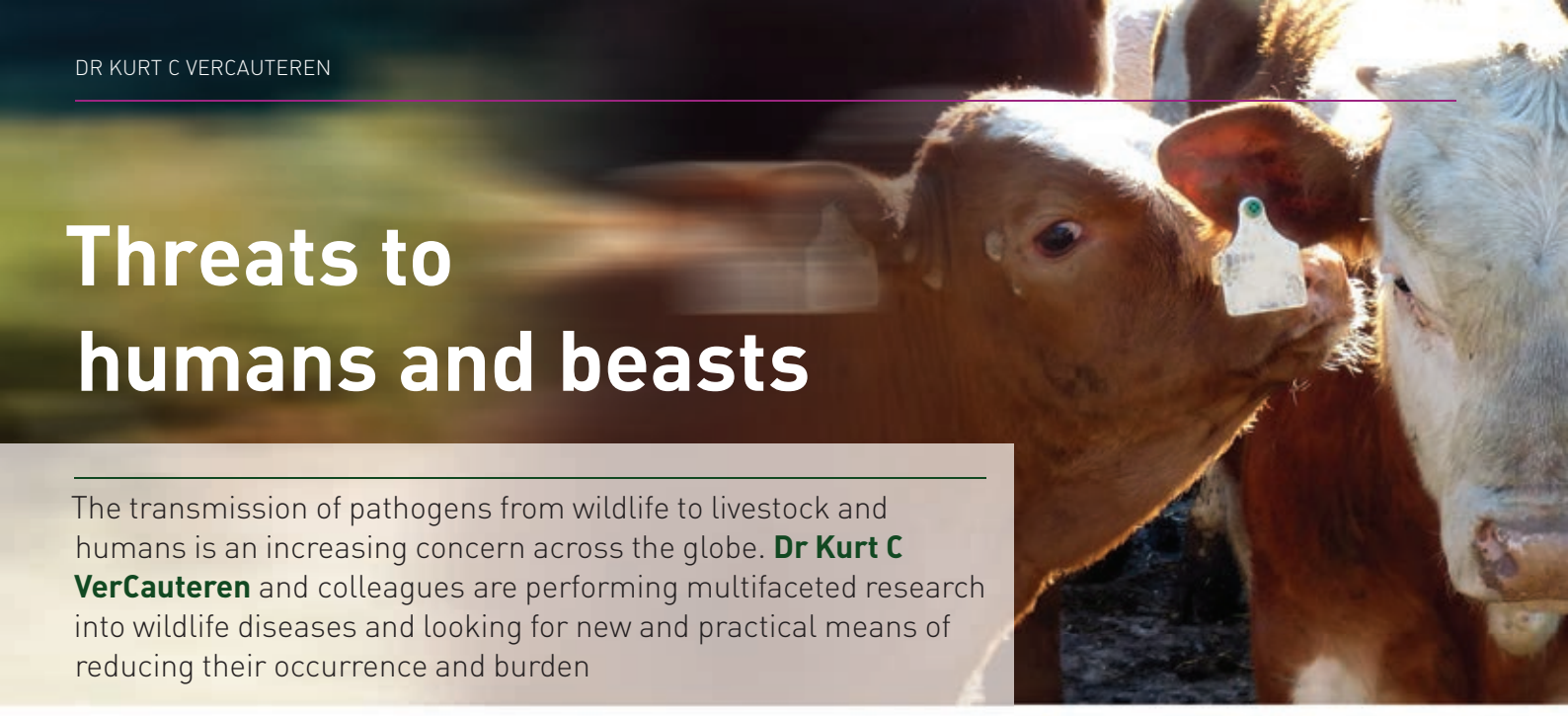
Threats to humans and beasts



The transmission of pathogens from wildlife to livestock and humans is an increasing concern across the globe. **Dr Kurt C VerCauteren** and colleagues are performing multifaceted research into wildlife diseases and looking for new and practical means of reducing their occurrence and burden

What prompted your focus on reducing disease transmission from wildlife to livestock?

