Report of the Committee on Tuberculosis

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Vice Chair: Dr. Kathleen M. Connell, Olympia, WA

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The Committee met on November 7, 2005, from 12:30 p.m. to 6:04 p.m. at The Hershey Lodge and Convention Center. There were over 130 attendees. Chair Chuck Massengill presided assisted by Vice Chair Kathleen M. Connell. After welcoming the Committee members and guests, the Chair reviewed the day's agenda.

Dr. Massengill briefly discussed the Bovine Tuberculosis (TB) Eradication Uniform Methods and Rules (UM&R) for cervids. The subcommittee formed to draft the UM&R provided a final draft and the document received unanimous approval from the full Committee. Dr. Massengill announced the formation of a working group for the standardization of tuberculin in North America and New Zealand. The working group will be composed of representatives from the United States Department of Agriculture (USDA), Agriculture Research Service (ARS), Animal Plant Health Inspection Service (APHIS), International Services (IS), Veterinary Services (VS), National Veterinary Services Laboratory (NVSL), academia and the United States Animal Health Association (USAHA).

Dr. Michael Dutcher, Senior Staff Veterinarian, National Tuberculosis Eradication Program, USDA APHIS VS, gave a status report of the Bovine TB Eradication Program in the United States. The full text of his report is included in these proceedings.

Dr. Robert M. Meyer, Western Region Tuberculosis Epidemiologist, USDA APHIS VS, provided an update on the United States' National Surveillance Program for Bovine Tuberculosis. The full text of his report is included in these proceedings.

Dr. Michele Miller, Disney's Animal Kingdom, Department of Veterinary Services, presented a time specific Committee paper entitled "Pack your trunk! We're going to Florida: The 2005 Elephant Tuberculosis Conference". This paper is included in its entirety in these proceedings.

Dr. Maria Koller-Jones, Senior Staff Veterinarian, Canadian Food Inspection Agency (CFIA), Ottawa, Ontario, Canada, presented "Current Status of the Bovine Tuberculosis Eradication Program in Canada". The full text of her report is included in these proceedings.

Dr. Guillermina Anduaga Rosas, Sub-director of Health for Large Animals, Secretaria de Agricultura, Ganaderia, Desarrollo Rural, Pesca y Alimentacion (SAGARPA), gave a report on the current status of the Campaign against Tuberculosis in Mexico and an update on Mexico's National Surveillance Program. Dr. Anduaga reviewed Mexican state and zone statuses under the Mexican program and the USDA classifications.

Over five million TB tests have been applied in each of the past two years. The tuberculin test response rate in 2005 is clearly lower than in past years. However Dr. Anduaga reported that this is a reflection of the reports received to date and further reports are being reviewed and the response rate is expected to increase as more reports are tabulated. Dr. Anduaga compared the number of tuberculin tests and the number of Accredited free herds in Accredited and non-accredited states. Current and future efforts include standardization between the Mexican Norma Oficial Mexicana (NOM) and the United States' Uniform Methods and Rules (UM&R), epidemiology training for veterinarians and inspectors, special dairy program under the new NOM, reducing the TB prevalence in Accredited and non-accredited zones and developing new Accredited zones in non-accredited states. Many Accredited free herd owners and owners of herds with a negative TB test receive a premium for their milk, which is an immediate benefit of participation in the TB program.

Dr. Bill Hartmann, Minnesota State Veterinarian, gave an update on bovine TB activities in Minnesota. Dr. Hartman reported that 39 herds had been placed under quarantine and of those, four were found infected. Twenty-three of the quarantined herds have been tested negative and released from quarantine. Further testing of all cattle herds within a 15 mile radius around each of the two locations with infection is in process. Hunter harvested deer within the area will be sampled during the hunting season that is now in process.

Dr. Billy Johnson, Binational TB and Brucellosis Committee (BNC) Coordinator, presented a report on BNC activities. The full text of his report is included in these proceedings.

Dr. Mitch Palmer, USDA-Agriculture Research Service (ARS) National Animal Disease Center (NADC), Chairs the Scientific Advisory Subcommittee (SAS) and gave the subcommittee report. The report was approved by the Committee and is included in these proceedings.

Dr. Michael Gilsdorf, Director, Ruminant Health Programs, USDA APHIS VS, led a discussion on the direction of the Cooperative State–Federal Tuberculosis Eradication Program. His report is included in these proceedings.

Dr. Dan Baca, Epidemiologist, USDA APHIS VS, led a discussion on the proposed Captive Cervid TB UM&R. The Committee passed recommendations in 2002 and 2003, which encouraged USDA to adopt standards for recognition of states' progress towards eradication of TB in captive cervids by establishing state status levels, similar to existing standards for cattle and bison and to incorporate those standards in a revised UM&R. USDA, in cooperation with USAHA, assigned a state-federal-industry working group to develop those standards and guidelines for consideration by the Committee.

Following a two year process, the working group developed proposed standards for state status based primarily on herd prevalence of captive cervid TB in a state or zone and requirements for levels of surveillance that support detection of the disease at those thresholds. The proposed plan provides for four state status levels with corresponding herd prevalence infection rates: Accredited free (0 percent), Modified Accredited Advanced (less than 1 percent), Modified Accredited (less than 6 percent) and Non-accredited (greater than 6 percent). The associated surveillance requirements are 0.1, 1.0 and 6.0 percent for Accredited free, Modified Accredited Advanced and Modified Accredited status respectively. In addition, the working group has proposed revisions in the UM&R to incorporate proposed state status standards, with additional revisions regarding interstate movement and herd status standards.

Copies of the proposed UM&R were provided and Dr. Baca reviewed recent and most significant revisions to the five parts of the draft document. After review and discussion, the UM&R was unanimously approved and forwarded to USDA.

At the conclusion of the formal presentations, Dr. Massengill reported on the 2004 Resolutions and Recommendations. Based upon one of the 2004 recommendations, the cattle scattergram was approved for classification of comparative cervical tuberculin tests in reindeer. The second recommendation dealt with the 2004 Strategic Plan. Funding has not been provided to implement the plan, so a subcommittee will be formed to pursue the goals and objectives in the 2004 Strategic Plan.

Five recommendations were discussed and approved by the Committee. These recommendations are as follows:

Recommendation 1:
The TB Committee of USAHA recommends that USDA APHIS change the definition of "herd test" in Part I of the UM&R to read as follows:

"An official tuberculosis test of all test eligible cattle and/or bison in a herd as well as any other commingled or exposed livestock which may be part of that herd, as deemed necessary by the DTE or the Regional Tuberculosis Epidemiologist."

Recommendation 2:
The TB Committee of USAHA recommends that USDA APHIS change the definition of "herd" currently found in the TB UM&R for cattle and bison to be consistent with the definition found in the Code of Federal Regulations so that feedlots are excluded from the definition.

Recommendation 3:
The TB Committee of USAHA recommends that specific timeframes be added to the TB UM&R that will assure prompt attention is given to completing investigations of cattle found to be affected with tuberculosis during regular slaughter examination.

To accomplish this, the TB Committee of USAHA recommends that USDA APHIS add the following wording under Part V, Section B 2 of the UM&R to read as follows:

"Epidemiologic investigation of positive TB cases detected in slaughter cattle must be completed within 90 calendar days of laboratory notification of positive PCR or isolation of *M. bovis* unless the timeframes are extended by the DTE with the concurrence of the Regional Tuberculosis Epidemiologist."

Recommendation 4:
The TB Committee of USAHA recommends that the USDA APHIS change the wording to exempt "approved feedlots" and "approved pens" from the requirement to hold pens vacant for 30 days when they are confirmed to have held tuberculosis-infected cattle.

Recommendation 5:
The TB Committee of USAHA recommends that USAHA encourage USDA APHIS Veterinary Services to act promptly to review, approve and publish these Uniform Methods and Rules for the Eradication of Tuberculosis in Cervids (Cervid TB UM&R).

Six other recommendations were approved that were part of the Scientific Advisory Subcommittee.

Three resolutions were discussed and approved by the Committee. The resolutions were forwarded to the Committee on Nominations and Resolutions for approval by the general membership.

Status of the State and Federal Cooperative Bovine Tuberculosis (TB) Eradication Program Fiscal Year 2005

Michael Dutcher, DVM, Senior Staff Veterinarian
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In fiscal year (FY) 2005, there was a decline in the number of cattle herds that were found to be TB-affected relative to the previous year. However, these herds were detected in locations where we have not had TB in some time. In FY2004, a total of six affected herds were found. In contrast, only four affected herds were discovered in FY2005. Slaughter surveillance for TB continued to improve in FY2005, and two out of the four (one-half) newly discovered herds were the result of slaughter surveillance. The other two herds were detected as a result of the epidemiologic investigation of one of the TB-affected herds identified at slaughter (they were fence-line contacts). This shows that by improving slaughter surveillance for TB in the United States we are achieving the goal of finding the last remaining sites of infection.

At the end of FY2004, 48 states and territories were TB Free, including Puerto Rico and the U.S. Virgin Islands. California, New Mexico and Texas, were all classified as Modified Accredited Advanced at that time. Michigan had been regionalized during FY2004. At that time, Michigan was divided into two zones; 11 counties and portions of two other counties in the northeastern Lower Peninsula were Modified Accredited while the remaining counties in Michigan were Modified Accredited Advanced.

