DEAD DEER WALKING:

Chronic Wasting Disease in New York State

by Amy Dechen Quinn
with David Williams and Bill Porter

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The sun dipped below the horizon, and I knew it would be fully dark in 30 minutes. While the condensation from my breath wove a tapestry of ice crystals on the inside of the blind, I tried to recall the last time I could feel my toes. My lower back ached and the legs of my Carhartt™ bibs were stiff with frozen mud. With my technicians, Dan and Amber, I had sat in silence for hours, listening to the creaking birches and the gentle shush of the nylon straps brushing against the blind.

It was my 46th consecutive day in the field, and a strangely belligerent exhaustion had taken residence in my bones. Just as my thoughts wandered to some Tahitian paradise, Dan elbowed me in the ribs and passed the binoculars.

Our quarry moved tentatively along the tree line, stepping high in the deep snow. She raised her wet, black nose and flicked her tail. Her impossibly large ears sat high and alert. We froze as she ventured into the open field, followed by another. They surveyed the area one last time, ears rotating, and finally lowered their heads to eat. With shaking fingers I pressed the button and even though I knew it was coming, the blast of ignited black powder stopped my heart for just a moment.

The rockets sailed up and over the startled deer, lighting the silvery snow with hues of orange and yellow. The net unpacked perfectly, looking like a spider web exploding in the sky. Dan grabbed two wool blankets, and Amber unzipped the blind. I reached for

the syringe in my pocket as we ran toward the tangled animals. In less than 30 seconds, Dan and Amber had subdued the struggling deer and I administered the anesthetics. I radioed to the rest of the team that we had successfully captured an adult doe and a button buck. Then, we waited quietly for the anesthesia to take effect.

The crew truck came to an abrupt stop about 100 yards from the sleeping deer. Dan and Amber untangled the animals from the capture net while I monitored vital signs and prepared blindfolds. We weighed the animals and rested them between wool blankets to guard against hypothermia. The next 30 minutes were a flurry of stethoscopes, pliers, forceps, headlamps, thermometers, catheters, and duct tape that could rival the most riveting accounts of alien abduction. Eventually the animals woke from their drug-induced slumber, adorned with ear tags and some very expensive technology.

Why would someone spend their winters this way—four months straight of 16-hour days trying to catch a bunch of white-tailed deer? I hope to convince you, it was for a very good reason.

A Spreading Menace

In April 2005 the state of New York got some very, very bad news. A captive white-tailed deer on a farm in central New York tested positive for chronic wasting disease (CWD). Subsequent surveillance identified four more captive deer and two free-ranging deer that tested positive for the fatal disease. In an instant, New York wildlife biologists were faced with one of the most mysterious and unusual wildlife diseases ever reported. CWD had plagued hunters and wildlife professionals in the western U.S. for decades, and in recent years the pernicious disease cropped up in several states and provinces throughout North America. As a newcomer to the east, CWD was unequivocally unwelcome. That's because this tiny, misbehaving protein can cause an awful lot of trouble.

CWD is a degenerative disease of the nervous system that affects members of the deer family. While fascinating from a science perspective, the disease is horrific if you have to deal with it on a practical level. CWD is not caused by a virus, bacterium, or fungus

