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References: **1.** Six RH, Everett WR, Young DR, et al. Efficacy of a novel oral formulation of sarolaner (Simparica™) against five common tick species infesting dogs in the United States. *Vet Parasitol.* 2016;222:28-32. doi:10.1016/j.vetpar.2015.12.023. **2.** Six RH, Guerden T, Packianathan R, et al. Evaluation of the effectiveness of a novel oral formulation of sarolaner (Simparica™) for the treatment and control of fleas on dogs. *Vet Parasitol.* 2016;222:18-22. doi:10.1016/j.vetpar.2016.02.015. **3.** Data on file. Study No. 17SORPAR-01-01. Zoetis Inc LLC.

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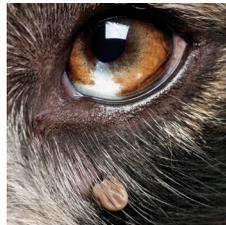
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Lyme disease spreading, CAPC study shows

By I. Craig Prior, BVSc, CVJ

Research from the CAPC indicates seroprevalence of Lyme disease in dogs is not only increasing in the Northeast, where it is considered endemic, but also spreading into areas that were previously thought to not be at risk for this serious, zoonotic tick-borne disease. (“Seroprevalence” in this case refers to the prevalence of dogs exposed to *Borrelia burgdorferi*, the pathogen responsible for causing Lyme disease in the U.S. based on serologic tests—hereafter referred to as “prevalence.”)

Study results were published in the December 2018 issue of *Environmetrics*, the official journal of The International Environmetrics Society (TIES). This milestone study, titled “A Large-scale Spatio-temporal Binomial Regression Model for Estimating Seroprevalence Trends,” suggests canine prevalence rates for Lyme disease are rising and that those rates are increasing most in areas where the pathogen has recently encroached.

Specifically, exposure in dogs to *B. burgdorferi* is rising in states not traditionally considered to be areas of high Lyme risk. Significant increases in the percentage of dogs testing positive for exposure have also been seen in areas that have not yet reported significant human incidence. These findings suggest canine Lyme prevalence could serve as an early warning system for changes in human risk of exposure. Areas where human risk may be increasing include regions in Illinois, Iowa, Michigan, North Dakota, Ohio, and Tennessee.

Consider the following: people don’t tend to worry about Lyme disease in Nashville, where I’ve practiced for almost 35 years. But I’ve seen Lyme increasing in Tennessee for several years, so I regularly test and vaccinate for the disease. This concerning spread of diseases such as Lyme is what motivated CAPC to create the 30-Day Parasite Forecast Maps (available at petdiseasealerts.org). Their main purpose is to provide a tool for veterinarians to help pet owners understand and act on the risk from parasites in their area.



Dynamic, data-driven forecasts

Generated by an innovative, data-driven model, these county-by-county forecasts provide the expected prevalence of four vector-borne canine diseases: anaplasmosis, ehrlichiosis, Lyme disease, and heartworm disease. All of these diseases are dynamic and ever-changing, threatening the health of pets and people alike.

The monthly forecasts are available for every county in the continental U.S. Data are collected each month from veterinary clinics and laboratories across the country; the forecasts use the spatial and temporal patterns in the data to estimate disease prevalence even in counties that don't report any data.

The monthly forecast maps represent the latest development in CAPC's effort to provide pet owners with crucial, time-sensitive information about disease threats. For almost a decade, CAPC has been mapping, tracking, and forecasting diseases to inform veterinarians and pet owners, while encouraging the latter to get their pets tested and protected against vector-borne diseases.

A compelling, complex process

The statistical team at Clemson University has worked over the past four years to develop the current sampling processes and computational algorithms used to create the monthly forecasts. One of the leading statistical teams in the country, it consists of Chris McMahan, MS, PhD, at the helm, along with Robert Lund, MS, PhD, Jenna Gettings, DVM, MPH, research assistant (RA) Stella Watson Self, MS, and previous RA, Yan Liu, PhD.

The forecast uses the millions of historical diagnostic test results in CAPC's database to predict disease prevalence rates for 3,109 counties or county equivalents (such as Louisiana parishes and organized boroughs) in the continental U.S.