During 2005, California once again became eligible and applied for TB Free Status. In April of 2005, California's application was approved and the state was once again granted TB Free Status. In April 2004, New Mexico applied for regionalization. USDA requested that New Mexico complete all of the epidemiology surrounding the affected herds in that state prior to any response to that application. During FY2005 that epidemiology was completed and in July USDA approved New Mexico's request for regionalization. New Mexico was divided into two zones. A portion of two counties in eastern New Mexico retained Modified Accredited Advanced status while the remainder of the state was granted TB Free Status. Early in FY2005, Michigan also submitted an application for further regionalization. After review of the state's application and the epidemiology related to its affected herds and Michigan's infected wildlife management, USDA approved Michigan's application. As of September 30, 2005, Michigan had received verbal approval from USDA and an Interim Rule was set to be published early in FY2006. As a result of these changes during FY2005, as of the end of the year, 49 states and territories are TB Free (including Puerto Rico and the U.S. Virgin Islands), two states are regionalized (NM and MI), and one state has Modified Accredited Advanced Status (TX). Assuming no additional affected herds are found, Texas will once again be eligible for TB Free status in mid-year 2006.

Three of the four affected cattle herds discovered in FY2005 were in Minnesota. The index herd was a beef herd discovered through slaughter surveillance. The other two herds were fence-line contact beef herds identified during the epidemiologic investigation of the index herd. Epidemiology for the index herd has been completed and the testing of trace herds around the country is ongoing. The source of this infection has not yet been determined and epidemiologic investigation of the two fence-line herds is in progress. Preliminary genetic analysis of the bacteria present in the index herd shows some commonalities with previously affected herds in the Western States and in Mexico. One newly affected dairy was found in Arizona through the course of slaughter surveillance. Epidemiologic investigation of this Arizona herd is ongoing.

During FY2004, two newly affected premises were dairy calf growing operations in Arizona and New Mexico. Discovery of TB in these dairy calf growing operations raised multiple hypotheses concerning the source of their infection. To sort out these hypotheses, VS is providing resources to assist in investigating these occurrences in New Mexico and Arizona. In addition, Dr Terry Beals was detailed to New Mexico and he assisted with completing the massive amount of trace-in and trace-out testing generated from the two affected dairy premises, which resulted in more herds being tested.

Although these dairy calf growing operations pose substantial problems and caused significant concern for the national TB program, no additional affected dairy heifer facilities were found to be affected during FY2005. Epidemiologic investigation of both the FY2004 herds was unable to identify the source of infection. As mentioned in the FY2004 report, the potential for successfully concluding these investigations is hindered by our inability to trace younger unidentified cattle and account for their movements throughout their lifetimes. The shortcomings of these investigations highlights the importance of good identification and traceability for U.S. cattle. This also underscores the importance to the TB Eradication Program of implementing a national identification system.

Depopulation of a previously affected dairy in New Mexico and the index herd in Minnesota was accomplished in FY2005. Federal and state cooperators are currently working with owners of the other affected herds in Arizona and Minnesota to depopulate those herds as well. As of November 1, 2005, the United States has three TB-affected dairy herds (one large herd in New Mexico and two small herds in Michigan) under test and removal herd plans. The current New Mexico affected dairy herd is a carry over herd from FY2003. The same is true for the two current Michigan affected dairies which were carry over herds from FY2004.

The FY2005 depopulations were accomplished at the cost of $4,123,613. Indemnity costs for caudal fold tuberculin test positive animals in affected herds, comparative cervical tuberculin test- or gamma interferon-positive and suspect animals in non-affected herds and for certain other situations were $1,039,533 in FY2005. These funds were paid out to 201 different producers. Total indemnity costs for all purposes were $5,163,146.

In FY2004, a process for transferring indemnity funds from staff to the regions in $50,000 increments was implemented with good results. This process has improved the government's service to affected producers by shortening the time it takes to indemnify them. The availability of these funds has improved the efficiency of our diagnostic capabilities in the TB program. It has expedited diagnostic investigations by enabling suspect cattle to be slaughtered and examined for evidence of TB instead of waiting for 60-day retests of suspicious animals (during which time the entire herd is quarantined pending classification of the suspect).

There were no TB-affected captive or farmed cervid herds found in FY2000 or FY2001. Three were found in FY 2002, none were found in FY2003, one was found in FY2004 (recrudescence), and none were found in FY2005. As stated last year, these numbers continue to be encouraging, considering that a total of 41 affected cervid herds have been disclosed in the U.S. since 1991, but only four affected herds have been found in this century. Of the 41 affected herds, 30 were depopulated (including the herd found this year) and 11 were tested out and qualified for release from quarantine. One of these 11 herds subsequently developed a recrudescent infection last fiscal year and was depopulated.

Nevertheless, there is continuing concern that the level of surveillance for TB in captive cervids may be inadequate. During FY2004, a working group of state-federal personnel developed a surveillance plan for captive cervids that was presented to, and conditionally approved by, cervid industry leadership. This surveillance plan is integral to the TB eradication program's designation of individual state's TB status. This surveillance plan outlines necessary procedures for achieving and advancing through the different TB status levels (e.g., Modified Accredited to Accredited Free). Given the evolution of this plan, an interim rule that would reclassify the status of 23 states has not been published. The current captive cervid status of all states, therefore, remains at Modified Accredited. During the 2004 annual meeting of the USAHA Committee on Tuberculosis, the surveillance plan for captive cervids was presented and discussed and comments and suggestions were made. All of this input has been incorporated into a draft of the UM&R document specifically for captive cervidae. This will be the first such document for captive cervids and has been long anticipated. It will be presented at this meeting of the USAHA Committee on Tuberculosis as well as at this year's meeting of the USAHA Committee on Captive Wildlife and Alternative Livestock. If a consensus can be reached on this document, we expect that a final UM&R will be published in January 2006. Some aspects of this document will not immediately go into effect, however, as they will be dependent on similar changes being made in the Code of Federal Regulations. The portions of the document which do not go immediately into effect will be clearly identified in the document itself.

Currently there are 14 states and the U.S. Virgin Islands that have achieved and maintained their TB Free status for over 25 years; 19 states that have been TB Free for 15 or more years; eight states that have been TB Free for 10 or more years; six states and Puerto Rico that have been TB Free for five or more years; and one state and two regionalized zones which have had TB Free status for less than one year. Given the four herds discovered this year and the three herds that remain under quarantine from last year, there were seven affected herds among the estimated 1,086,210 cattle herds in the United States at the end of FY2005. Therefore, the national prevalence for FY2005 is estimated to be 0.0006%, or one affected herd per 135,776 U.S. herds. Though TB

does exist in the United States, this extremely low level of prevalence should certainly be a significant factor in convincing international trading partners of the very low level of risk with TB in our cattle; and especially so for cattle originating in states with no disease for five or more years, of which there are 49 (including two territories). Additional evidence for the extremely rare frequency of TB in the U.S. is provided by the low prevalence of infection detected during the extensive active surveillance activities in California, Texas, Michigan and New Mexico during FY2004 and FY2005. More than 600,000 cattle were tested in Texas, 350,000 in California, 28,000 in Michigan and at least 50,000 in New Mexico with only one affected herd found in Texas as a result of that testing in FY2005.

Veterinary Services is continuing to provide oversight for the completion of the agreements to remove all dairy operations from the El Paso, TX, milk shed. The process is progressing as anticipated and is on track to be completed during FY 2006. There were a total of 10 dairy operations, some with multiple production units, being removed to create a buffer zone between the U.S. and the TB-affected dairy operations immediately across the border in Juarez, Mexico. Nine of the 10 operations have completed the depopulation of their livestock. Cleaning and disinfection is complete for seven of these depopulated premises. Currently, VS has two personnel, and TAHC has one person, who are responsible for ensuring that every animal leaving these premises is identified and permitted to slaughter or a quarantined feedlot for eventual slaughter. This oversight will continue until all the herds are completely depopulated within the next year. The dairy with cattle is in the process of depopulating. All depopulated cows were inspected at slaughter and, to date, have not had TB lesions detected. Each depopulated dairy will remain out of operation, in the El Paso area, for at least the next 20 years.

Veterinary Services continues to work with Mexico on ensuring there is equivalency between the two countries' requirements. To accomplish this, reviews of several of Mexico's state TB programs have been ongoing under the umbrella of the U.S. and Mexico Binational Committee. Twenty-one states or regions in Mexico have had status either suspended, granted or continued as a result of this activity. One of the milestones in the phased transition of participating Mexican states or regions to equivalence with the U.S. program was to reach a prevalence level of 0.25% by June 2003. The second milestone was to achieve 0.1% prevalence and qualify as equivalent to the U.S. Modified Accredited status by June 2005. This second milestone was reached by many Mexican states as of June 2005. These milestones have been and will be a focal point for the Review Teams. For this fiscal year there have been 22 review trips completed during which time the teams reviewed the TB programs' integrity, progress and the level of prevalence. These efforts have covered 17 states in Mexico. The travel, salary and related costs expended by Veterinary Services were $281,034. There were three reviewers working under contract, 11 that were VS or IS employees, and 17 that were employed with and paid by state or industry from Arizona, California, Colorado, Michigan, Missouri, New Mexico and Texas. The financial contributions of those states and industry groups are recognized and appreciated.

Though remarkable progress has been made in the National TB Program, much work remains. Eradication is a daunting goal and it is the nature of eradication campaigns that the difficulty of the work increases as the goal gets closer. During FY2005, progress was made in bolstering the foundations of the National TB program to enable us to achieve our goal. In FY2005, an automated process for submitting Form 6-2 was to be fully implemented. This process includes a crucial component previously missing from the manual submission process. All Form 6-2's are to be audited by one or more responsible individuals in each submitting state prior to the transmission of the form to the national database. To date, this process has not been fully implemented but it is expected that data quality will be improved by the incorporation of this auditing step.

During FY2005, Veterinary Services amended the regulations concerning tuberculosis in cattle and bison by reducing, from six months to 60 days, the period following a whole herd test during which animals may be moved interstate from a Modified Accredited state or zone or from an Accreditation Preparatory state or zone without an individual tuberculin test. It was determined that the six month period during which individual tuberculin tests have not been required is too long given the risks of exposure to tuberculosis that exist in Modified Accredited and Accreditation Preparatory states or zones, especially in such states or zones where there are wildlife populations affected with tuberculosis. This interim rule should lower the potential risk of movement of infected animals and decrease the likelihood of tuberculosis transmission. It was effective on May 18, 2005.

