally within the urban environment. This is important, because, often, wildlife have large home ranges or migratory movements, especially birds, and they could therefore be exposed to ticks far from the field site where we capture them. But here, our data support local establishment of ticks within Chicago. In contrast, we also found the

blacklegged tick on migratory birds both in the spring and in the fall migratory seasons. These were individual birds that do not breed in Chicago but were just passing through when we happened to capture them. Most likely, this means that these birds picked up blacklegged ticks from other areas either to the south or to the north, and they have the potential to import them to Chicago during their migratory stopovers. Therefore, our data suggest a local establishment of the tick, which is also supplemented by deposits of the tick from migratory birds in the spring or in the fall.

Additionally, we found that some of these blacklegged ticks that we removed from the birds were infected with the Lyme disease pathogen, including strains of the pathogen that have been associated with human Lyme disease in endemic areas. It's important to know that with the Lyme disease pathogen, there are many different strains that can be found in ticks and that can be found in wildlife, but only a subset of these strains have been shown to be really important for human disease. In these bird ticks, though our sample size was really small, we found three of the four strains thought to be responsible for a majority of the disseminated human Lyme disease cases. Because these ticks are generalists—meaning they bite not only birds but also mice and other wildlife, humans, and dogs—there is therefore the potential for these Lyme disease strains to be bridged into the human population around Chicago.

Finally, we also found that two individual birds, of over the 6,000 that we looked at, had these 'exotic' tick species. There are two *Amblyomma* genus ticks that are known to be established in Central and South America, but not North America, and we found these two *Amblyomma* genus ticks on the birds. And this makes sense because we found these ticks on migratory birds during the spring, during the migration season, when they would have just left their wintering grounds in Central and South America. Likely, they picked up these ticks down south, and we happened to catch them on a migratory stopover on their way north. Larval and nymphal ticks typically stay attached to a bird for up to a week, after which they will detach from the host and drop down into the new environment. But during that week, a migratory bird can certainly cover a lot of ground, transporting the tick right along with it. So it's likely that every spring, many migratory birds can drop off these neotropical, exotic tick species into the urban environment, and, most likely, these ticks cannot survive because the climate, the habitat, or the wildlife hosts are so different than from where these ticks originated. For example, anteater species are the main host for the adult ticks of one of these neotropical species, and there are no anteaters around Chicago, but, whether some other large wild or domestic host could take the place of the anteaters is something that we just don't know. In the neotropics, these ticks are vectors of a number of different pathogens that are important for public health, so our research team really started thinking about the species invasions, the receptivity of the urban environment, and we try to understand what changes would have to occur in order for these ticks to be imported by the birds, survive, and establish locally. Could this be a mechanism for the introduction of new tick-borne pathogens?

[Ted Pestorius] That's extremely interesting. I think the question a lot of folks are gonna want to know as a result of this is how are people affected by ticks, you know, and ticks on birds? Do we have to look for falling ticks when birds fly over?

[Sarah Hamer] No, that's not the case. There's no direct effect, meaning that having a bird with infected ticks in your yard does not pose an immediate public health risk. A tick on a bird will stay attached to that bird until it has consumed enough blood, after which it will drop off and develop into the next life stage over a period of weeks or months or even winter, and this takes place on the ground, usually under the leaf litter. Only when that tick is actively host-seeking in its next life stage could it potentially get onto a human; the rest of the time, the tick is either burrowed down in the leaf litter or already attached to a different host. However, we found multiple life stages of infected ticks on local birds, and this does reflect an active, natural cycle of the tick and pathogen transmission in the urban environment. What we see on the birds is just the tip of the iceberg, and so the areas where these birds spend time may have established populations of infected ticks that do indeed pose a public health risk. But regarding your question, these blacklegged ticks typically do not fall off birds or fall off trees and land onto humans; rather, they host-seek at ground level. They prop up on grass, or the leaf litter, or small twigs and they wait for a host to pass by. It takes physical contact between the host and the tick to allow the tick to crawl onto the new host and eventually find a spot on that host to start blood feeding.

[Ted Pestorius] Is this increase in ticks found on birds specific to what you call in your study "a natural corridor for migratory birds," or do you think it's an emerging problem for all urban areas?