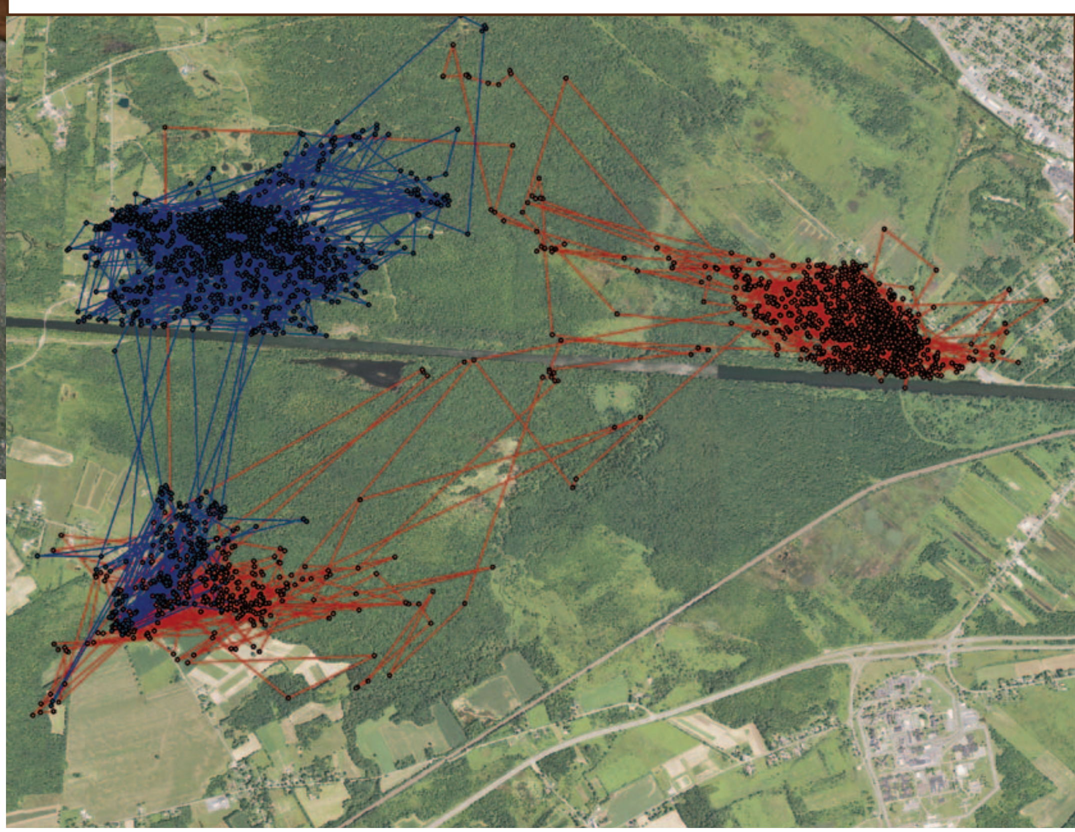
the way most diseases are. Instead it's caused by a protein (called a prion) that most mammals produce naturally. When the prion protein is shaped properly, it functions normally. When it takes on a different shape, it fails to break down with normal enzyme activity and accumulates in the brain. This causes lesions that ultimately lead to brain degeneration in the infected animal. What's more, it seems that diseased prions can change the shape of normal prions, allowing for a kind of replication not normally ascribed to non-living proteins.

CWD is believed to be transmitted between animals both directly, through nose-to-nose contact, and indirectly through contaminated environments. Prions remain viable for a long time in the environment and are resistant to extreme temperatures, moisture, and UV light. Infected animals may incubate the disease for months to years while appearing outwardly healthy. But during this time, prions accumulate in the host animal's central nervous system and are shed through various biological materials. Consequently, animals with CWD are believed to be contagious to other animals shortly after infection. By the time the animal develops the clinical symptoms of poor body condition, excessive salivation, and disorientation, death is not far off. CWD is fatal and there is currently no cure or vaccine to prevent the disease.

CWD represents a very troublesome suite of characteristics for a wildlife disease. It infects deer both directly and indirectly, has the ability to persist for extended periods in harsh environments, and exhibits a prolonged incubation period during which infected animals look healthy but are contagious. A newly detected case of CWD is enough to keep any wildlife biologist awake at night.

A key question is, how can a wildlife agency best respond when a diseased animal has been identified? The current protocol is to draw a circle around the disease site to establish a containment area. In New York and many other states, the circle's radius was set at 16 kilometers (about 10 miles) based on the natural history of the host animal as well as political boundaries within which management actions could be directed.