The cooperative State–Federal–Industry effort to eradicate bovine TB from the United States has made significant progress toward eradication, markedly decreasing the prevalence of the disease. However, the goal of eradication has been elusive despite renewed efforts. Remaining challenges—infected wildlife, large affected dairies and calf raising facilities, and infected cattle from Mexico—hinder eradication. During FY 2005, Veterinary Services established an in-house Tuberculosis Working Group (TWG) that reviewed the current TB eradication

program in the United States, previous tuberculosis planning documents and the 2004 USAHA TB strategic plan. The group developed a proposal on how best to proceed with the TB program by evaluating program costs and benefits.

Based on cost-benefit analysis, qualitative measurement, and some quantitative measurement, the TWG concluded that eradication of bovine TB remains biologically and economically feasible and helps in protecting human health and international trade of livestock. As a result of the group's recommendations to Veterinary Services, the Agency intends to discuss this issue at this year's meeting of the USAHA Committee on Tuberculosis to see if there is support for merging the TWG cost-benefit report with the USAHA 2004 TB strategic plan to provide future direction for the program.

Updates on States with Recent Infection

Arizona update: One newly affected dairy was found in Arizona through the course of slaughter surveillance. The epidemiologic investigation and plans for depopulation of this Arizona herd are ongoing.

Michigan update: No new TB affected herds were detected in FY 2005. The Upper Peninsula was granted Accredited Free status this year. One thousand one hundred herds were tested in the MA zone this fiscal year. The prevalence of TB in wild deer decreased during the last year. The prevalence in wild deer in the Modified Accredited zone was 0.2% in 2004 which is down slightly from 0.5%.

There are two dairy herds under test-and-removal herd plans that are classed as "carry-over herds" from FY 2004. One is located in Alpena County, with about 100 head total. This herd was detected through area (annual surveillance) testing and one positive animal was found. There have been four herd tests conducted on this herd with no additional infected cattle found. The other herd is located in Montmorency County, with about 175 head total. It was detected through area (annual surveillance) testing as well with five reactors found. There have been four herd tests conducted on this farm as well with three more TB positive cattle found. This is the second time this herd has been found affected. It was originally found positive in 2000 and released in 2002, before being detected again in 2004.

Michigan had two slaughter (6-35) investigations in FY 2005. The first one was a histocompatible head lymph node found at slaughter. This was a cross-bred beef steer that came from a feedlot in Michigan, however, all of the cattle in the lot originated from out-of-state. The second was a finished Holstein steer also found at slaughter. However, the PCR found this one positive for *M. avium*.

Minnesota Update: There were three positive beef herds detected in FY2005. The last previous case was in 1971, making it 34 years since Minnesota has had a positive case of bovine tuberculosis. The index herd was a commercial/purebred beef herd which has since been depopulated. Epidemiological traces are underway in Minnesota and additional states. As of November 4, 2005 investigations in Minnesota have led to quarantines of 39 beef herds in seven counties (Beltrami, Goodhue, Polk, Marshall, Cass, Lake of the Woods and Roseau). Twenty-three of these herds have completed the required testing and had their quarantine removed. Remaining herds are in the process of having exposed animals removed and/or whole herd tests completed. In September, as a result of their investigation, the state discovered that two fence-line contact cattle operations (300 to 350 head each) were also affected. A fourth herd (600 head) was detected early in FY2006 (October). The state is in the process of arranging for indemnity and depopulation of all affected herds. Minnesota Department of Natural Resources will conduct surveillance in affected areas this fall to determine if infection is present in the wild deer.

New Mexico update: The affected herd epidemiological tracebacks and investigations were completed this fiscal year. An additional infected animal was found in one dairy during FY2005 and that premises remains under quarantine as the owner opted to continue under test-and-removal in place of depopulation. There is a regionalization plan in effect in parts of Curry and Roosevelt counties (the MAA zone of New Mexico). The current plan includes annual testing of all herds within the zone for at least the next two years and using RFID eartags to assist in tracking of movement of animals within and out of the zone. All dairies were tested in eastern New Mexico in 2005 with no additional infection discovered. Plans are underway to do an extensive review of dairy calf rearing facilities to evaluate the risk they present and to also develop mitigating procedures.

Texas update: There were no affected herds carried over from FY2004 into FY2005. There were no affected herds disclosed in FY2005. The last affected herd was depopulated in September 2004. Texas initiated 310 TB investigations in FY2005, including one adult slaughter trace, 32 feedyard slaughter traces, and 277 6-4A/B

traces associated with affected herds and dairy calf raising operations in NM, AZ, TX and MN. Fourteen new dairy operations, with 4358 cattle, were tested in FY2005, and classified negative. This brings the total Texas dairy surveillance in FY2004/2005 to 786 herds and 339,305 cattle tested. Twelve hundred and forty-four beef seedstock herds, with 70,240 cattle were tested in FY2005, and classified negative. This brings the total beef surveillance in FY2004/2005 to 1,574 herds and 102,092 cattle tested. Approximately 500 registered beef herds remain to be tested within the state to meet the surveillance objective. Texas changed its approach from voluntary recruitment to mandatory by random selection in April 2005. The timeline for completion of this testing is December 31, 2005.

Update on the United States' National Surveillance Program for Bovine Tuberculosis
TB Surveillance in U.S. Livestock FY 2005

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Sustained efforts over the past five years by USDA APHIS and the Food Safety Inspection Service (FSIS) to improve slaughter surveillance for bovine TB continue to show significant and productive results. A record number 9,439 suspicious granulomas were submitted to approved diagnostic laboratories during Fiscal Year 2005 representing more than a nine-fold increase in the numbers of samples submitted since FY 2000. Eight thousand six hundred and twelve of these submissions came from nearly 5.4 million adult slaughter cattle two years of age or older.

The national granuloma submission rate for adult cattle at the end of this year was 16.2 submissions per 10,000 adult cattle killed. For the fourth consecutive year, this rate greatly exceeds the target of five submissions per 10,000 adult cattle killed, and documents the good efforts and commitment that our state and federal meat inspection professionals are making to improve TB surveillance.

Three diagnostic laboratories and their professional staffs provide outstanding support for the national bovine TB surveillance effort: the National Veterinary Services Laboratories (NVSL) in Ames, IA, the FSIS Pathology Laboratory in Athens, GA, and the California State Diagnostic Laboratory located in Tulare, CA. Six thousand seven hundred thirty-three or 71.3% of the total samples were sent to NVSL for diagnosis, 1,378 samples (14.6%) were evaluated by the FSIS lab, and 1,328 samples (14.1%) were handled by the Tulare, CA, lab.

During FY2005, 40 plants located in only 20 states slaughtered 94.4% of all adult cattle. These plants play a critical role in all our national animal disease surveillance programs. TB granuloma submission rates per 10,000 adult cattle killed ranged from 77.8 to 0.00 among these 40 plants.

Thirty-five (87.5%) of these 40 plants were outstanding in their efforts to support the National Bovine TB Eradication Program by contributing 87.1% of all the granulomas submitted from adult cattle last year (7,500 submissions). Their combined granuloma submission rate was 16.5 submissions per 10,000 adult cattle killed or more than three times the target of five submissions per 10,000 adult cattle killed. Nearly 85% of the total adult cattle killed last year were from these 35 plants.

Three (7.5%) of these 40 large plants made significant progress toward achieving the goal of 5.0 submissions for every 10,000 head of adult cattle killed by submitting at a combined rate of 4.1 per 10,000. These plants together submitted 2.2% of the total adult submissions (196 submissions), and killed 8.9% of the adult cattle slaughter population.

Two (5%) of these large, adult cattle slaughter plants submitted at a combined rate of only 0.9 submissions per 10,000 adult cattle killed. However, these two plants inspect only 0.62% of the adult cattle killed annually, and only this year qualified as part of the "Top 40" plants in terms of volume of adult cattle killed. We expect these plants to improve over the next year as many others have since this report was given last year.

Slaughter surveillance continues to identify new cases of TB in both adult and fed cattle. Forty new cases of TB were found in cattle in U.S. slaughter plants during the year. Thirty-five cases were reported last year. No cases of TB were detected in bison slaughtered under state or federal inspection either this year or last. No cases of TB were detected in captive cervid operations during FY 2005.

Five (12.5%) of 40 TB cases involved older, adult cattle. One of the adult cases involved investigation of an adult dairy cow, and four adult cases related to the tracing of beef cows. Thirty-five cases of bovine TB (87.5%) were detected in fed steers or heifers – all considered to be beef-type cattle.

Locations for the initial investigations of these 40 TB cases involved six states. Arizona, Texas, Nebraska, South Dakota, and Minnesota were involved in tracing the five adult cattle. Feedlot case investigations were initiated in Arizona (one case), Nebraska (two cases), Kansas (one case), and Texas (31 cases).

Epidemiologic investigation of these cases resulted in a newly-infected dairy herd being disclosed in Arizona. This herd is comprised of nearly 4,500 dairy cattle, and negotiations to depopulate the herd are in process. Tracing of a beef cow detected with TB lesions in a Wisconsin slaughter plant also led to the confirmation of a mixed, purebred/commercial beef herd in Minnesota. The index beef herd in Minnesota was depopulated, and further epidemiologic investigations have resulted in the finding of three additional infected herds in Minnesota to date. Traces of exposed cattle leaving the index Minnesota herd to date are extensive, and involve at least eight states.

Two cases of TB tracing to beef herds located in Nebraska and Texas resulted in extensive testing of the most likely herds of origin. However, confirmation of the disease in these herds was not successful. One case found in an adult, beef cow slaughtered in a Minnesota plant but originating from a South Dakota livestock market was considered to be completely untraceable since most of the identification devices that were present on the cattle in the slaughter lot containing the TB cow were not collected as required in the Market Cattle Identification program.