[Sarah Hamer] It is true that the areas in which we worked around Chicago were centered around a migratory flyway for birds, and this is due to the bottleneck created by the Great Lakes. And as such, many migratory birds typically do move through that region, and where we were studying were certainly hotspots known by the birding community to be great places to watch birds. But, our findings do not relate to these migratory birds alone. Our data suggests not only that migratory birds can import ticks from other areas, but also that some tick species, including the blacklegged tick, are already established locally at these sites, using urban birds, including house sparrow and the American robin, as hosts. Establishment of the blacklegged tick and the Lyme disease pathogen is by no means just an urban problem. Because both the tick and the pathogen are generalists—meaning they're able to use many different wild or domestic hosts--species as hosts—the Lyme disease system is established in many different habitat types, including both urban, or forested, or more rural zones. From our work, it is clear that the urban environment has the right combination of habitat and host features to support this disease system.

[Ted Pestorius] So are there particular types of pathogens and ticks that are more worrisome than others?

[Sarah Hamer] With our tickborne disease ecology and epidemiology research, we are finding that there are lots of different tick species out there in the woods that may contain pathogens capable of causing human disease, but only a small subset of the tick species include humans on their list of potential hosts. Furthermore, of all of the ticks that feed on humans, only some are actually capable of transmitting these pathogens. For example, there is one tick species we found on the Chicago birds called *Haemaphysalis leporispalustris*. This is commonly known as the bird–rabbit tick because it feeds almost exclusively on birds and rabbits, and the genus of this tick is not thought to be capable of transmitting the Lyme disease pathogen. So, while this bird–rabbit tick was the most abundant tick in our collection from birds, we conclude that it by itself does not have much public health importance in the context of Lyme disease. The blacklegged tick, on the other hand, is a generalist that will feed on humans and on wildlife and is capable of transmission of the Lyme disease pathogen. In the eastern half of the United States, the blacklegged tick is the most important vector for human Lyme disease, and it's a bridge vector, meaning it's able to become infected by feeding on infectious wildlife and, subsequently, it can bridge the pathogen into the human population. It's important to keep these concepts in mind because with improved diagnostic testing and molecular capability, we're continuing to find more--more zoonotic pathogens in wildlife and in vectors, but we must understand when these situations actually reflect a public health risk.

[Ted Pestorius] So do you have any ideas about why this is happening now? Or has it always been going on and we're just now becoming aware of it?

[Sarah Hamer] The increasing numbers of blacklegged ticks that we found on birds over our six-year study reflects an ongoing geographic range expansion of this tick species across the Midwest. The reason that these invasions are happening now may relate to broad-scale patterns of deforestation and subsequent reforestation that occurred on the landscape over the past century, with direct impacts on deer and on other wildlife species. Deer are very important species for feeding the adult stage of the blacklegged tick, which is why the blacklegged tick is also known as the deer tick. It is thought that increasing deer densities in many areas has allowed for the blacklegged tick populations to grow and to emerge to new areas. Certainly for some of our work, however, it's simply a case of the more you look, the more you find. For example, we found those two neotropical tick species in Chicago, but this required searching well over 6,000 individual birds, and this search effort simply hasn't been conducted across many regions. Nonetheless, the rarity of our observations do not imply that these findings are biologically insignificant; rather, we can look to the wildlife to provide early signals of potentially emerging human health issues.

[Ted Pestorius] What about climate change, do you think that plays into this issue?

[Sarah Hamer] Yeah, climate change, it's an area that a lot of tick, especially the tick researchers are looking to try to predict and use models to understand as the climate changes, how might these ticks change their distribution—and not just the distribution of the ticks, but the

distribution of the pathogens—and there are certainly projections that given different scenarios of the warming climate, these ticks can move further north into areas where they were previously climatically restricted and bring with them the pathogen of Lyme disease. So yeah, we're not sure, but we think that things will begin to change and public health risk will increase.

[Ted Pestorius] Can other diseases and pathogens be spread by birds, in addition to the tick-borne ones?