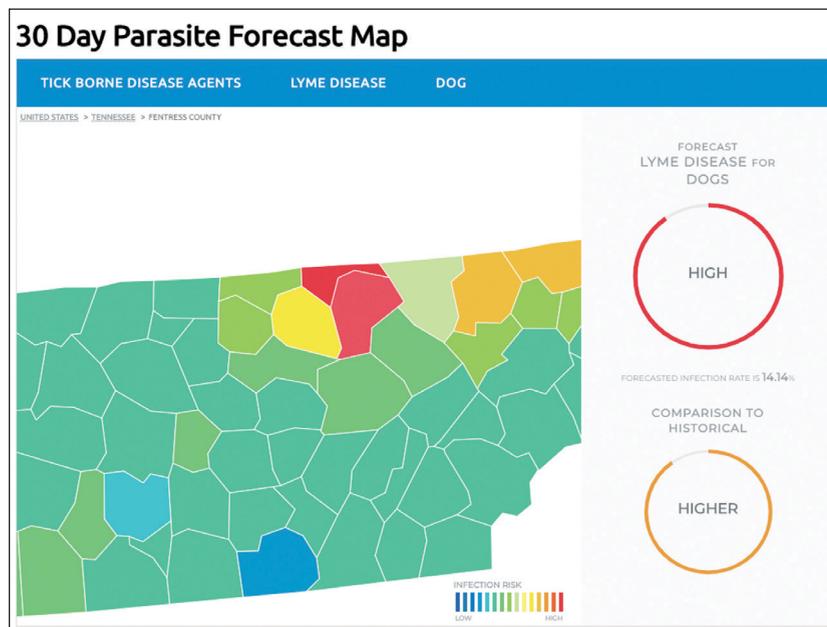
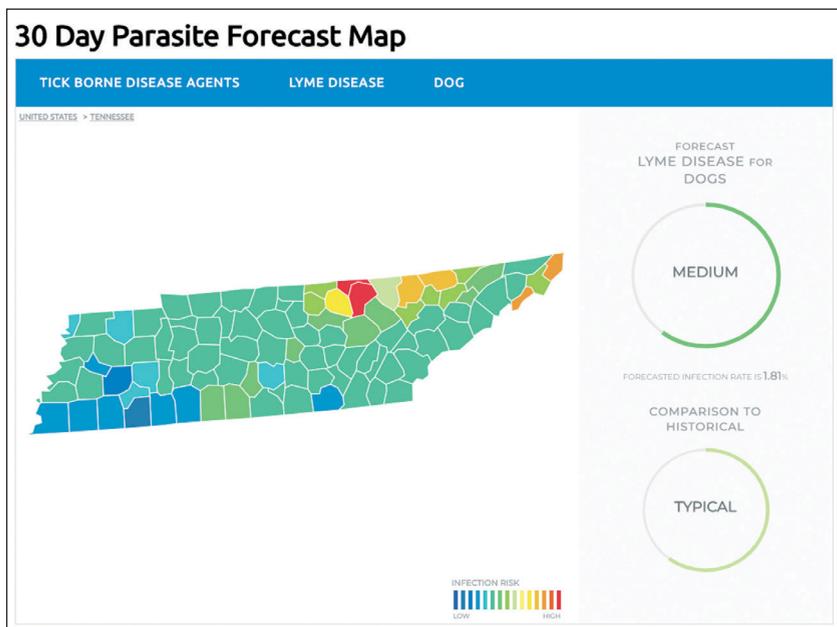
As you can imagine, the forecasts don't use a simple formula. They are built around a complex Bayesian methodology. (For those who prefer a more technical explanation, it's a Bayesian spatio-temporal generalized linear mixed model that has been made computationally



tractable through the development of new sampling strategies [e.g. chromatic sampler], as well as carefully constructed data augmentation steps.) Dr. McMahan explains formulas are used to help create the forecasts, but not in the sense that “you give me data, and I put it into a function and evaluate the function, and the forecast comes out.”

Hundreds of thousands of calculations are being run each time a monthly forecast is created. The forecast calculations take every single data point that has been captured going back in time to January 2012 and use all of it to build the prediction for the month ahead. For the most current forecasts, prevalence for all four diseases is predicted using the more than 141 million test results collected from 2012 through 2018, aggregated by county and month.

Specifically, exposure in dogs to *B. burgdorferi* is rising in states not traditionally considered to be areas of high Lyme risk.



Monthly forecast maps on Pet Disease Alerts for Tennessee (top) and Fentress County in the same state.