Only two of five cases detected in adult cattle during FY 2005 resulted in finding a newly-infected herd. This low, 40% success rate is reason for concern as it may indicate there are herds with infection which have yet to be disclosed.

Twenty-two of 35 TB cases found in fed cattle were identified with an official Mexican eartag at the time of slaughter. In addition, the epidemiologic investigation of five other cases indicated the origin of the cattle to be from Mexico. Five more cases likely resulted from exposure to an “M” branded, chronically infected steer located in a small, Texas feedlot. One case was considered to be untraceable due to lack of identification and multiple possible sources, and two cases are pending further investigation. As a result, 91% (32/35) of the feedlot cases involved Mexican steers or exposure thereto.

The origin states in Mexico for the 22 cases in feedlot cattle wearing Mexican official eartags are as follows: Durango – seven cases; Chihuahua – four cases; Nuevo Leon, Coahuila, Tamaulipas and Veracruz – two cases each; Jalisco, Aguascalientes and Campeche – one case each.

Data describing Mexican feeder cattle imported from 2003 to 2005 was compared by status of the Mexican origin state. 81.5% of cattle imported during this three-year cycle came from states classified Modified Accredited (MA) or better. 18.5% of the cattle originated from states now considered to be Accredited Preparatory (AP) or less. However, TB case rates varied significantly from 1.13 cases per 100,000 cattle imported in MA/MAA states versus 3.58 cases in AP states ($p=0.0000198$). This analysis shows that feeder cattle from AP states may be at least three times (OR=3.16; 95%CI: 1.79-5.56) more likely to contain TB exposed cattle as those from MA/MAA states, and suggests that more restrictive procedures to handle such cattle may be needed if they continue to enter the United States. These data also support the need to make sure that cattle from higher risk Mexican states do not expose cattle in those Mexican states which have made substantial progress to date with their eradication programs.

A cluster of six TB cases found in cattle located in a small Texas feedlot this past year was particularly interesting. Investigation of this outbreak suggested that an “M” branded steer, later shown to be chronically infected with bovine TB, was the likely source for infecting five other native steers as they spent prolonged periods of time together in common hospital or “poor doer” pens in the feedlot. Eartag identification provided by the owner for the native steers allowed tracing to the specific herds of origin in Texas, and results of complete herd testing for the origin herds were negative for TB infection. This cluster of cases again clearly emphasizes the infection risk that higher-risk cattle pose for other cattle in a feedlot setting as has been documented historically, and would be particularly dangerous had breeding cattle also been present.

An evaluation of the time required to complete the investigation for each of the 40 cases detected at slaughter indicated that 21 cases have been considered officially closed and approved by the designated epidemiologist with the required, written case closure documents in the official case file. Twelve of the 21 cases required three to six months to completely close. Nineteen cases remain to be officially closed even though investigatory activity has been started on most of these cases. Eleven of the 19 cases are pending receipt of the official closing reports for six months or longer. To insure more urgency in completing these cases, USDA is proposing changes in the TB Uniform Methods and Rules requiring cases to be investigated and officially closed within 65 days of laboratory notification.

Tuberculin testing of livestock also contributes to the national TB surveillance system. During FY2005, at least 1,247,486 caudal fold tuberculin tests were conducted on cattle and bison nationwide. There were 16,566 responders (1.3%) reported among these caudal fold tuberculin tests. On a regional basis, 899,282 tests were performed in the Western Region as opposed to 348,204 tests in the Eastern Region. However, 1.9% of all tests conducted in cattle and bison in the Eastern Region were classified as suspect versus 1.1% of tests in the Western Region – the difference of which is statistically significant ($p \leq 0.000001$).

Nationwide, 21,471 captive cervids were reported to the USDA national database as being single cervical tuberculin tested during FY2005 revealing 338 suspects (1.5%). Regionally, 12,694 cervids were reported as being tested in the Eastern Region versus 8,777 cervid tests in the Western Region. Response rates differed significantly from 1.7% to 1.3% respectively ($p= 0.007$).

An evaluation of caudal fold response rates in cattle and bison based on the reason the test was conducted showed wide variations. Tests conducted for the reasons of area testing, epidemiology, or quarantine resulted in response rates between 2-3%. In contrast, testing for the reasons of herd accreditation, importation retests, or sale and show resulted in response rates near 0.5%. Considering the extremely low prevalence of TB in our national herd, and also considering the lower response rates that usually result when tests are conducted while cattle are in marketing channels, these data may suggest that the probability of detecting cattle with TB when such cattle are tested in marketing channels is extremely low. In other words, it may not be the “best bang for the buck” unless prior continuing education related to tuberculin testing is provided to veterinary practitioners conducting such tests on a continuing basis. With the exception of tuberculin testing of herds by regulatory veterinarians as a result of epidemiologically tracing cattle detected with TB at slaughter, testing of livestock on farm or at markets by private veterinary practitioners did not detect a newly-infected herd during FY 2005, and has identified only one TB case in at least the past 10 years.

The percentage of test responders reported by test reason and region were also compared. Similar to data presented in FY2004, substantial differences in these percentages are evident between Eastern and Western Regions depending on certain reasons why cattle are tested. However, in both regions, the percentage of responders reported on testing done for accreditation and sale/show purposes are similar and low. Such testing is typically conducted by accredited veterinarians. In contrast, the epidemiology caudal fold tuberculin testing is typically done by government veterinarians and the response percentages for these tests are similar between regions and much higher. These results suggest the continued importance of implementing the caudal fold performance standard that is part of the revised UM&R for adult cattle and bison.

Use of the gamma interferon test as an official test in the national eradication program for bovine TB was approved last year. Five laboratories throughout the United States have been approved to conduct gamma interferon testing. Together, these labs tested at least 10,946 blood samples collected from cattle.

Pack your trunk! We're going to Florida: The 2005 Elephant Tuberculosis Conference Committee Time Specific Scientific Paper

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Background

A workshop was held on May 21-22, 2005, to discuss the current status of diagnosis and treatment of tuberculosis in elephants. The working groups identified specific "next steps" needed to improve the diagnosis and treatment of elephant TB. A summary document was produced and is available at several websites including: http://www.elephantcare.org/protodoc_files/2005, and under "Elephant TAG/SSP information" at www.aazv.org/elephants.htm.

Tuberculosis in elephants has been sporadically occurring for possibly as long as 2,000 years. It "emerged" as a disease of concern for elephants in 1996 when two elephants died. This diagnosis raised public concern for elephant and human health. The USDA formed an advisory panel to establish diagnostic and treatment protocols and guidelines for the surveillance of all elephants (Guidelines for the Control of TB in Elephants), published as Policy 21 under the Animal Welfare Act (1998; revised in 2000 and 2003). The Guidelines established culture as the recommended test for TB diagnosis in elephants, classified elephant into groups based on culture results and exposure history, and revisions established target serum drug levels and updated treatment regimens and options.

Between 1994 and June 2005, there were 34 confirmed cases of tuberculosis in elephants in the U.S. population. Thirty-one Asian and three African elephants were affected. *Mycobacterium tuberculosis* was the etiologic agent in 33 cases and *M. bovis* in one case. Three cases of tuberculosis caused by unusual non-tuberculous mycobacteria are excluded from this discussion. Twenty-two of the 34 cases were diagnosed antemortem on the basis of cultures and 12 cases were post-mortem. The majority of elephants, including the 12 cases diagnosed post-mortem, did not show clinical signs suggestive of TB. Of the 34 cases, 19 have died or were euthanized. In some cases, TB was an incidental finding at necropsy.

Currently, the diagnosis of TB in elephants remains a dilemma. The sensitivity of trunk wash cultures is unknown. False negatives have been documented (trunk wash negative elephants that were subsequently found to be culture positive at necropsy). Other non-culture techniques for TB diagnosis include ELISA, PCR, gamma interferon (under development), and lymphocyte stimulation (not available at this time).

Similar to diagnostic issues, treatment parameters are still under investigation. Effective drug levels for elephants have not been determined. Adverse drug levels have been a significant issue for some elephants. Long-term medication administration is challenging and there is currently no pre-mortem method to confirm a cure.

I. Diagnostic Testing for Tuberculosis in Elephants

Culture has been used to diagnose TB in 34 captive elephants. Trunk wash samples may be submitted to any microbiologic laboratory capable of culturing for mycobacteria so it is difficult to determine the actual number of trunk wash samples submitted from elephants. From 1997-2005, 8,715 trunk washes with swabs were submitted to National Veterinary Services Laboratories (NVSL) that yielded 423 different mycobacterial isolations. The most prevalent isolate (142/8,715 samples) was *Mycobacterium avium*, which is not considered a public health risk or risk to other animals. NVSL has also performed over 1,100 Gen Probe MTDs (a nucleic acid amplification test). Although it correctly identified 13 culture positive elephants, there were both false positive and negative MTD elephant samples.

Studies are currently underway to examine the ability to detect mycobacterial organisms in trunk wash samples using PCR. Additional work needs to be performed to determine sensitivity of the assay and run PCR on trunk washes from known TB infected elephants.

Serologic assays appear to hold promise for diagnosis of tuberculosis in elephants. Enzyme-linked immunosorbent assay (ELISA) has been used in two versions to detect differences in seroreactivity between infected and non-infected elephants. Antigens that appeared to discriminate between culture positive and negative samples were CF, MPB70, and ESAT6. A study was performed with 68 Asian elephants, including 16 culture positive animals. Using CF + ESAT6, the specificity was 100% and sensitivity was 94% (one culture

positive elephant showed no seroreactivity). ELISA appeared capable of differentiating infected elephants earlier than culture (months to years).