Initially, as a specialist in wildlife damage management, my experience was mostly with white-tailed deer. My partners and I developed non-lethal strategies and methods for keeping deer from consuming agricultural crops such as corn and, more recently, sunflowers.

By the early 2000s, two diseases had become established in deer and elk in the US; they were important issues because of their impacts on American agriculture and their trade implications, as well as their threats, to wildlife. One was ancient, bovine tuberculosis (bTB), and the other was new and emerging, chronic wasting disease (CWD). The segue from protecting crops to protecting livestock from wildlife-mediated disease, a novel area of applied research, was easy.

Your group has evolved to work on diverse diseases. How do you manage such broad-ranging research?

I surround myself with the smartest, most motivated and productive colleagues I can find! I have the luxury of being part of an agency full of experts across a great diversity of disciplines and the freedom to engage with and enlist other national and international experts. In the course of a day, I'm constantly shifting gears from, say, mongoose rabies issues in Puerto Rico to feral swine in Texas, to bTB or CWD in deer in some other state. My employees would attest that I do have trouble keeping all our studies straight.

Why do you encourage wildlife managers to deliver pharmaceuticals to the animals they are monitoring?

Wildlife managers need more tools to address human-wildlife conflict; we all agree that non-lethal tools are preferable whenever appropriate. An example is bTB, which is entrenched in white-tailed deer in a region of Michigan and has impacted the cattle industry nationally. The deer population contracted bTB from cattle over 100 years ago as Europeans settled in the area; the deer have been giving it back to the cattle ever since. Models predict that vaccination of the deer may be needed to eradicate bTB. Colleagues have made great progress on developing a vaccine, and we are now performing studies in the field to determine the best strategies for delivering it.

Can you describe the significance of your team's testing for bTB in live deer via volatile organic compounds (VOCs)?

The VOC work is really exciting. Our ultimate goal is to develop a practical 'sniffer' device to detect whether cows have bTB using their breath or faeces and a version for sampling free-ranging deer to assess the proportion of infected deer in an area. We are also poised to evaluate the potential of using VOCs to detect CWD, brucella and Johne's disease.

What are proximity loggers and how do they play into your research activities?

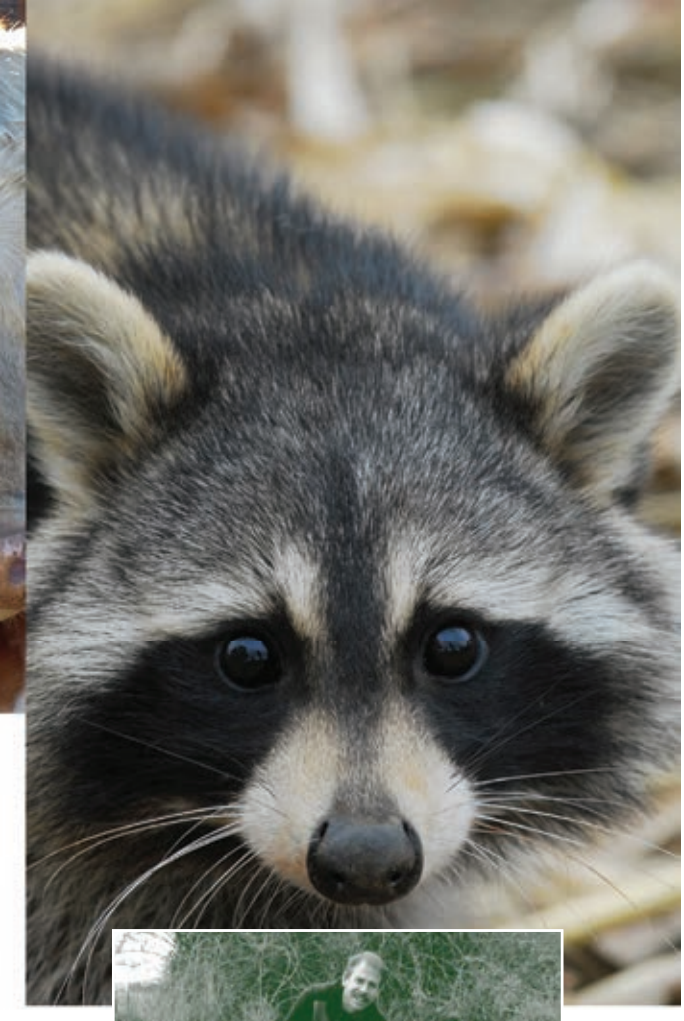
Proximity loggers are a relatively new technology we've helped pioneer. In short, they are biotelemetry devices that can track animal-animal interactions unobtrusively. One logger detects another when it is within a few metres. For example, in Michigan where bTB is present, we have put proximity logger collars on deer, raccoons, opossums and cows, as well as at food and water sources meant for cows. As bTB is a bacterial disease that can be transmitted through breath via close contact or contaminated feed, we use the data to inform network analyses and develop contact rates. The results will help us determine what role wildlife other than deer play in transmitting bTB to livestock and where risk is greatest and intervention could be most successful.