Streamlining for faster data output

The original version of the Bayesian methodology used for the annual forecasts CAPC provides took up to two days to fit to the annual data. Over the next four years, as the amount of data increased yearly, the Clemson team knew the computational process was going to become more complicated and challenging. Just when they had figured out how to adjust their methodology to shrink the computational time substantially, the idea of monthly forecasting was born. That's when Zach Williams and his technical team at Venveo got involved.

A digital strategy marketing and development agency, Venveo constructed an automated workflow that takes the place of all the time a person would need to attend to the current monthly forecast process, including structuring the data, turning on the algorithms, fitting the data to the model, and populating and creating the forecast maps.

A closer look at this unique undertaking reveals:

- Without the automated system—even with the powerful desktop computers the Clemson team has—someone would be spending 10 to 12 days every month working on nothing but the forecasts

- The algorithms alone would have to run for 12 hours—for each of the four diseases—one after the other
- The automated process now takes only about four or five hours to run the forecasts for all four diseases
- CAPC has to rent server time from Amazon Web Services (the Amazon cloud-based servers) to complete the monthly forecasts
- It would take more than 30 average computers working together at the same time running at maximum capacity to run the computations at the rate Venveo is now running them

“Part of what we’ve been trying to accomplish has been something we’ve all been working together toward over the last decade, and it’s culminated in this work,” Williams says. “I really give Chris Carpenter, DVM, MBA, (the executive director of CAPC) the credit. He had the vision for this years ago, but the technology just wasn’t there to be able to do what he wanted. As technology advanced, it’s really opened up the opportunity for us to push the boundaries of what CAPC can do with this data in a way that it previously couldn’t.”

The forecasting methodology now even includes a way to compare the monthly forecast to “normal” levels for each location and determine if the forecasted prevalence is high, low, or normal.

To further refine the monthly forecasts, the Clemson team is currently exploring the use of data collected from sources such as social media and common internet search engines, as well as incorporating relevant results from other biological models.

Leveraging the forecasts

These forecast maps are an engaging visual tool the entire veterinary team can use to help clients understand just how much of a risk vector-borne diseases are in your locality.

Many people have a common misperception that if they don’t hike or spend time in wooded areas, neither they nor their pets are at risk for Lyme disease. Unfortunately, ticks are everywhere, including suburban and gated communities where deer, raccoons, opossums, birds, and other hosts frequent backyards.

That’s why CAPC recommends year-round tick prevention and regular screening to help protect dogs—and cats—from this debilitating disease that can be difficult to treat. And because Lyme disease is zoonotic,

protecting pets also helps protect human family members.

Clinic teams can show the maps to clients to increase their awareness of the threat of all four diseases (tick-borne Lyme disease, ehrlichiosis, and anaplasmosis, as well as heartworm disease) in their county. Because these forecast maps are available for every county across the continental U.S., clinic teams also can advise clients about risks in any areas they plan to travel with their pets.

By leveraging the CAPC monthly forecast maps and the work that’s gone into making them accurate predictors of future disease prevalence rates, you can help get even more pets on year-round protection, as the council recommends.

Why wait until diseases are in your area when you can help protect pets—and their owners—before they’re at high risk? ●

I. Craig Prior, BVSc, CVJ, is immediate past-president of Companion Animal Parasite Council’s (CAPC’s) board of directors. Dr. Prior is the previous owner of VCA Murphy Road Animal Hospital, an eight-doctor practice in Nashville, Tenn., and former owner/partner in three BluePearl emergency hospitals in Middle Tennessee. A 35-year veteran, Prior’s professional interests include all aspects of small-animal medicine and surgery, as well the operations and metrics of well managed practices. Born and raised in Australia, Prior represented Australia at the 1982 World’s Fair in Knoxville, Tenn., before graduating from the University of Queensland in Brisbane with a degree in veterinary medicine in 1984. He moved to the U.S. in 1985. Prior shares his veterinary and business knowledge as a practice management consultant, and through speaking engagements throughout the country, sitting on advisory boards and making guest appearances with various national media outlets.

“By leveraging the CAPC monthly forecast maps and the work that’s gone into making them accurate predictors of future disease prevalence rates, you can help get even more pets on year-round protection.”



Send a clear parasite-prevention message

Why do so many pets continue to go unprotected?

By Jackie Brown

Clients simply aren't getting the message when it comes to preventing fleas, ticks, and in particular heartworm.