One company, Chembio Diagnostics Inc., has developed two tests for the diagnosis of TB in animals by detection of anti-mycobacterial antibodies. The Rapid Test (RT) is an immunoassay based on lateral-flow technology. Nitrocellulose membranes are impregnated with a set of test antigens in a single test strip that can be used as a field screening test, and has a relatively high sensitivity but lower specificity. The MAPIA assesses the presence of antibodies to eight to 12 individual mycobacterial antigens. The RT and MAPIA are developed as screening and confirmatory tests similar to current technologies in use for HIV testing. Immunoblot is similar to MAPIA but uses whole cell sonicate of *M. bovis* as the antigen separated on polyacrylamide gel and transferred to nitrocellulose membrane.

Multiple serum samples collected from 90 Asian and African elephants in Europe, South Africa, and the U.S. have been tested using MAPIA and RT. Of these, 17 were culture-positive for *M. tb* or *M. bovis*. Of 63 culture negative control elephants, one was reactive with RT but not MAPIA (this animal had a chronic osteomyelitis). Overall, with this test population, the RT showed 100% sensitivity and 98% specificity; the MAPIA had 94% sensitivity and 100% specificity.

Using the RT, MAPIA, and immunoblot, sera were tested from known culture positive elephants over time to examine the development of the serologic response. Individual antibody responses showed that all three assays could detect seroconversion years prior to the first positive culture in a number of infected elephants. These assays were also used to test sera from culture positive elephants before, during, and after treatment for tuberculosis. The pattern of antigen seroreactivity in MAPIA and immunoblot changed as treatment was initiated, and in those elephants with recrudescence, a rise in titer to specific antigens was also detected.

At this time, other diagnostic tests have not been tested or are not currently available for use in elephants. A gamma interferon assay is being developed but is not expected to be available for at least another few years.

Status of Diagnostic Testing: The ELISA, Rapid Test, MAPIA, and immunoblot detect antibodies in elephant sera to mycobacterial antigens; therefore, they provide indirect evidence of infection or exposure. Data presented suggest that these assays may be used to detect seropositive elephants months to years before a trunk wash or necropsy culture is positive. Patterns of seroreactivity may also be useful for monitoring response to treatment. Since the RT detects seroreactivity to all target antigens simultaneously and therefore cannot distinguish the pattern of seroreactivity, it would best be used as a screening test, with the MAPIA and/or ELISA as a confirmatory test. PCR of trunk wash samples has not been tested with field samples, but may provide another method of organism detection. Definitive diagnosis of infection still requires identification of the mycobacterial organism, usually by culture. Culture is essential to determine antibiotic sensitivity patterns and the selection of drugs that will be used for treatment. Culture of trunk wash samples is the only test currently required by the Guidelines for the Control of Tuberculosis in Elephants 2003. All other tests discussed are considered ancillary at this time and further work is needed for validation.

II. Therapeutic Issues for Tuberculosis in Elephants

There have been five elephants treated for tuberculosis that have subsequently died or been euthanized. Three were culture negative at necropsy, and two that had recrudescent disease, were positive. Of the two elephants that were culture positive at necropsy, one may not have received adequate treatment in compliance with protocols outlined in the Guidelines and the second was euthanized prior to completing treatment. Clinical signs associated with toxicity are common and complicate ability to follow treatment guidelines. Knowledge of transmissibility to other elephants and zoonotic potential is also limited; therefore, elephants in contact with infected animals are often treated prophylactically and may exhibit drug side effects.

Of the 34 culture positive elephants, 22 have been treated; three animals were treated twice. In one survey of isolates from elephants, it was found that 26.5% were resistant to at least one antibiotic. Multi-drug resistance (defined as resistance to two or more first line anti-TB drugs) was observed in two elephant isolates at NVSL. Drug resistant *M. tb* has been isolated from elephants and requires treatment with multiple first and second line drugs. New anti-TB drugs may provide safer more effective choices for treatment in the future.

Status of Therapy: At the current time, combination drug therapy is recommended for treatment of tuberculosis in elephants as recommended in the Guidelines (2003). Preliminary data indicates that effective treatment may rapidly cease shedding and even eliminate culture positive organisms from lesions tested at necropsy (n=3).

However, lack of early diagnosis, toxicity of drugs, and prevalence of MDR TB may complicate the ability to achieve a cure.

III. Recommendations and Action Plans

Based on the information presented, the current knowledge and future direction of diagnostic testing and treatment of tuberculosis in elephants was discussed. Concerns for the public health and regulatory consequences were taken into consideration. Over the past approximately 10 years of work in this field, significant progress has been achieved but there is still a lot of questions regarding the pathobiology of the disease in elephants. In order to address some of the most immediate practical issues facing diagnosis and treatment, the following recommendations and action plans were developed.

A. Diagnostics
    a. Correlate retrospective and future necropsy data with diagnostic test results and clinical history (culture, serologic tests, PCR, gross lesions, histopathology, presence of acid-fast bacilli).
        i. Recommend thorough necropsy on all elephants with data collected as outlined above.
        ii. Perform data validation and comparison for currently available assays (ELISA, RT, MAPIA)
    b. Create a set of reference sera ("positive" and "negative") that can be used to validate future assays.
    c. Recommend that all elephants have antemortem annual trunk wash cultures (triple samples) and serum collected at the same time for ELISA/RT/MAPIA and banked.
    d. Perform retrospective epidemiological review of culture positive elephants using new serologic data.
    e. Recommend further studies of pathobiology of *M. szulgai* and other non-TB mycobacterial infections in elephants.
    f. Request speciation of all mycobacteria isolated from elephants.
    g. Recommend frequent serum collection of treated elephants for serologic monitoring (at least every six months, or more frequently).

B. Treatment
    a. Investigate new routes of treatment, such as transdermal and inhalation.
    b. Review current TB drug therapy in elephants.
    c. Create an information sheet regarding clinicopathologic changes associated with drug toxicities.
    d. Investigate new TB drug options for elephants.
    e. Pilot pharmacokinetic studies.
    f. Recommend using serologic tests (ELISA, RT, MAPIA) to monitor treated elephants every three to six months, along with culture.

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Bovine Tuberculosis Eradication Program in Canada

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Canada continues to near complete eradication of bovine TB from cattle and farmed bison. During the six-year period from October 1999 through October 2005, *M. bovis* was confirmed in seven herds of cattle (6) and farmed bison (1).

Five of these seven herds were in Manitoba: one in 2001; three in 2003 (first year of area testing); and one in 2004. The five infected herds in Manitoba are believed to have acquired TB from contact with diseased wild elk or deer in or around Riding Mountain National Park (RMNP). Investigation using molecular techniques determined that all five isolates were identical to the unique strain found in wildlife.

The other two infected herds were in Ontario (cattle-2002) and Alberta (bison-2001). In the case of both of these herds, the source was long-standing latent infection.

These findings indicate that, with sustained aggressive surveillance and eradication strategies, excellent progress has been made in eradicating residual latent infection in livestock. The remaining challenge is the new infections that occur in livestock as a result of direct or indirect contact with diseased wildlife.

In 2004 and to October 31, 2005, there was a single finding of bovine TB in Canadian livestock in a dairy cattle herd located in southeastern Manitoba. This was the first finding in the province since 1996 occurring outside the special eradication area surrounding RMNP. However, the investigation found that the source of the infection was the purchase of an infected cow that had been dispersed in 2002 from a herd located near RMNP inside the special eradication area. (Dispersal had occurred prior to the implementation of movement controls in the special eradication area.) Spoligotyping and RFLP analysis confirmed that the organism isolated from this herd was identical to that isolated from livestock and wildlife in and around RMNP. The case was detected on routine slaughter surveillance.

This herd, as all infected herds detected since 1985, was depopulated. All exposed susceptible animals were traced from the infected herds, investigated, tested, destroyed, and tissues collected for laboratory tests. Federal compensation was paid for all animals ordered destroyed up to maximum prescribed amounts. All potential sources of infection were investigated and tested. Other contact herds and all herds in a 10-kilometre perimeter zone were investigated and tested. No spread was found.

General surveillance of cattle and farmed bison herds is based on routine inspection at slaughter and the submission of granulomatous lesions for laboratory examination, with trace-back investigation of all histopathological diagnoses of mycobacteriosis. In 2004, a total of 468 lesions were submitted from slaughter cattle and bison. Histopathological and culture examinations of these tissues found: three were due to *M. avium* complex; two were due to *M. terrae* complex, one was due to a scotochromogen, and 1 was due to *M. bovis*. The *M. bovis* case is described above. No *M. bovis* in livestock has been detected during slaughter surveillance in 2005 to October 31.

Targeted on-farm area testing is used to supplement slaughter surveillance. Area surveillance testing continued around RMNP in Manitoba in 2004 and 2005, an area where 37 TB-infected wild cervids (30 elk and seven white-tailed deer) have been found since 1997. Since October 2002, surveillance testing has required the periodic testing of cattle and farmed bison in a special eradication established around the park. The Riding Mountain TB Eradication Area (RMEA) consists of two provincial game hunting areas, encompasses approximately 50,000 breeding cattle on 650 farms, and represents approximately 10% of Manitoba's cattle herds and 1% of Canadian cattle herds. All cattle and farmed bison herds in the RMEA are tested at 12 to 36 month intervals, with the interval based on the risk of exposure to diseased wild cervids. Annually, this translates into 25,000 to 35,000 animals tested. During the three years ending September 30, 2005, more than 100,000 livestock were tested in the RMEA.

In the RMEA, all animals 12 months of age and older are screened using the caudal fold tuberculin test and all responders are retested using the Bovigam assay. All animals classified as positive on the Bovigam are slaughtered and tissues are submitted for confirmatory laboratory tests. Animals classified as suspect may be

retested or slaughtered. However, if the owner elects to retest the animal and it retests negative, the herd is scheduled for a herd test in the following year.

In 2004, a total of 46,448 cattle and farmed bison were tuberculin tested by federal inspectors across Canada in conjunction with surveillance testing and investigations. Bovine TB was not detected during on-farm surveillance testing in 2004 and to October 31, 2005.

