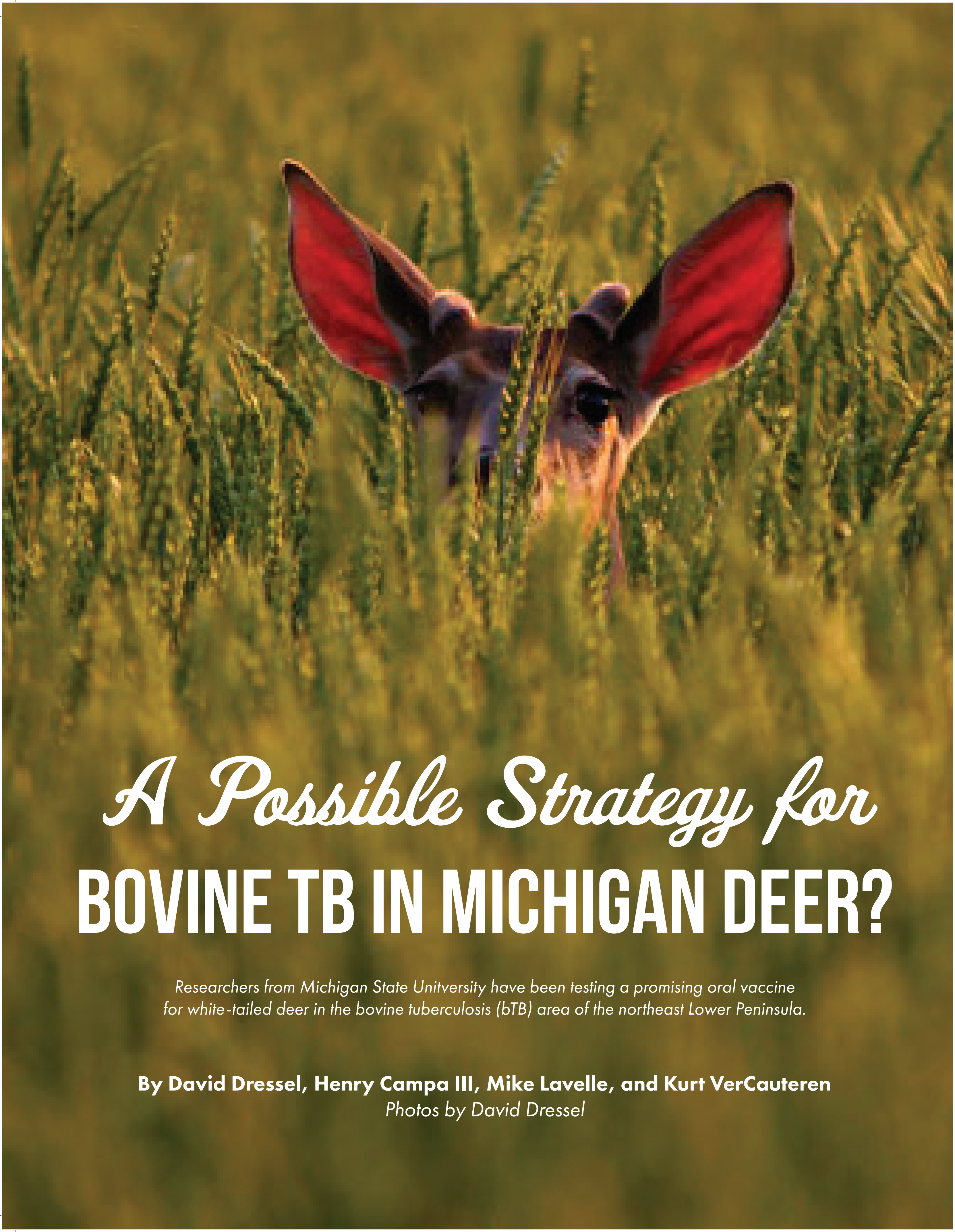

A Possible Strategy for BOVINE TB IN MICHIGAN DEER?

Researchers from Michigan State Unitversity have been testing a promising oral vaccine for white-tailed deer in the bovine tuberculosis (bTB) area of the northeast Lower Peninsula.

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There it is: the sun, beating down on the snow covering your garden or perhaps the fields you planted last year. As the snow melts you feel the sun's warmth on your skin for the first time since the long, harsh Michigan winter began. You can see the freshly exposed crop fields as the sun begins to warm up the land. However, you're not the only one feeling the sun's rays beaming through the blue sky, or better yet, to smell spring right around the corner.