"Despite the knowledge we have regarding heartworm disease, and the fact that heartworms are known to be transmitted throughout the U.S., the number of doses of prevention appear to have decreased from 2016 to 2017," said Stephen Jones, DVM, past-president of the American Heartworm Society and practice partner at Lakeside Animal Hospital in Moncks Corner, S.C. "This is a frightening trend and does not reflect a single product, but appears to be across all product lines."

With current weather patterns contributing to the parasite problem, pets are more in need of prevention than ever before. Heartworm in particular is now present in geographic regions that used to be considered heartworm free.

"Canine heartworm has been diagnosed in every state in the United States, including Alaska and Hawaii," said Heather D.S. Walden, MS, PhD, veterinary parasitologist and Companion Animal Parasite Council (CAPC) board member. "The development of ticks can vary based on species, geographic location, and climatic factors in each location, so there cannot be an overall assumption made for each species. Fleas are similar and rely more on temperatures and relative humidity for optimal development."

With fleas, ticks, and heartworm more prolific than ever, year-round prevention for all parasites should be standard for all pets.



“The importance of discussing parasite prevention at every single visit cannot be overstated.”



“The days of seasonal administration of heartworm preventives in the northern half of the U.S., especially the northeast, where the overwhelming majority of people live in urban areas, need to go away,” said Charles Thomas (Tom) Nelson, DVM, medical director at the Animal Medical Centers of N.E. Alabama, based in Anniston, and executive board member of the American Heartworm Society (AHS). “Changes in mosquito vectors, urban heat island effect, and global warming have extended the transmission season where most people live.”

Such changes in mosquito vectors necessitate new strategies of attack to keep pets safe from heartworm infection.

“The newest thing that’s come out in the last two years or so is really looking at the vector and looking at the increase in mosquitoes, and instead of just killing the heartworms once they’re in the pet, killing the mosquitoes or trying to prevent mosquito exposure or bites,” said AHS president Christopher J. Rehm, Sr., DVM, of Rehm Animal Clinics of Mobile and Baldwin Counties in Alabama, referencing a study by John McCall^{1,2} using a resistant strain of heartworms.

In the study, the group that received both a mosquito repellent/killer and heartworm preventative had no heartworms. Pets that received just heartworm prevention all got heartworms, but they got fewer heartworms than

the control dogs, which didn’t receive any prevention. Of the dogs given mosquito repellent only, roughly half got heartworms and half didn’t.

“If we’re protecting the dog on the outside and the inside, then we’re going to have a better chance of preventing heartworm disease,” Dr. Rehm said.

Compliance struggles

With effective preventives available in oral, topical, and injectable forms, veterinarians and pet owners have the tools to keep parasites off pets. So why are so many pets unprotected? Lack of compliance comes in many forms, including clients who don’t see the need for preventives, those who are confused

about the products they're using, and still others who simply forget to give the preventive every 30 days.

Clients are more confused about the prevalence of parasites and the diseases they transmit than you might think.

"It is easy to assume all pet owners understand these diseases because someone has informed them at one point in time," Dr. Jones said. "However, repeated efforts to educate and to stress the importance of prevention are necessary if we are to expect our clients to comply with administering preventive medication, especially on a continual basis."

Dr. Walden suggests using CAPC parasite prevalence maps in the clinic to demonstrate to clients that tick-borne disease like Lyme might be more prevalent in their area than they thought.

"Making sure clients are educated regarding preventing not only the fleas and ticks that can infest their pets and their homes, but also the potential disease agents and other parasites these arthropods can carry can help drive home the message and the importance of year-round protection," she said.

The plethora of products that are available, some without a prescription, often adds to client confusion.

"Many owners believe the products they purchase from a big-box store protect their pets from *all* parasites when all they may be receiving is flea control," Dr. Nelson said.

Skipped doses is another effective prevention roadblock. Many pet owners who purchase medication miss doses simply because they forget.

"If it's still in the box then it doesn't do the pet any good," Rehm said, who adds that compliance nationwide is less than 50 percent for dogs and just two percent for cats. "We live a very hectic and busy life and sometimes you might get that reminder when you're out of town or when you're doing something else and you don't make good on it."

To help your clients remember, employ a variety of reminder methods, both high-tech and a few old-school.

"Most people have smartphones, so I just tell people when they give that first dose to ask Siri to set up a reminder," Rehm said. "Some people have

Drug-resistant heartworm

The topic of drug-resistant heartworm is trending, most recently with the case of a Metairie, La., Labrador retriever. We know heartworm resistance is real, but just how big of an issue is it?