Canada continues to near complete eradication of bovine TB from farmed cervids, which consist mainly of elk, red deer, elk/red hybrids, fallow deer and white-tailed deer. During the first 10 years (1989 through 1999) following extension of the National Bovine TB Eradication Program to farmed cervids, 35 infected herds were found in five provinces. During the last seven years (1999 through October 2005), two infected herds were found - one in Ontario (1999) and one in Quebec (1999).

All infected farmed cervid herds, except one, underwent complete depopulation of all exposed susceptible animal species. Compensation, quarantine, investigation, trace-out and trace-in, contact and perimeter premises, cleaning and disinfection, and restocking were all carried out in the same manner as for infected cattle and farmed bison herds. The lone exception, in 1993, involved a zoological collection that underwent partial depopulation followed by a 10-year period of quarantine of primates and several endangered species. This was followed by implementation of a further five-year management plan of on-going surveillance.

Because relatively few adult cervids are routinely slaughtered, surveillance for bovine TB in this sector has been based on the testing, every three years, of all cervid herds involved in the commercial trade of these species. In 2004, a total of 26,709 farmed cervids were tuberculin tested by federal inspectors under this program. Bovine TB was not detected during this surveillance testing in 2004 and to October 31, 2005.

Thirteen lesions were submitted from cervids during routine slaughter surveillance, including one associated with the CWD surveillance program. Histopathological and culture examinations of these tissues found two were due to *M. avium* complex and none were due to *M. bovis*. In 2004 and to October 31, 2005, no infected farmed cervid herd was detected through routine slaughter surveillance.

Bovine TB and brucellosis are endemic in a free-roaming herd of approximately 4,500 wood bison in and around Wood Buffalo National Park which straddles the northern boundary between Alberta and the Northwest Territories. Due to its remote location, this herd poses its greatest threat to adjacent disease-free wild bison herds. An interim bison management plan includes: no-bison buffer zones; controlled access of livestock to risk areas; the killing of stray bison; and other measures to minimize the risk of disease spread to other wild bison, farmed bison, or cattle.

Since 1998, bovine TB has been known to exist in a free-roaming herd of approximately 2,000 elk in and around Riding Mountain National Park (RMNP), located in the southwestern part of Manitoba. A similar number of elk in Duck Mountain Provincial Park and Forest to the north of RMNP are believed to be free of the disease at this time, however, surveillance continues in this population to further confirm this. The ecosystem in also home to approximately 7,500 white-tailed deer.

To October 31, 2005, bovine TB has been confirmed in 37 wild cervids (30 elk and seven white-tailed deer) in and around RMNP. The five cattle herds in Manitoba in which bovine TB has been found during the past six years were all located close to the park boundary or associated with a herd close to the park; and three were located within two kilometres of diseased wild elk and deer cases.

Of these 37 cases, 17 (11 elk and six deer) were detected through a hunter-harvest surveillance program targeting animals outside the park, which has screened more than 5,000 animals since 1997. The remaining 20 cases (19 elk and one deer) were detected through a capture, test and removal program that targets animals inside the park and is used to augment hunter-harvest samples as well as to validate blood tests. Under this program, which began in 2003 and has tested nearly 400 animals, elk and deer are captured, blood samples are collected, and a radio-tracking collar is attached before the animal is released. Samples are tested using the lymphocyte stimulation test (LST) and a fluorescent polarization assay (FPA). Any animal that is positive on one or both test is tracked using the radio-collar, humanely destroyed, and necropsied, and tissues are collected for confirmatory testing.

In response to the detection of this wildlife reservoir, a comprehensive management strategy was implemented in

2000. Its objectives are: surveillance to determine the distribution (geographic and species) and prevalence of the disease in wildlife; prevention of the spread of the infection from wildlife to livestock; and elimination of the disease in wild cervids. The major elements of the program include:

- on-going surveillance sampling of wild cervids inside and outside both parks using regular hunter-harvest samples; passive surveillance of road-kills; special land-owner hunts to augment samples from selected areas; and use of the capture, collar and test program inside both parks, incorporating new diagnostic methods as they become available;
- separation of wild cervids from livestock through the barrier fencing of forage/feed and cattle feeding yards (by the end of 2005, a total of 134 feed/forage yards will have been fenced); prohibitions on the feeding and baiting of elk or deer; and changes to crop insurance programs for hay depredation to encourage owners to remove hay from fields into fenced areas;
- elk population management through increased hunting opportunities outside the parks; habitat improvement inside the park; and the selective removal of infected animals through the capture, collar and test program (the elk population in RMNP has been reduced from over 3,000 animals to less than 2,000).

Under legislated program standards, all provinces in Canada, except Manitoba, are classified as TB-free areas for farmed bovines. Under the regulations, Manitoba was assigned split status in 2003. The RMEA is classified as TB-accredited-advanced and the rest of Manitoba is TB-free. In conjunction with Manitoba's split status, legislated movement controls require owners to obtain a movement permit to remove any bovines from the RMEA to elsewhere in Manitoba or to another province. Permits are issued on the basis of a negative herd test and/or individual animal testing. Compliance is monitored through audits conducted at markets or on the farm, and has been assisted by the coincidental implementation of a mandatory cattle identification program across Canada.

Under legislated program standards, all Canadian provinces are classified as TB-free areas for farmed cervids. The movement of all farmed cervids in Canada, including those in the RMEA, is subject to a movement permit.

Status Report of the U.S.-Mexico Binational Tuberculosis and Brucellosis Eradication Committee

Billy G. Johnson, Binational Committee Coordinator

The U.S.-Mexico Binational Tuberculosis and Brucellosis Eradication Committee (BNC) was formed in 1993 based on a recommendation by the United States Animal Health Association (USAHA) with responsibility to provide oversight on the eradication programs in each country and to provide recommendations for the minimum requirements for the exportation of cattle from Mexico to the United States. This followed other cooperative efforts between the two countries that have eradicated animal diseases such as foot and mouth disease, screwworms and Venezuelan Encephalomyelitis. The BNC has sixteen members with representation from the livestock industries, research, and State and federal officials.

From 1995 until 2000 the Committee assumed the responsibility for coordinating reviews in Mexico for compliance with the Consensus Document developed by the border states officials. This document was developed pending the publication of USDA regulations covering the importation of cattle from Mexico. The Consensus Document placed responsibility on the states in Mexico to initiate programs that would quickly reduce the prevalence of tuberculosis in that country and therefore reduce the risk of infected cattle entering the United States. USDA, APHIS then published a regulation establishing authority to control the importation of cattle regarding tuberculosis. Special waivers were then issued to states and zones in Mexico that met established disease eradication procedures and incidence rates. All States or zones receiving waivers had to first reduce their prevalence rate to 0.25% and then to less than 0.1% by June 1, 2005. The BNC worked closely with APHIS officials in developing these requirements and in developing review procedures to be followed in Mexico.

By June 1, 2005, federal officials in Mexico were required to certify those states meeting the Modified Accredited requirements. The Accredited Preparatory states with waivers initially certified and allowed to continue exporting cattle to the United States were: Chihuahua Zone A, Coahuila Zone A, Tamaulipas, Colima, Baja California Zone A, Aguascalientes Zone A, Yucatán, Quintana Roo, Campeche Zone A, Nuevo León Zone A and Sinaloa.

The states that were Accredited Preparatory without waivers were: Nayarit Zone A, Puebla Zones A1 and A2, Quintana Roo and Zacatecas Zone A1/Jalisco Zone A.

The following Zones that were previously Accredited Preparatory with waiver are now Accredited Preparatory states: Jalisco Zone A2 and Veracruz Zone A. The following Zones were downgraded to non-accredited status following reviews: Durango Zone A and Chiapas Zone A.

BNC members have participated in the reviews and are familiar with the progress in each of these states.
The Committee has met three times during the past year, twice in the United States in conjunction with the National Cattlemen's Beef Association and at the USAHA meetings and once in Mexico during the Confederation National Ganadera (CNG) meeting. These organizations as well as other industry groups have worked cooperatively with the BNC since its beginning by providing space, financial aid and other assistance. By meeting at these locations, cattlemen and other industry and veterinary officials have the opportunity to participate. Program procedures reviewed at these meetings include surveillance programs in each country, traceback efforts, eradication program progress, research programs in each country, state reviews, interstate and interzone movement controls and law and regulation adequacy in each country.

The BNC is similar to the USAHA committees in that it does not establish the eradication procedures in Mexico, but makes recommendations. Since USDA APHIS now requires countries exporting cattle to the U. S. to have eradication procedures equivalent to those in the U.S., the recommendations established by USAHA's Committee on TB are important not only to the U.S., but also to those countries exporting cattle to the U.S. Although the BNC was originally established for tuberculosis procedures, brucellosis was later added to its responsibilities. Although the brucellosis programs in most states in Mexico are not progressing at the same rate as their tuberculosis eradication programs, Sonora has progressed well and is looking at Brucellosis Free status. Also a U.S.-Mexico Tick Committee meets at the same time as the BNC and provides a summary of its meeting to the BNC since most of the BNC members are also involved with tick eradication programs.

Some Mexican states or zones have met the standards of Modified Accredited status to export cattle to the U.S. based on individual animal tests or as Modified Accredited Preparatory to ship cattle based on whole herd tests.

The individual animal test problems will continue to occur for many cattle producing areas in Mexico. These include:

- The difficulty for the Non-accredited zones in states with Modified Accredited zones to make the required progress if large infected dairies exist.
- The problem of meeting the required herd prevalence levels in Modified Accredited zones if infected dairies exist.
- The difficulty of marketing feeder calves from Non-accredited states
- The ability to provide adequate indemnity funds to depopulate herds in meeting the required prevalence levels

These and other problems and concerns will come before the BNC in the future.