Thus a typical response establishes a very large area—more than 800 square kilometers (308 square miles)—for managing disease spread. Effective management action may prove exceedingly difficult over such a large area due to variations in population abundance, landowner cooperation, and available resources. Adding to the problem are behaviors of white-tailed deer that complicate our ability to predict where a disease will spread in an environment. We all intuitively understand that deer are not likely to move with equal probability in any given direction. So it stands to reason that disease spread is unlikely to radiate from a point of occurrence with equal probability in all directions. But where will the risk of disease



ABOVE AND OPPOSITE PAGE: Deer are netted and sedated, then fitted with a GPS collar while tests are ran and vitals recorded. A total of 95 deer were collared and their GPS locations were recorded every 5 hours for about a year. RIGHT: Each GPS location was connected chronologically, representing the path that the deer traveled over the entire time it was monitored.

spread be highest? Where will the risk be negligible? At what distance from an incidence of disease will the risk attenuate?

The answers to such questions can help managers target their limited resources to more effectively contain or reduce the spread of disease. Those questions are what drove me to spend countless hours in a cold blind, year after year, as a doctoral student at the State University of New York College of Environmental Science and Forestry (SUNY-ESF).

The When, Where, and Why of Deer Behavior

The discovery of CWD in central New York state was the catalyst for a collaborative research project between wildlife biologists at the New York Department of Environmental Conservation (NYDEC) and researchers at SUNY-ESF. My doctoral advisor, Dr. Bill Porter, and I sought to apply knowledge of animal behavior to develop more informed response plans for disease management. David Williams, another doctoral student, joined the project the following year. We began with a conceptual idea that a disease "sees" the host population of deer as a landscape upon which to navigate. Studying where deer spend time and the spatial interactions between animals should tell us a lot about how far and how fast a disease will spread through a population.

Observing deer biology and behavior is nothing new; hunters have been using knowledge of rutting, marking, and habitat selection behaviors for centuries. The challenge is to quantify the magnitude of different behavioral responses over time and space in order to identify areas of high risk for disease spread. For this we deployed global positioning system (GPS) collars on 95 animals including 53 does, 8 bucks, 14 doe fawns, and 20 button bucks. The collars were programmed to record a satellite location every five hours over the course of a year. When all of the collars were retrieved, we possessed more than 100,000 GPS locations offering important insights on how often deer contact one another, the space that animals occupy, and the resources that deer select and avoid across seasons.

Deer-to-Deer Contact

We found that deer contacted each other with varying probability at different times of the year. For example, when we looked at GPS locations recorded from two does in the same social group, we saw that they were in nearly constant contact with one another during the winter and early spring (January to April) but began spending more time apart during late spring leading up to fawning. These does were separated by more than 100 meters during much of the summer, when we suspect they were rearing their respective fawns. They were farther apart as the rut approached, but by the beginning of January were nearly inseparable again. When we looked at all possible pairings of deer, we saw similar behavioral patterns and concluded that contacts occurred most frequently during the winter months.

We calculated a function that allowed us to quantify the space over which contacts occurred. We found that 75 percent of the direct contact probabilities for deer across our 80-square kilometer study area occurred within 6.2 km, 85 percent occurred within 6.8 km, and 95 percent occurred within 8.5 km. Surprisingly, we found that indirect contacts occurred within a similar spatial extent (95 percent occurred within 12 km). This suggests that the majority of first-order contacts between deer are happening at distances much smaller than the traditional management model. With knowledge of deer distribution, managers can decide what landscape scale they need to manage to account for a certain percentage of contact probabilities.

Deer Use of Space

Understanding the distance at which the probability of contact drops off is an important first step in identifying the area of risk associated with a newly detected case of disease. However, we still need to account for the habitat choices animals make. When a diseased animal is identified in a new area, managers often have only a single point of reference (i.e. the location where it was harvested) and must make inferences about the space that individual used in the months leading up to its death. Remember that animals with CWD can be contagious for months to years before showing any clinical signs, so it is important to identify the spatial extent they have occupied during that contagious period.

Deer require multiple resources (food, cover from predators, etc.) that are reflected in different land cover classes. Forest edges provide productive and structurally complex habitat that may meet the needs of deer, and edges are created by landscape fragmentation. If you imagine the way a landscape looks from an airplane, you immediately see that different land cover types (agriculture, forest, wetland) make up a mosaic of patch types. Deer respond to the composition and arrangement of those patch types because different patch types represent different resource requirements. We found that configuration of important land cover types

(agriculture, forest, and rangeland) strongly influenced the space used by deer and that animals used much less space, both seasonally and annually, in areas where these cover types were highly fragmented and interspersed. This information assists managers by allowing them to investigate the landscape configuration surrounding a point of disease occurrence, thus indicating the likely area a diseased animal occupied in the months prior to its identification.