"We have known that drug-resistant strains of heartworm have existed for a while, even though it is uncommon," said Heather D.S. Walden, MS, PhD, veterinary parasitologist and Companion Animal Parasite Council (CAPC) board member. "This case is not surprising, and is one of three verified in Louisiana so far. This is one of many reasons why [annual testing] is so important."

According to Christopher J. Rehm, Sr., DVM, of Rehm Animal Clinics of Mobile and Baldwin Counties in Alabama, president of the American Heartworm Society (AHS), the four preventive drugs—selamectin, ivermectin, milbemycin oxime, and moxidectin—are still highly effective.

"I believe there are enough studies out there that show all the macrocyclic lactones do what they're supposed to do," he said. "There are some advantages to some over the others in certain areas, and those advantages are generally in the application or the administration or convenience or palatability. What we've seen with resistance is it's not dose-related."

Drug resistance is far less of an issue than other issues surrounding heartworm prevention, specifically lack of prevention use, missed doses, or inadequate doses, according to Dr. Rehm.

"Resistance is not a big player really," he said. "Even in the Delta, Clarke Atkins, DVM, did a very exhaustive study, and he found that just a little over one percent of all the lack-of-efficacy reports he reviewed could not be explained by anything other than resistance. Roughly 99 percent of all the heartworm positives he reviewed when he did his case review could be explained by missed doses or improper dosage." ●



their online pharmacy set up to where their clients are getting their preventative delivered monthly. My personal system is I have a sticker on the first day of the month and I put an X through it with a Sharpie when I administer it.”

Jones suggests that clients use repeating alerts on Google calendar or store the preventives in the same place as another monthly task, such as in a file with household bills.

Also consider using automated reminders for prescription refills.

“Reminders are used in the majority of practices for vaccinations and testing, but not near as often for purchasing parasiticides (approximately 25 percent),” Nelson said. “With today’s practice management software, reminders to administer as well as refill medications can be easily set up and sent as emails or text messages as not to incur any printing or mailing cost.”

Strongly recommending clients give parasite prevention year-round rather than seasonally is another way to improve compliance. It’s easier to remember to give the medication every single month rather than select months out of the year. This is also a sound recommendation in the face of warmer and wetter climate conditions, which lend to more parasites 12 months out of the year.

Finally, for some clients, cost is certainly a deterrent to giving parasite preventives.

“The second most common reason pet owners miss doses of prevention or stop giving it completely is because of expense,” Jones said. “Making certain that the cost-conscious client is aware of less expensive options for prevention is often very helpful in increasing both acceptance and compliance.”

Education key

The importance of discussing parasite prevention at every single visit cannot be overstated.

“Annual to biannual physical exams remain the mainstay of a strong relationship between veterinarians, clients, and patients, and also allow the opportunity for questions regarding parasite preventative, compliance,

““ Recommending clients give parasite prevention year-round rather than seasonally is another way to improve compliance. It’s easier to remember to give the medication every single month rather than select months out of the year.”

and concerns to be addressed,” said Heather B. Loenser, DVM, senior veterinary officer with the American Animal Hospital Association (AAHA). “While it can be difficult to cover all the topics necessary in wellness appointments, it behooves the veterinarian and the staff to ensure the client understands these recommendations.” ●

References

¹ McCall JW, Hodgkins E, et al. (2016, August). “Blocking of the transmission of *Dirofilaria immitis* L3 (JYD-34 ML resistant strain) from infected mosquitoes to dogs and prevention of infection in dogs treated topically with dinotefuran-permethrin-pyriproxyfen and orally with milbemycin oxime alone or in combination.” Abstract presented at the meeting of the American Association of Veterinary Parasitologists, San Antonio, Texas.

² McCall JW, Hodgkins E, Varloud M, Mansour A, DiCosto U. (2015, July). “Inhibition of the transmission of *Dirofilaria immitis* to mosquitoes by weekly exposure to microfilaremic dogs treated topically with dinotefuran-permethrin-pyriproxyfen.” Abstract presented at the meeting of the American Association of Veterinary Parasitologists, Boston.

³ bit.ly/2DDMkHT



Ticks' **increasing threat**

The blood-sucking arachnids, now seen 12 months a year and in every state, pose an ever-growing public health challenge and a year-round menace to pets.