2005 Report of the USAHA Scientific Advisory Subcommittee on Tuberculosis

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In 2003 conditional approval was granted for use of the Cervigam™ as an ancillary test for diagnosis of tuberculosis in Cervidae, pending further analysis of data to be collected between 2003 and 2005. Specifically, analysis was to include evaluation of specificity using approximately 200 samples each of white-tailed deer, fallow deer, red deer/elk and reindeer. The sale of the company which produced Cervigam™, as well as difficulties in obtaining an adequate number of samples from all the above deer species, has delayed data collection. Due to this delay a one year extension was requested in 2005 by Victorian Industrial Animal Health Consultancy on behalf of the assay manufacturer.

The TB Scientific Advisory Subcommittee (SAS) recommends that the one year extension be granted and data collection be continued, a summary of which should be submitted to the TB SAS for review prior to the 2006 USAHA meeting. The TB SAS also strongly encourages producers in the cervid industry to support continued evaluation of the Cervigam™, as well as other potential diagnostic tests for tuberculosis in deer, by providing samples for analysis.

In 2004, USDA approved the use of the cattle scattergram for interpretation of the comparative cervical tuberculin test (CCT) in reindeer. Approval was based on data collected by USDA-APHIS on skin test responses of reindeer in the field, as well as on data provided by USDA-ARS using experimentally infected reindeer. In 2005, data was submitted by USDA-APHIS to the TB SAS summarizing the use of the cattle scattergram in reindeer and requesting suggestions on the continued use of the cattle scattergram for interpretation of the CCT test in reindeer.

Based on summary data provided by USDA-APHIS, the TB SAS has no objection to the continued use of the cattle scattergram for interpretation of the CCT in reindeer. The TB SAS encourages USDA-APHIS to modify reporting of skin test results in all deer species to allow data collection and analysis at the deer species level, thus allowing more thorough and accurate review of the performance of intradermal skin testing of all deer species in the US.

The National TB Working Group for Zoo and Wildlife Species was established to collect data and provide recommendations for the development of guidelines for the control of TB in elephants and other exotic animals. The current guidelines recommend annual culture of trunk wash samples for surveillance. While highly specific, this strategy lacks adequate sensitivity for early diagnosis and disease control. A workshop on advances in TB diagnosis and treatment in zoo species was held at Disney's Animal Kingdom on May 20-22, 2005 with participants from the American Association of Zoo Veterinarians, academia, industry, zoo / circus veterinarians, a medical doctor with TB expertise, USDA-APHIS, and USDA-ARS. The workshop provided a venue for information sharing and coordination of a plan to advance TB diagnosis and treatment of elephants. With a majority consensus of the workshop participants, it was determined that serum should be collected for evaluation by ELISA (University of California), VetTB Stat-Pak™, and MAPIA (Chembio Diagnostic Systems) annually in addition to trunk wash and culture. Advantages of serologic-based tests include early diagnosis relative to trunk wash, increased sensitivity, and ability to monitor therapy (i.e., recrudescence of responses associated with failed therapy). The TB SAS was provided data for analysis concerning the use of the VetTB Stat-Pak™ and MAPIA for diagnosis of tuberculosis in elephants.

The TB SAS supports the conclusions of the 2005 Workshop on advances in TB diagnostics and recommends to USDA-APHIS, Animal Care and the National TB Working Group for Zoo and Wildlife Species that as part of the diagnostic regimen for detection of tuberculosis in elephants, serum be collected on an annual basis for evaluation by the VetTB Stat-Pak™ and MAPIA serological assays in addition to bacteriologic culture of trunk washes. Due to the low number of animals available for testing in the US, the TB SAS supports extension of serological evaluation to samples collected from abroad to further increase assessment of sensitivity and specificity. The TB SAS encourages the continued workshop support and participation in the evaluation and collective recommendations on testing regimens for diagnosis of TB in elephants and other zoo species. The TB SAS encourages developers of other diagnostic assays to collect and submit data for future review by the TB SAS.

PriTest of Redmond, WA, submitted an interim report on the development of a serological screening test for bovine tuberculosis known as SeraLyte-Mbv™. PriTest has developed the test to be used as a primary test and replacement to the caudal fold tuberculin (CFT) test. Data included results from approximately 100 serum samples obtained from naturally infected cattle in the United Kingdom.

The TB SAS finds the preliminary results of the PriTest SeraLyte-Mbv™ assay promising. The TB SAS encourages PriTest to continue evaluation of SeraLyte-Mbv™ using larger numbers of well characterized samples from both *M. bovis*-infected and non-infected cattle, cattle infected with *M. avium subsp paratuberculosis* and cattle sensitized to *M. avium subsp. avium*. The TB SAS recognizes the difficulty faced by PriTest and other test developers due to the paucity of available samples from *M. bovis*-infected cattle for analysis. The TB SAS views the lack of access to suitable samples as a major obstacle to bovine tuberculosis diagnostics research and development. Therefore, a high priority should be placed on the creation of a national repository of well characterized serum samples available for research and development purposes. Therefore, the TB SAS recommends to USDA that resources be made available to create and maintain a repository of serum samples from well characterized cases of experimental and natural *M. bovis*-infected cattle as well as samples from cattle infected with or sensitized to *M. avium subsp paratuberculosis* and *M. avium subsp avium*. Samples from the repository would be available to evaluate potential serological tests of bovine tuberculosis under the direction and management of USDA. The TB SAS recommends that guidelines be drafted addressing the minimum number of samples from each category that need to be tested to provide statistically valid results.

Chembio Diagnostic Systems of Medford, NY, submitted data for review on a novel serological assay to detect specific antibodies to specific proteins of *M. bovis*. Immunodominant antigens were first determined using the multi-antigen-print-immunoassay (MAPIA) and sera from cattle, white-tailed deer, reindeer, elk and badgers naturally or experimentally infected with *M. bovis* as well as elephants naturally infected with *M. tuberculosis*. Several key antigens were selected for use in development of VetTB-StatPak™, a novel lateral flow rapid test for serological diagnosis of TB in multiple animal species. Diagnostic sensitivity was evaluated in various numbers of over 20 different animal species. Depending on the species Chembio suggests the test may be used as a primary screening test or as an ancillary test combined with tuberculin skin testing or other current testing methodologies.

The TB SAS recommends conditional approval of the Chembio VetTB Stat-Pak™, as an ancillary test for tuberculosis in cattle, white-tailed deer, red deer, elk, reindeer and elephants for a period of two years. The TB SAS recommends use of the test in cattle in conjunction with current testing strategies in program herds; including confirmed *M. bovis*-infected herds, in herds working under test and removal protocols rather than depopulation, and in other high risk situations under the direction of the Designated Tuberculosis Epidemiologist (DTE). The TB SAS suggests that USDA consider use of the VetTB Stat-Pak™ in the above deer species in conjunction with current testing strategies in herds testing for accreditation purposes, in confirmed *M. bovis*-infected herds, in surveys of hunter-killed free-ranging deer, and in test and removal strategies conducted in free-ranging deer. It is recommended that USDA provide guidelines to the DTE concerning the use of the VetTB Stat-Pak™ as an ancillary test in both cattle and Cervidae. It is recommended that during the two year period of conditional approval, data be collected on the use of the VetTB Stat-Pak™ in both cattle and deer and annual updates be provided to the TB SAS for review prior to consideration of changes in conditional approval or ancillary test status. The TB SAS strongly encourages producers in the cervid industry to support the evaluation of the VetTB Stat-Pak™ by providing samples for analysis from all species of Cervidae.

The Bovigam™ assay for IFN gamma is being used as a replacement for the CCT in the United States as well as other countries. Methods relating to collection, handling, and shipment of blood samples submitted for analysis by the Bovigam™ assay differ from country to country and state to state. The manufacturer of the assay recommends the assay be started within eight hours of blood collection. Currently in the US samples are shipped to the laboratory and the assay begun within 24 hours of blood collection. Research conducted previously by USDA demonstrated no significant difference in test interpretation resulting from a delay in processing from eight to 24 hours, allowing overnight shipment of samples. Research in Ireland recently demonstrated a significant decrease in test sensitivity resulting from such a delay in processing.

The TB SAS recommends that USDA support and conduct further research to evaluate the effect of delayed processing of blood by the Bovigam™ assay using methods that reflect the manner in which samples are being collected and assayed in the United States.

At the SAS meeting held on November 5, 2005, the following presentations were made:

Use of Bovine Single Nucleotide Polymorphism Markers for Confirmation of Identity and Parentage by Drs. W.W. Laegreid, M.L. Clawson and M.P. Heaton, U.S. Meat Animal Research Center, USDA, ARS, Clay Center, NE

Development of animal identification systems for use in the event of livestock disease outbreaks and public health investigations has recently become a national priority. While various tagging, implant, and/or other technologies will form a sound basis for an identification system, they remain subject to error or fraud. Thus, a means to audit and verify the performance of identification systems will be required. DNA marker technology represents a promising means for confirming the identity and parentage of an animal because DNA is the only informative identification that 1) is integral to most parts of an animal, 2) remains stable throughout the life of the animal, and 3) provides a "code" unique to the animal. Compared with other types of DNA markers, single nucleotide polymorphisms (SNPs) are attractive because they are abundant, genetically stable, and amenable to high-throughput automated analysis. In cattle, the challenge has been to identify a minimal set of SNPs with sufficient power for use in a variety of popular breeds and crossbred populations. We report the development of a set of bovine SNP markers with high informativity in U.S. cattle populations and provide examples of their use in confirmation of identity or parentage in field situations.