Has your research changed the way wildlife disease issues are addressed?

Wildlife managers and livestock producers use many tools we developed, and in many cases they have been incorporated into policy. For example, we helped inform Michigan's Risk Assist programme for bTB. A computer model we developed helps producers and managers determine which mitigation tools best fit their needs, such as adapting livestock protection dogs to keep potentially infected wildlife from moving into pastures.

Other examples include studies of how high a fence needs to be to prevent deer passage and evaluations of fence designs to prevent breaches by highly motivated deer and feral swine. Our studies provide agricultural producers, and state and federal managers and policy makers with practical knowledge about fence design efficacy.

We also impact policy by invention and evaluation of products that are then licensed through regulatory agencies. We are currently working on licensing a toxicant for invasive feral swine and a novel oral rabies vaccine for wildlife. Additionally, we developed a method of digesting CWD and bovine spongiform encephalopathy prions that has been incorporated into regulations regarding the disposal of infected or potentially infected carcasses.



Disease management and elimination

Research applying knowledge of biology, ecology, demography, medical science, human values and economics at the **United States Department of Agriculture** seeks to prevent disease transmission between wildlife and livestock, and so protect humans, animals and the environment

Dr Kurt C VerCauteren with a sedated mongoose in Puerto Rico. The mongoose is being sampled for presence of rabies as part of a study to gather biological and ecological information in preparation for the implementation of an oral rabies vaccine programme. © Bruce Leland

FROM ITS INITIAL identification as a new disease affecting wild elk, deer and other cervids in a few states in North America in the 1980s, chronic wasting disease (CWD) has spread and is now found in at least 23 states. Transmitted via abnormally folded proteins called prions, CWD is a neurodegenerative disease of the spongiform encephalitis class, with effects similar to bovine spongiform encephalitis in cattle, scrapie in sheep and Creutzfeldt-Jacob disease in humans.

Dr Kurt C VerCauteren with a sedated eurasian wild boar that has been sampled for bovine tuberculosis and equipped with a global positioning system collar, while working in Spain with colleagues Drs Christian Gortazar and Joaquin Vicente. © Dr Christian Gortazar

Though wild animals are most often viewed as beneficial to the environment and highly valued by humanity, interactions between wild deer and their captive counterparts can lead to CWD transmission in both directions and have significant negative effects on agricultural and other economies. A key concern underlying this issue is that knowledge of how CWD is transmitted and moves across the US landscape is scant. In an effort to uncover this information, and within the framework of non-lethal wildlife management, Dr Kurt C VerCauteren's group at the US Department of Agriculture's National Wildlife Research Center is aiming to contribute greater understanding of how pathogens transmit within and among species, so as to prevent this from occurring and thus help protect wildlife and livestock.