By Kim Campbell Thornton

Masters of ride-sharing well before Uber and Lyft came along, ticks hitch rides with white-tailed deer, migrating birds, and other animals, making their way to locales where they didn't exist in the past. Now, one or more tick species are found in every state, including Alaska and Hawaii. And milder winters mean that even if ticks aren't out 365 days a year, they are seen 12 months out of the year. Dogs, cats, and humans are at risk for various tick-borne infections, making them a public health issue.

In fact, dogs are sentinels for Lyme disease in humans, according to the Centers for Disease Control and Prevention (CDC). While dogs don't transmit the disease themselves, they can bring ticks into contact with humans. A CDC research paper shows a direct correlation between a five percent or higher incidence of Lyme disease in dogs in an area and development of Lyme disease in humans in that area, according to I. Craig Prior, BVSc, immediate past-president of the Companion Animal Parasite Council (CAPC).

"Ticks that infest dogs can also feed on people, and some of the pathogens they carry can also infect people," said Meredith Miller, DVM, DACVIM, at Cornell University College of Veterinary Medicine in Ithaca, N.Y. "The pathogens they transmit can vary from very treatable to life-threatening or even cause death."

Affecting tick numbers

Because disease-spreading ticks have a two- to three-year lifecycle, it's difficult to predict just how numerous and widespread ticks and tick-borne diseases will be in 2018, but the blood-sucking arachnids typically are most active in spring, summer, and early fall. Factors affecting their

numbers include temperature, rainfall, humidity, and the availability and numbers of host animals such as mice, deer, dogs, and other animals. In any given year, the CDC reports, the number of ticks in an area varies from region to region, state to state, and county to county.

"The seasonality of ticks varies geographically," said Dr. Miller. "Some ticks can infest homes or kennels and survive cold temperatures."

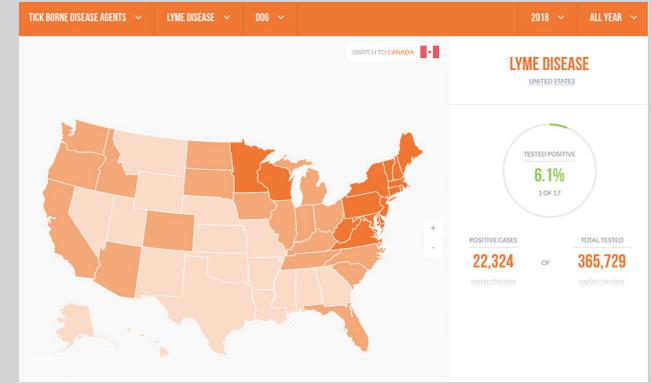
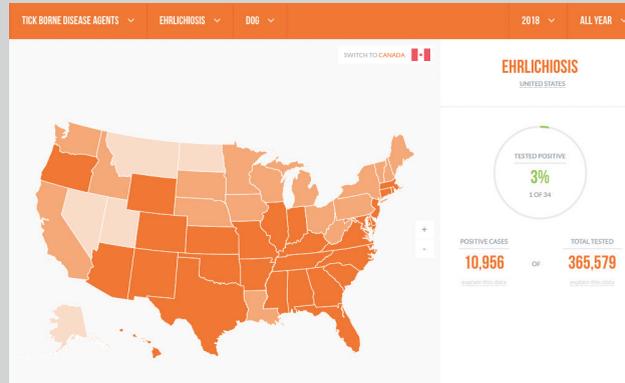
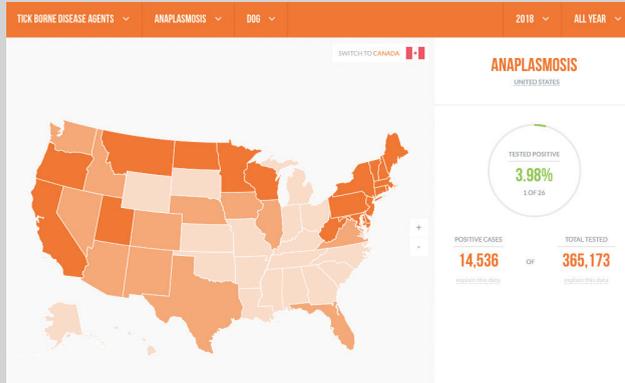
They do this by seeking shelter beneath logs or leaf litter, which provides thermal insulation, and reducing their activity level to conserve water. Ticks are vulnerable primarily to dehydration. Short of massive drought or an extremely cold winter with no snow, tick populations are unlikely to decrease. The minimum temperature from which various tick species can recover without mortality ranges from 3.2 F to 17.6 F, said Michael Dryden, DVM, in a lecture at VMX 2018.

