MANAGING WILDLIFE DISEASES
with insight on bioeconomics

ABOVE: Richard Horan and Christopher Wolf are taking a bioeconomics approach to assessing the long-term ecological and economic effects of various wildlife disease-management decisions. *Photo: G.L. Kohuth, MSU CABS. Opposite page: David Kenyon, MDNR.*

Since 1975, the Michigan Department of Natural Resources (MDNR) has worked to eliminate bovine tuberculosis (bTB) from free-ranging white-tailed deer populations. This disease, caused by *Mycobacterium bovis*, can spread from infected deer to humans and other animal species, especially cattle.

Because bTB can affect Michigan livestock industries as well as deer management decisions, baiting guidelines and livestock trade flows, the MDNR and the Michigan Department of Agriculture and Rural Development (MDARD) have taken great measures to reduce disease prevalence in endemic areas of the state. Collectively, the two agencies have invested more than $86 million in surveillance, control and testing activities to reach and maintain a relatively consistent level of success for more than a decade.

When diseases spread from wildlife to domesticated livestock, producers often incur significant economic damage . . .

Michigan State University (MSU) AgBioResearch economists **Richard Horan** and **Christopher Wolf**, MSU professors of agriculture, food and resource economics, are developing a bioeconomics decision theory to help wildlife and livestock managers better understand the economic and epidemiologic trade-offs of disease management actions, equipping them to identify actions with the greatest economic welfare.

"My initial interest in this area was sparked because of the predominance of white-tailed deer hunting in Michigan and the prevalence of bTB; I wanted to understand how to manage this valuable wildlife species while taking disease impacts and hunter benefits into account," explained Horan. "Though we've done some numerical work with bTB in deer, this theory will be applicable to disease management across many wildlife species."

Horan takes a bioeconomics approach to disease management — which combines economic, ecological and epidemiological models — to better understand disease proliferation, the costs and benefits of various management actions, and how people respond to risk.

Horan explained that traditional disease management is rooted primarily in epidemiology and is based on metrics that do not acknowledge the impact of human/ecological interactions on disease dynamics. One such metric, the basic reproduction ratio (R0), is used as a fixed value to predict how quickly a disease will spread and to calculate population thresholds – the percentage of a population that must be targeted to effectively stop or diminish the spread of disease.

Horan contends that these thresholds should not be treated as fixed values because human behavior can change them. For example, feeding and baiting sites promote transmission of bTB by bringing deer into close proximity with one another. If wildlife managers reduce the number of feeding sites and thereby reduce the rate at which disease is transmitted, then the number (threshold) of deer that must be culled to stop or slow the spread of disease changes.

Economic variables can also change thresholds, as well as how managers might choose to respond to them.

"We've found that getting rid of a disease is not always cost-effective," Horan said. "Because the costs can be so high and the benefits marginal, managers may decide it's best to allow the disease to remain in the population at a low level and invest in control measures."

When diseases spread from wildlife to domesticated livestock, producers often incur significant economic damage from lost productivity, imposed herd depletions and trade bans. Part of Horan and Wolf's research explores the economic effect of disease management on trade. One finding is that the relative level of infection is a key driver of trade incentives.

"If a cattle breeder has a low level of infection in his herd and the owner of a feedlot has a higher level of infection in his herd, the feedlot owner may have more incentives to trade — to sell off more of his animals and purchase others from other breeders," Horan explained. "Taking a group of animals with a high-prevalence disease rate and replacing them with animals from a low-prevalence source reduces risk and is a means of managing disease."

Horan noted that there are a number of regions in the country with livestock trade bans.

"If we can use trade patterns to predict which places are more likely to import infected animals, it may be possible to thwart the disease, and ultimately save money, by better targeting surveillance efforts to identify infected animals when they arrive," he said.

"Epidemiological systems and human systems are jointly determined," Horan concluded. "People respond to environmental risk and the environment responds to the actions taken by people. Decision models that utilize this theory will give livestock and wildlife managers a better understanding of how their choices may affect economic welfare, wildlife populations and disease rates."