DETECTING DISEASE EARLY

A major portion of VerCauteren's research involves developing novel methods for detecting disease in live animals, both in populations and individual animals. For example, one of the first tests that his team helped create was a rectal biopsy test to look for CWD in lymphoid follicles in the rectal mucosa of elk. Based on its success, the researchers have developed the test further and are now using it as a component of several studies relative to CWD transmission and progression. In this same vein, they are also developing methods to establish whether an animal is acting as a reservoir of CWD long before it shows any apparent signs of the disease: "A chilling finding is that some animals, depending upon genotype, are likely serving as 'Typhoid Marys', harbouring and shedding infective CWD prions long before succumbing to the disease themselves," VerCauteren expands.

Outside of their work with CWD, the researchers are tracking volatile organic compounds (VOCs) to test for bovine tuberculosis (bTB). This is an infectious disease that mainly affects cattle, but that can be passed back and forth between cattle and other wildlife such as deer, coyotes and opossums, making it particularly hard to eradicate. Using their VOC test, VerCauteren and his colleagues hope to quickly sample an animal's breath for signals of disease and remove infected individuals. This method will be of significant benefit to the US cattle industry, which in the last 15 years has seen more losses of farm animals to bTB than to all other infectious diseases combined.

PROXIMITY LOGGERS AND DISEASE TRANSMISSION

In addition to detecting CWD, VerCauteren and his collaborators are examining how it and bTB are passed between wildlife and livestock. To this end, they are employing novel techniques and computer-aided modelling to examine animal behaviours. They are currently pioneering a data gathering technique that involves placing non-invasive biotelemetry devices known as proximity loggers at animal

The researchers are not only elucidating how CWD prions are transmitted, they are also finding ways to stop it from occurring, thus mitigating the prevalence of the disease

UNDERSTANDING AND PREVENTING TRANSMISSION OF PATHOGENS FROM WILDLIFE TO LIVESTOCK

OBJECTIVE

To understand transmission of pathogens and develop practical and effective methods for assessing and mitigating disease involving wildlife, agriculture and humans.

KEY COLLABORATORS

Richard Chipman, United States Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) Wildlife Services (WS) National Rabies Management Program, USA • **Justin Foster**, Texas Department of Parks and Wildlife, USA • **Dr Scott Hygnstrom**, University of Wisconsin-Stevens Point, USA • **Dr Rique Campa**, Michigan State University, USA • **Dr Dale Nolte**, USDA/APHIS/WS National Feral Swine Management Program, USA • **Dr David Hewitt**, Texas A&M University-Kingsville, USA • **Dr Terry Spraker**, Colorado State University, USA • **Dr Patricia Klein**, USDA/APHIS/Veterinary Services, USA • **Alex Beath**, Artemis Technologies, Canada • **Dr Christian Gortazar**; **Dr Joaquin Vicente**, National Wildlife Research Institute, Spain • **Dr Simon Humphrys**, Invasive Animals Cooperative Research Centre, Australia • **Professor Linton Staples**, Animal Control Technologies Pty Ltd, Australia • **Dr Ad Voss**, IDT Biologika, Germany • **Dr David Walter**, The Pennsylvania State University, USA • **Dr Alistair Ward**, National Wildlife Management Centre, UK

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CONTACT

Dr Kurt C VerCauteren
Project Leader, Supervisory Research Wildlife Biologist

National Wildlife Research Center
USDA / APHIS / WS
4101 Laporte Avenue
Fort Collins, Colorado, 80521
USA

T +1 970 266 6093
E kurt.c.vercauteren@aphis.usda.gov

KURT VERCAUTEREN, PHD, is a Supervisory Research Wildlife Biologist and leads the Rabies Management and Management of Ungulate Disease and Damage Projects at the USDA/APHIS/WS National Wildlife Research Center in Fort Collins, Colorado, USA.