Over the winter in northern Michigan, white-tailed deer have been secluded in deep conifer swamps trying to stay warm. As spring breaks they begin to venture out and feed on the newly exposed plants and crop residues from last fall. Deer are eager to feed and replenish their nutrient-stressed bodies as the year's winter has taken its toll. Some deer may have tried to venture across roads to reach a thawed field with emerging vegetation and were struck by a vehicle. Or perhaps some have succumbed to starvation from the harsh winter. However, others meet their demise through a more chronic and slow process: disease.

The Bovine Tuberculosis Problem

It all began in 1994, or perhaps 1975, when a hunter harvested what appeared to be a sick deer. The deer tested positive for bovine tuberculosis (bTB). This was the second positive bTB case in Michigan deer; the first was in 1975 but many thought it was an isolated case. The 1994 incident led to the statewide surveillance and testing of road-killed and harvested deer for bTB as wildlife managers tried to gather information and formulate a plan to manage this emerging disease.

Wildlife managers have come a long way since that initial bTB case. State efforts have decreased the prevalence rate of bTB in deer from 4.5% to around 1-2%. This decrease is attributed to numerous management strategies that are still in practice today: disease control permits, fencing, liberal antlerless harvest and baiting restrictions. However, Michigan residents, livestock producers, wildlife managers, and hunters continue to hear about cattle herds contracting the disease from spillover of bTB from deer. To date, there have been 66 cattle herds infected with bTB in northeastern lower Michigan (MDARD Legislative Report BTB Program Oct 2016 Qtrly Update). With the continued occurrence of bTB-infected cattle herds and a stalled bTB prevalence rate, an additional management strategy has been proposed to combat the disease.

Researchers from the USDA/APHIS/Wildlife Services – National Wildlife Research Center (NWRC, Fort Collins, CO) and Michigan State University, Department of Fisheries and Wildlife, along with Michigan Wildlife Services biologists have collaborated on a project evaluating a potential vaccination strategy to inoculate deer against bTB if it is desirable in the future. The objective of our study was to create an oral vaccine strategy that could reach the maximum number of white-tailed deer in the core bTB area, Deer Management Unit 452, west of Alpena. It was our hope that we could design a cost effective placebo vaccine strategy that if successful could be used with the actual vaccine Bacillus Calmette-Guerin (BCG).

Let's Talk Deer

As fellow nature enthusiasts, hunters, and conservationists, we all appreciate the importance of understanding deer ecology. Whether we are trying to observe, study, or hunt that animal we must understand its behavior. Even if we are simply setting out trail cameras to scout for a hunt, we are studying the animal's movements and patterns. To design a successful vaccination strategy, it was crucial that we understood how, when, and possibly why deer would behave under certain conditions such as snow cover, temperature and forest cover throughout the year.

Let's begin with an idea that became the framework for our vaccine strategy: timing of winter break up in northern Michigan. Deer tend to congregate in "deer yards" during the peak winter months in northern Michigan and conserve energy by limiting their movements. Reduced movement and feeding leaves deer in a nutrient deficient state as winter drags on. When the snow begins to thaw, deer are drawn to the newly exposed agriculture fields to feed on any residual grain from the previous year. This natural congregation and behavior of deer appeared the perfect opportunity to efficiently target multitudes of deer with an oral vaccine delivery unit (VDU). A VDU is a desired food product that can potentially hold a vaccine and be distributed to feeding deer.

Designing a Vaccine Delivery Strategy

First, we experimented with four potential VDU formulations to deliver an oral vaccine during the winter and springs of 2015 and 2016. We wanted to create a product that could be mass produced and mimicked natural forage deer were already seeking. Thus, we constructed VDUs that resembled the crop residue of last season's crops: a corn product, apple product, alfalfa product, and an alfalfa/molasses product. We distributed VDUs to free-ranging deer to determine if they preferred one over another.

Second, we timed the distribution of the VDUs to maximize the number of deer exposed to the vaccine system. Vaccine delivery units were distributed on agriculture fields during the spring thaw in Alpena County, Michigan. The spring thaw draws deer to the exposed agriculture fields. To assess the

By spacing out the vaccine delivery units(VDUs) in grids, researchers avoided unnaturally congregating deer at bait sites, which can increase the chances of disease transmission.

number of deer visiting and possibly consuming our VDUs we mounted trail cameras on edges of these agriculture fields.

Third, we explored how the distribution of VDUs on fields would result in the highest consumption by deer. We wanted to design a strategy that reflected deer feeding patterns on those fields; slightly dispersed, moving and feeding as a group through the field (Image 3). Because congregating deer at feeding sites can increase disease transmission, we minimized unnatural congregations of deer around the VDUs by distributing them in grids of: 109 x 32 yards (yds), 54 x 32 yds, 54 x 21 yds and in lines bordering field edges next to forests. Each VDU was spaced 2 yds or 5 yds apart depending on the grid size. The size of each VDU was designed to be approximately 0.6 ounces to maximize full consumption by deer and limit any residual material.