To aid veterinarians in understanding the risk in their area, CAPC's website (capcvet.org) provides maps for Lyme disease, ehrlichiosis, and anaplasmosis. The prevalence maps show the percentage of pets tested who are positive for a given infection. Factors influencing results include the number of pets tested, the history of the pets prior to testing, the reason the pets were tested, and the assays used.

"We'll be able to add soon a local forecast for one month in advance," Dr. Prior said. "You'll be able to see what's going on in your local county on a month-by-month basis. We're getting really good information out there so people can understand what their risks are."

In Wisconsin, for instance, CAPC's figures show a total of 172,888 dogs were tested in 2017, with 14,813 testing positive for Lyme disease. That's approximately one out of 12 dogs, for an 8.6 percent infection rate.

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The University of Georgia also offers a forecasting map detailing which areas in the 48 contiguous states are most likely to see Lyme disease infections in dogs, information that could also predict the infection in humans.

Tick-borne diseases in dogs

It's a common misconception that dogs don't get Lyme disease, transmitted by blacklegged ticks—*Ixodes scapularis*—and, on the West Coast, Western blacklegged ticks—*Ixodes pacificus*. Although 95 percent of dogs exposed to Lyme do not show signs, those who do may experience fever, anorexia, depression, shifting lameness, swollen joints, and enlarged lymph nodes.

Dogs with chronic Lyme disease may exhibit persistent polyarthritis, acute progressive renal failure, and in rare instances, neurological signs such as sudden unexplained aggression. In areas with high numbers of ticks, consider

running a tick panel on dogs presenting with unexplained signs of aggression, depression, fear, or a combination.

According to CAPC, prevalence of Lyme infection in dogs ranges from as high as 16.37 percent at ground zero in Connecticut, where the disease first emerged, to as low as 0.19 percent in Louisiana. Some surveys by CAPC found that more than half of questing nymphs (immature ticks seeking hosts) and adult ticks harbored *Borrelia burgdorferi*, the spirochete that causes Lyme disease, putting dogs living in tick-infested environments at high risk of infection. Adult ticks transmit most canine Lyme infections, while ticks in the nymph stage transmit most human Lyme infections.

A Lyme disease vaccination may benefit dogs at high risk such as hunting dogs in Lyme-endemic areas. According to the 2017 American Animal Hospital Association (AAHA) vaccination guidelines, dogs in areas where risk of exposure

is sustained should be vaccinated annually with a single dose after the initial two-dose series. In areas where risk is not high, the vaccine remains noncore.

Two tick-borne disease threats, both deadly to dogs, are Rocky Mountain spotted fever (RMSF) (transmitted by the brown dog tick, *Rhipicephalus sanguineus*) and an emerging disease called American canine hepatozoonosis, which is transmitted indirectly when dogs ingest infected Gulf Coast ticks (*Amblyomma maculatum*) or intermediate hosts such as rabbits.

Name notwithstanding, RMSF isn't limited to the Rocky Mountain region. It occurs east of the Mississippi, including in New York. Again, dogs do not transmit the disease to humans, but if dogs are exposed to ticks, humans likely are as well.

Signs of the rickettsial infection include high fever, anorexia, muscle and abdominal pain, stiff gait, and vomiting

and diarrhea. Unless effectively treated, RMSF has high morbidity and mortality in dogs and humans.

“There’s been a case where two dogs in a family and a person have all three died of Rocky Mountain spotted fever,” Dr. Bowman said.

Dogs with hepatozoonosis develop fever, depression, weight loss, muscle atrophy and pain, hypertrophic osteopathy, and weakness. Treatment with antibiotics brings temporary relief, but without continued support, dogs typically do not live more than one or two years after diagnosis. Infection is not known to be zoonotic.

Ticks may also infect dogs with anaplasmosis, ehrlichiosis and, less commonly, babesiosis. *Anaplasma phagocytophilum* is transmitted primarily by the blacklegged tick and is seen most commonly in the northeast and in California. Signs of infection include lameness, diarrhea, vomiting, and fever. The term “ehrlichiosis” refers to a group of bacterial diseases usually transmitted by the lone star tick and the brown dog tick. Babesiosis, a protozoal infection transmitted by blacklegged ticks, invades red blood cells, triggering fever, anemia, and weight loss. It is seen in the south and in California.