Interactions within and between wildlife species are difficult to document and quantify, yet such data are valuable in understanding disease dynamics. In collaboration with multiple universities, researchers from the National Wildlife Research Center developed and evaluated the utility of a novel deer-borne contact detection system (DCDS) consisting of cameras and proximity loggers installed on global position system collars. The DCDS collars proved effective for collecting an array of information related to deer behaviours, forage consumption, interactions and movements on the landscape. Photo: Aaron Hildreth

feeding sites and attaching proximity loggers enhanced with global positioning systems to track both wildlife and livestock. "By understanding how animals share space and resources we will be better able to mitigate risky contacts and behaviours that could lead to disease transmission," VerCauteren states.

The researchers are also using proximity loggers with cameras to quantify the risk of pathogen transmission between wild animals and livestock, trace disease likelihood and prevalence, track the familial relationships between animals and test the effectiveness of different interventions. "The added value of the data gathered via enhanced proximity logging is incredible," VerCauteren enthuses. "It can even be used for additional purposes, such as understanding the food habits of deer at the microscale. Technologies like this will really aid researchers in addressing a myriad of questions."

FINDING AND DESTROYING PRIONS

Another aspect of VerCauteren's wide-ranging research explores new hypotheses concerning the modes of pathogen transmission. For example, he and his collaborators recently established that CWD prions can be transmitted to live animals as particles in soil dust. They have also discovered that even after prion-contaminated tissue has passed through the digestive tracts of wide-ranging scavengers such as crows and coyotes, the risk of transmission to an animal that ingests traces of their droppings remains high for days.

The researchers are not only elucidating how CWD prions are transmitted, they are also finding ways to stop it from occurring, thus mitigating the prevalence of the disease. Using transgenic mice to emulate CWD in deer and elk, they have discovered that alkaline hydrolysis can be used to render prions non-infectious. In fact, it is such a successful approach that this method of digestion is now reflected in government policies and is becoming the standard for safely disposing of carcasses infected with CWD and bovine spongiform encephalitis.

More recently, VerCauteren's group has also established that commercially available enzyme detergents are effective at removing prions from contaminated surfaces and medical equipment.

TAKING THE BITE OUT OF RABIES

In addition to CWD, a key focus for VerCauteren is wildlife rabies, which remains a significant danger to humans and animals throughout most of the world. Rabies has been eradicated in domestic dogs in the US through longstanding vaccination programmes; however, it is still carried by many wild animal species, such as raccoons, skunks and foxes. Therefore, the US operates an annual seeding of 8 million oral rabies vaccine baits that target these reservoir species. VerCauteren's research group contributes to the operational management of the disease by providing new knowledge about vaccine creation, vaccination strategies and the ecology of the wildlife, thus helping the initiative against rabies formulate methods and strategies.

For example, the scientists have found that maternal antibodies in baby raccoons lessen the efficacy of the current standard vaccine, Raboral VRG. Equally, they have discovered that co-administration of a mucosal adjuvant to this vaccine increases its efficacy in adult raccoons. They are now participating in a large multi-state evaluation of a newer oral rabies vaccine for wildlife, ONRAB, by conducting tests of its efficacy and utility in both free range and captive, controlled settings.

VerCauteren and his collaborators are also exploring methods of making doses of vaccines and other medications both attractive to the target species and effective in terms of cost and benefit. They have experimented with a variety of bait flavours and attractants and are optimising oral rabies vaccines for raccoons, skunks, coyotes, foxes and mongooses; bTB vaccines for deer; and toxicants for wild boars.

ELIMINATING THE THREAT TO HUMANS

Though CWD has not spread to humans, it is similar to prion diseases, like Creutzfeldt-Jacob disease and Kuru, which do infect people. Thus, VerCauteren's work on CWD is currently extending into human medical research on these human spongiform encephalopathies and other potentially prion-borne diseases such as Alzheimer's: "We have some interesting datasets that show how components of animal diets, like ratios of copper, magnesium, manganese and cations, impact the odds of infection with CWD," he expands.

VerCauteren now plans to widen his current research to foreign animal diseases and the issue of threats to food safety via bioterrorism: "Determining and understanding the transmission dynamics of the various bacterial-, viral- and prion-mediated diseases is a continuous challenge," he concludes.