Resource Selection

Our next step was to investigate how landscape composition and configuration influence home range sizes of individual deer so that we could provide managers with an estimate of space used by a recently detected animal. Then we took a closer look inside home ranges at the step-by-step path each animal took over the course of the time it was monitored. Our purpose was to identify whether specific resources were selected, avoided, or simply used as they were encountered by deer. To do this, we needed to compare the resources animals used to those that were available to them. We know what the deer used because we have a GPS record of the animal's location, but defining what is available can be tricky. What appears to be available to us may not be perceived the same way by deer. We chose to let the deer tell us.

Imagine that a series of points on a map are the GPS locations of a given deer. If you drew a line connecting each of those points chronologically, the line would represent the path that the deer traveled over the entire time it was monitored. We have paths like this for every animal, determined from locations taken every five hours for about a year. When we add all that data together, we get a distribution of the distance traveled between each point (the step length) and the angles traveled (turn angle). And since we know what an animal chose at each time step, we can estimate what was available to them by generating random points at each step. We generate those points by pulling from a step-length distribution and a turn-angle distribution.

What does all that tell us? For each point, we know an animal chose a particular location, but it could have traveled to any of the randomly generated locations instead. Compiling these hundreds of thousands of selection events reveals the choices animals are making about habitat use. In this way, we are able to quantify the behavioral responses of deer to different resources on the landscape. For example, most hunters and wildlife biologists can tell you that in areas of deep snow, deer will often move away from open areas to patches of conifer cover because these areas provide some thermal benefits. Radiant heat trapped by the conifer branches provides a warmer microclimate, and because the snow is less deep, deer do not have to expend as much energy moving around. Our resource selection models are able to quantify the strength of the behavior: deer are nearly twice as likely to select conifer cover and only half as likely to select agriculture over deciduous cover in winter. These responses to land cover type, distance to roads, elevation and the like can be compiled into maps that show managers the geographic locations that deer are likely to occupy (and avoid) at different times of the year. This information is valuable because deer of a particular demographic class have similar resource requirements. Thus identifying hotspots on the landscape that are attractive to deer helps pinpoint the areas where deer are more likely to come in contact with one another or with contaminated environments.

Managing CWD Risk

The goal of our research was to use animal behavior data to better inform disease management strategies. This information helps managers move away from hard boundaries that delineate large disease management areas, and instead allows them to focus their efforts based on probable patterns of deer contact, space use, and resource selection. No disease management strategy for free-ranging animals will be able to contain 100 percent of the risk of spread because some small percentage of deer will behave in unpredictable ways. Instead, the ability to define a range of risk probabilities allows managers to be more informed as to the likely impact of their management actions. For example, managers may elect to enact disease control measures that contain 90 percent of disease risk. Alternatively, managers may be able to determine how much of the disease risk they can manage given a specific amount of funding. This information allows for targeted management of wildlife disease on the landscape and promotes more effective investment of limited financial resources.

As I see it, enduring cold and cramped quarters was a small price to pay for the increased understanding of deer behavior revealed to us during this study. It's satisfying to know that the knowledge gained can be used by the biologists and managers on the front lines of the CWD war.

I still daydream about that Tahitian paradise from time to time, wondering if they might need the occasional services of a wildlife scientist with a passion for weird diseases. ■

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Dr. David Williams is a post-doctoral research associate and Boone & Crockett Fellow in the Department of Fisheries and Wildlife at Michigan State University. His interests include understanding how landscapes influence animal movements and how that understanding may be used to address wildlife management issues.

Dr. William (Bill) Porter is Boone and Crockett Professor of Wildlife Conservation at Michigan State University. He and his students have been addressing the challenges facing wildlife management through studies of animal movement behavior for more than 30 years.

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