Lastly, we needed a way to estimate how many deer consumed our VDUs, allowing us to answer the all-important question of how many deer can be reached with this strategy. Were there just two or three hungry deer that were eating the majority of our tasty VDUs or were groups of 10-20 scarfing down these treats?

To evaluate this question, we used a biomarker to monitor the deer's feeding activities. A biomarker is an additive we incorporated into VDUs that allowed us to determine whether or not a deer consumed a VDU. We chose a biomarker called Rhodamine B (Rb) because it is easily added to the VDUs and easily detected after it's consumed by deer. Rhodamine B has been used extensively as a biomarker for several oral vaccination programs including rabies in raccoons and plague in prairie dogs. Rhodamine B is a green powder that we placed inside gel capsules and then into each of our individual VDUs. When deer consumed the VDUs with Rb, two things happened: (1) the deer's digestive tract was stained pink for 24-36 hours and/or (2) their whiskers became marked with a fluorescent band. By collecting whiskers from harvested deer and placing them under a fluorescent microscope, we could detect the fluorescent band, giving us concrete evidence that they consumed at least one VDU. The biomarker allowed us to evaluate what percentage of deer, from those that were harvested, consumed our VDUs.

We Know What Deer Like

During our trial from May 1 – June 18, 2015, the apple-based VDU was consumed the most. Deer consumed on average 47.6% of the apple VDUs within 24 hours. The consumption rate for the apple VDU was 31% higher than the corn-based VDU and 47% higher than the alfalfa-based VDU.

However, as we may have witnessed in our own backyards, if you leave anything sweet and tasty out raccoons will find it! We distributed our VDUs on 17 agriculture fields from 5-19 consecutive days on each field. Deer visited our VDU grids 63.9% of the nights and to nobody's surprise those pesky raccoons accounted for 52.9% of the visitations we photographed. This was troublesome since raccoons surely were consuming some VDUs.

The 2015 trial taught us the best and worst sides of our potential vaccine delivery strategy and we modified our plans for 2016. During our second field season we started earlier in the year; March 6, giving us the opportunity to distribute our VDUs during the crucial first thaw. Second, getting an earlier start helped reduce the number of VDUs consumed by raccoons as the heavy snow cover reduced their activity. However, the largest change we made was using a new customized alfalfa/molasses-based VDU intended to appeal to deer and to reduce consumption by non-target species, such as raccoons and turkeys.

As hoped, raccoons did not readily consume or even visit the alfalfa/molasses grids while deer consumed on average 48.2% of the VDUs in 24 hours. Furthermore, deer accounted for 87.9% of the visits to our VDU grids while raccoons only visited 17.9% of the nights. These results were in stark contrast to what we observed in 2015. Considering we distributed 8,636 VDUs in 2016 and deer being the primary species visiting our VDU grids, this has great implications for creating a successful oral vaccine strategy for white-tailed deer.

After deer were exposed to our VDU grids for seven consecutive days, Wildlife Services collected deer on each VDU grid with the use of disease control permits. Throughout the 2016 field season, a total of 107 deer were collected on the alfalfa/molasses VDU grids. I collected six whiskers from each deer and using a fluorescent microscope, I looked for the presence or absence of the tell-all fluorescent band, indicating whether or not that deer consumed one of our VDUs.

Out of the 107 deer, 36.4% (39) had staining on their tongue and digestive tract. However, the most significant finding was 74 deer, or 69.1%, had whisker or internal staining. This was a significant finding showing 69.1% of the deer that were presented our alfalfa/molasses VDUs during the Spring thaw consumed them! Researchers have modeled that a vaccination rate above 50% would substantially increase the possibility of reducing the prevalence of bTB in the deer of northeastern lower Michigan.

The success of a potential bTB vaccine program for white-tailed deer will be additive to the success of other management strategies already in place in the area; wildlife mitigation practices such as fences, liberal antlerless harvest, disease control permits, and restrictions on baiting in the core TB area. Imagine for a moment the possibility that one day Michigan can be bTB free. Livestock producers would no longer have to live with the worry that their cattle may fall ill costing them and the State millions of dollars. Or imagine the hunting community no longer concerned about hunting in a diseased area. By combining this potential vaccine delivery strategy with other management strategies, perhaps one day a bTB free Michigan can be a reality.

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