[Sarah Hamer] Yeah—certainly, there are a number of human disease agents that are maintained by wild birds. And, of course, you know, one of the most obvious examples right now is West Nile virus. You may have heard a lot about West Nile virus in the late summer and in the early fall this year; 2012's been a particularly big year for West Nile virus transmission. So, as a reminder, West Nile first emerged in the United States way back in 1999 and it's been circulating among wild birds and mosquitoes ever since, with occasional outbreaks of human disease. In the West Nile disease system, birds are the key wild animals that maintain and amplify the virus in nature, and mosquitoes serve as the bridge vector, bridging that pathogen out of the birds and into the human population. Birds are important for the maintenance and transmission of other disease agents too, and certainly we can think about influenza. Our research group here, we're starting some new work to explore the role of wild birds in spreading some really important foodborne human pathogens, including *E. coli* and *Salmonella*, and the birds can spread these through their feces, their excrement. Of course there're other emerging pathogens of birds that do not cause a disease risk in humans. There's been an emergence of conjunctivitis in finches in the eastern United States. This is caused by a bacterium that's spread from bird to bird and it causes these crusty eye lesions. Some types of bird feeders become contaminated by this bacterium, and they serve as a source of infection. So yeah, in our recent study, we focused on the Lyme disease pathogen, but birds are associated with a lot, lots of different disease agents.

[Ted Pestorius] Yeah, yes, I think this notion of feeders that you finished with, that, that's gonna be interesting. Obviously, lots of people, people like birds, and they like birds in their backyard and they do numerous things—they plant foliage and trees and they do specific activities to—to attract birds. Given your study, I mean, should people change this practice or should they give more consideration to what they're doing and how they're attracting birds to their homes?

[Sarah Hamer] Yeah, that's an interesting question, and certainly, like you say, bird feeding and bird watching are hobbies for many of us. I don't think that our study findings should cause anybody to immediately remove their bird feeders from their yards all together. The establishment of blacklegged ticks and the Lyme disease system in this highly urban ecosystem of Chicago probably occurred, in part, due to the occurrence of these urban green spaces, like cemeteries and small parks, that can support deer populations and other wildlife that are known to be important in Lyme disease ecology. Given the mobility of birds, they may move between these urban green spaces and the residential zones, bringing the ticks with them. So, while

feeding birds can certainly cause more birds to spend time in your yard and to even locally boost the numbers of birds within a given area, there are more diverse wildlife species that are needed to actually maintain the ticks and this Lyme disease pathogen.

But in general, it's been shown that the human practices of feeding wildlife can lead to increased disease transmission between wild animals simply because feeding animals brings them into close proximity to each other, allowing for more direct contact between animals, like nose-to-nose contact. But, that's more of a problem for a directly transmitted diseases. Vectorborne diseases, like Lyme disease, those aren't directly transmitted: the tick vector is required. So yeah, there's a chance that feeding birds means more birds spending time in your yard and more of a chance for ticks on those birds to drop off while they're in your yard. And, subsequently, those ticks could host-seek weeks to months later—and that's only if your yard is a suitable environment for them. But, you know, our study isn't implying that that's a major risk. Another factor to consider is that the seed that is used to draw birds into your yard in bird feeders can also attract mice and chipmunks and other critters that are important in the Lyme disease maintenance system, and these other wildlife can carry ticks and the pathogen with them. So, I guess, what I'm trying to say is there is really no clear answer.

[Ted Pestorius] Before we finish, Doctor, are there ways that people can protect themselves from this emerging threats?

[Sarah Hamer] Yes, fortunately many tick-borne diseases are preventable if we can simply prevent the ticks from biting us in the first place or remove them shortly after they attach. When spending time outdoors in areas where ticks are established, we can wear clothing to provide a barrier to the ticks and also be sure to check ourselves for ticks. Simple things like tucking pants into your socks or tucking your shirt into your pants can help prevent ticks getting access to your skin. If you do find a tick attached to yourself, it's wise to remove the tick with tweezers or forceps, and save that tick for identification by a professional in case you do become sick. There are some tick prevention measures that are used in Lyme disease endemic areas, where densities of infected ticks are quite high, but the risk level in Chicago hasn't made those measures quite necessary yet. Regarding the bird element, as I mentioned, it isn't possible for direct bird-to-human transmission of the Lyme disease pathogen; but, nonetheless, there are other reasons to avoid direct contact with wild birds and their feces.

[Ted Pestorius] Thank you very much. I've been talking with Dr. Sarah Hamer about her study, *Wild Birds and Urban Ecology of Ticks and Tick-borne Pathogens, Chicago, Illinois, USA, 2005–2010,* which appears in the October 2012 issue of CDC's journal, *Emerging Infectious Diseases*. You can see and read the entire article online at www.cdc.gov/eid.

If you'd like to comment on this podcast, please send an email to eideditor@cdc.gov. That's e-i-d-editor at c-d-c-dot-gov. I'm Ted Pestorius, for *Emerging Infectious Diseases*.

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