Cats at risk, too

While cats are typically more resistant than dogs to tick-borne diseases, outdoor cats are increasingly at risk of a serious and often fatal disease called cytauxzoonosis, transmitted by the lone star tick (*Amblyomma americanum*) and to a lesser extent the American dog tick (*Dermacentor variabilis*). Those ticks are most commonly seen in southeastern and south-central states such as Arkansas, Florida, Oklahoma, and Texas, but their range continues east to the Atlantic coast and north to North Dakota.



Two tick-borne disease threats, both deadly to dogs, are Rocky Mountain spotted fever (RMSF) (transmitted by the brown dog tick, *Rhipicephalus sanguineus*) and an emerging disease called American canine hepatozoonosis

The protozoal infection, caused by *Cytauxzoon felis*, usually occurs between spring and fall, when ticks are most active. Disease can develop five to 20 days after an infected tick bites a cat. Signs include high fever (up to 106 F), lethargy, anorexia, and dehydration.

Cats succumb quickly to cytauxzoonosis (popularly known as bobcat fever after the wildcats who appear to be the primary reservoir for the disease). Even with treatment—a combination of antiparasitic and antibiotic drugs, plus IV fluid therapy, heparin, a feeding tube, and oxygen therapy and blood transfusions as needed—the

mortality rate can be greater than 50 percent. Cats recover best with minimal stress and handling.

“Cytauxzoon is deadly,” said Dwight D. Bowman, PhD, a parasitologist at Cornell University College of Veterinary Medicine. “It’s a reason why cats should not even be allowed outside in certain parts of the country.”

More rarely, ticks can transmit *Ehrlichia spp.*, *Mycoplasma spp.*, and *Anaplasma spp.* to cats. Signs of *Ehrlichia* or *Anaplasma* infection in cats include fever, lethargy, anorexia, weight loss, joint pain, and vomiting and diarrhea. A 1997 report in *JAVMA* of a suspected

ehrlichial infection in five cats from the same household notes that it may be associated with anemia, leukopenia, thrombocytopenia, or dysproteinemia. The cats responded to a 21-day course of doxycycline.

Mycoplasma infection in cats with feline leukemia virus or feline immunodeficiency virus as well as some healthy cats may cause severe and in some instances fatal hemolytic anemia.

Cats do not appear to be susceptible to Lyme disease, but that is not definitive.

“At this point in time, there is no documented evidence that cats get Lyme disease,” Dr. Dryden said.

There are, however, anecdotal reports of cats with Lyme-like signs responding to Lyme disease antibiotic therapy, so the possibility shouldn't be ruled out. While there are no feline-specific tests for exposure to tick-borne diseases, canine SNAP-4DxPlus tests can be used to screen for exposure to tick-borne pathogens such as ehrlichiosis, anaplasmosis, and Lyme disease in cats.

Disease transmission: What we know

Surprisingly, less is known than you might think about the time frame in which pathogens are transmitted from a tick bite. At his VMX lecture, Dryden reviewed several studies from the past century that contained no actual statistics or records to support the generally accepted time frame of 24 to 48 hours for RMSF pathogens to be transmitted from tick to host. The same was true for other diseases.

It's understood, though, that the longer a tick remains on the host, the more likely the host is to become infected. It's rare for *B. burgdorferi* to transmit infection within 24 hours, but transmission rates increase markedly after 42 hours. Studies do support that *Babesia* transmission takes 48 to 72 hours. Data is limited for other infections.

While cats are typically more resistant than dogs to tick-borne diseases, outdoor cats are increasingly at risk of a serious and often fatal disease called cytauxzoonosis, transmitted by the lone star tick.

What is known is that ticks transmit disease through saliva, but when they begin to feed, pathogens are in the mid-gut, not the saliva. Pathogens must be reactivated to migrate from mid-gut to salivary glands so they can be transmitted. Repelling, detaching, or killing the tick during the time following attachment and before deposit of pathogens helps to prevent disease transmission, Dryden said. This phenomenon is documented for RMSF, Lyme disease, babesiosis, and *Anaplasma phagocytophilum*.



Most important, pets—especially those who go outdoors—should have tick protection year-round throughout life. Which preventive is best depends on the pet's lifestyle and the prevalence of ticks in the area. Currently, there's no evidence of tick resistance to acaricides, with the exception of the brown dog tick. Counsel owners to perform tick checks regularly and remove ticks as soon as they find them, especially during warmer months. ●