Chembio VetTB Stat-Pak, a rapid test for tuberculosis in multiple species by Dr. Konstantin Lyashchenko, Chembio Diagnostic Systems Inc, Medford, NY

A broad range of animal species are susceptible to tuberculosis. This disease has serious zoonotic and regulatory concerns. As the current testing methodologies are inadequate, to improve TB control programs new diagnostic tools that would be simple, rapid, accurate, inexpensive, and host species-independent are urgently needed. We propose a novel serological assay, Rapid Test, which is based on the lateral flow technology to detect specific antibody using colored latex particles. To select immunodominant antigens we used the multi-antigen print immunoassay (MAPIA) and sera from cattle, white-tailed deer, reindeer, elk, and badgers experimentally or naturally infected with *M. bovis* as well as from elephants with culture confirmed TB due to *M. tuberculosis*. The results demonstrated the remarkable animal to animal variations of antibody responses during infection in these species. Several key antigens that were commonly recognized by all of them were selected to develop VetTB Stat-Pak, a novel lateral flow test for TB in multiple host species. This rapid immunoassay is easy to perform and requires no laboratory equipment. It can use serum, plasma or whole blood samples to deliver results within 20 minutes. Diagnostic sensitivity of VetTB Stat-Pak evaluated in over 20 species varied from species to species, ranging from 53% in badgers to 100% in elephants. The specificity ranged from 94% in badgers or reindeer to 98% in elk or white-tailed deer. The proposed assay format is most suitable for TB surveillance in a variety of wildlife and zoo species, especially where instant results are needed.

Diagnosis of *M. bovis* infection in white-tailed deer using IFN-γ RNA by Dr. Tyler Thacker, NADC, ARS, Ames, IA

Interferon-γ protein is synthesized in T cells in response to *M. bovis* infection. IFN-γ messenger RNA serves as the signal between the INF-γ gene in the nucleus and the protein synthetic machinery outside of the nucleus. Both IFN-γ protein and mRNA may be used as indicators of infection in diagnostic tests. To begin to assess the ability of IFN-γ mRNA as a diagnostic tool, 10 white-tailed deer were infected with *M. bovis* and five uninfected deer served as controls. At various time points blood was drawn and stimulated with *M. bovis* PPD or ESAT6:CFP10. IFN-γ RNA was quantified by real-time reverse transcriptase PCR (RT-PCR). Serum was analyzed for the production of IFN-γ protein by Cervigam™. Over the course of infection IFN-γ protein reached a peak at 60 post-infection (p.i.) then declined, whereas, IFN-γ RNA expression peaked at 60 days p.i. then remained high throughout the infection. These data suggested that measuring IFN-γ RNA may be a more sensitive method of detecting infected animals. At 14 days p.i. two out of 10 animals were positive by Cervigam™, while four out of 10 were positive by RT-PCR. By two months post infection (60 days p.i.) both Cervigam™ and RT-PCR were able to detect eight out of the 10 infected animals. However, six months p.i., (168 days) RT-PCR detected nine out of 10 infected animals as positive but Cervigam™ only detected three out of the 10 infected animals. Because IFN-γ RNA expression does not wane during infection as does IFN-γ protein, measurement of IFN-γ RNA may provide a more sensitive assay for the detection of infected white-tailed deer.

Fluorescence Polarization *M. bovis* Assay by Mr. Ed Corrigan and Dr. Mick Jolley, Diachemix LLC, Grays Lake, WI

Serology assays can play an important role in the eradication and control of *Mycobacterium bovis* disease in cattle due to speed, ease, and accuracy. Fluorescence Polarization (FP) technology is an homogenous assay with quick reaction times, no washing steps, stable reagents, no prozoning, and automation opportunities for high

volume processing. The Diachemix MBOVIS FPA is designed for bovine surveillance purposes: slaughterhouse sample testing or whole herd testing. It is specific for the *Mycobacterium tuberculosis* complex, with minimal cross-reaction with other mycobacteria species. The MBOVIS FPA uses a peptide from the MPB70 protein. Serology offers an advantage over cell mediated immune response diagnostic methods: the humoral response occurs later but with higher specificity and is more convenient for surveillance purposes. The MBOVIS FPA is a direct binding primary screening assay which is followed by a confirmatory inhibition assay performed on equivocals and presumed positives. The MBovis FPA distinguishes between *M. bovis* antibody binding and non-specific binding. Specificity is a cumulative 99.8% in eight studies involving more than 5,000 presumed negative bovines. Sensitivity is a cumulative 75% based on seven studies and 147 bovines using lesion histopathological positive, culture positive or PCR positive samples.

A Mexico slaughterhouse study involving 105 *M. bovis* suspects, showed FPA accuracy better than lesion histopathology identification, with 78% of FPA positives confirmed by PCR methods. Two herd surveillance studies were performed involving 10 herds in Mexico and South Africa. The MBOVIS FPA had perfect specificity for three negative herds, and identified six of seven infected farms having *M. bovis* infection. FPA assays, using other antigens, are also being developed for use with cervids, bison, and badgers.

Update on serological detection of *Mycobacterium tuberculosis* infection in Asian elephants by R. Scott Larsen, DVM, MS, Dipl ACZM,[1,*] Meagan Kay, BS, [2] Joni Triantis, MS, [3] and M.D. Salman, BVMS, PhD, Dipl ACVPM, F.A.C.E. [3]

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Tuberculosis has become an important disease in captive elephants, particularly Asian elephants (*Elephas maximus*). Diagnosing tuberculosis in elephants has been problematic as many tests have inadequate sensitivity or specificity. A multiple-antigen enzyme-linked immunosorbent assay (ELISA) was previously investigated for detecting infection in Asian elephants and African elephants (*Loxodonta africana*); this test had excellent sensitivity and specificity, but needed further evaluation. Modifications to the multiple-antigen ELISA panel have since been made. Valuable antigens were retained, other antigens were removed, and new ones were added. This modified ELISA was re-evaluated, using serum from 68 Asian elephants. Sixteen had *M. tuberculosis*-positive trunk cultures, while 52 were either culture negative at necropsy or had a history of negative trunk cultures and no contact with infected elephants. Seven elephants were evaluated over time. The test was 100% (95% CI; 95-100%) specific and 94% (95% CI; 79-100%) sensitive using two of the six antigens (*M. bovis* strain AN5 culture filtrate and *M. tuberculosis* early secretory antigenic target 6). “Effectively-treated” elephants had decreasing seroreactivity, but those that were culture-positive post-treatment were more consistently seroreactive. Although “effectively-treated” elephants had declining seroreactivity, they still usually had higher values than animals that had never been infected. Serology continues to show great promise in detecting tuberculosis in elephants, often detecting infection months to years sooner than trunk wash culture. Advances in techniques may soon make serology even more practical. While serology should not replace trunk wash culture, it is a useful adjunct for early detection of infection in elephants and for monitoring treatment.

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Direction of the Cooperative State–Federal Tuberculosis Eradication Program

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The cooperative State–Federal–Industry effort to eradicate bovine tuberculosis (TB) from the United States has made significant progress toward eradication, dramatically decreasing the prevalence of TB in livestock (5 percent reactor rate in 1917 compared to 0.02 percent reactor rate in 1991). However, the goal of eradication has been elusive despite renewed efforts. Because of the success, many livestock producers and members of the general public no longer consider TB in livestock to be a threat to their economic or physical well-being as they did before the implementation of control measures. As is the case with any disease eradication program, the last vestiges of infection are often the most difficult and least cost effective to abolish. Since the vast majority of the benefits to society are obtained by effectively controlling the disease, the political will to invest in complete disease eradication also may be elusive.

In addition, the recommendations from the 1994 National Research Council (NRC) evaluation and the policies included in strategic plans for the TB program have never been fully implemented. Important goals, such as optimal slaughter plant surveillance levels, are yet to be achieved, and the threat of disease from Mexican imports has yet to be adequately addressed. This lack of full implementation has contributed to limitations in the success of the current TB program. Further, other challenges, such as infected wildlife and large affected dairies and calf raising facilities, hinder eradication. Despite these challenges, eradication of bovine TB remains biologically and economically feasible and helps in protecting human health and international trade of livestock. Therefore, Veterinary Services (VS) is recommending a more aggressive approach to TB eradication—a progressive program—that would enhance many elements of the current TB program.

Progressive Program

Previous recommendations, such as those from the 1994 NRC report on the Evaluation of the Bovine Tuberculosis Eradication Program and subsequent program reviews, would be implemented along with further enhancements to improve the program's chances for successfully eradicating TB from the United States. The table below compares the elements of the current program with the recommended progressive program:

Comparison of current program to progressive program

Category	Current program	Progressive program
Border	Test at border	Quarantine feedlots
Surveillance	Slaughter, herd test	Slaughter, interstate testing adult dairy cattle
Testing	Current protocol	Current protocol
Wildlife	Decrease population density	Increase surveillance, owner responsibility
Vaccination	Allowed when available	Wildlife
Depopulation (cattle)	Test & slaughter or depopulation	Optional
Regionalization	Allowed	Limited

Border protection

A key component of the progressive program requires that feeder animals from lower status states/zones in Mexico be placed into quarantine feedlots after entering the United States and only be moved from quarantine feedlots directly to slaughter. This would increase cost to importers of feeder animals (a small segment of the industry) but would significantly benefit the TB eradication efforts since this procedure is identified as a key element in transmitting TB within the United States and needs to be addressed successfully to ensure eradication of TB. In addition, more stringent testing and movement control criteria would be implemented for livestock entering the United States as rodeo animals. Currently, the movement of animals that meet testing requirements for importation from Mexico is not carefully monitored once these animals enter the United States. This presents a significant risk for TB exposure to the domestic cattle population.

Slaughter surveillance

One hundred percent slaughter surveillance would also be a key component of the program.

Interstate testing requirements

Interstate testing requirements for all adult dairy cattle, regardless of state or herd status, would be implemented.

Wildlife
Surveillance of wildlife for the presence of TB would be increased, especially in areas where TB in wildlife is known or believed to exist. In areas where TB is identified in wildlife, increased owner responsibility would be emphasized, especially providing barriers to prevent contact between cattle and wildlife and keeping wildlife species from contacting animal feeders and feed.

The progressive program should result in a net marginal benefit to wildlife, as incidence of infection among wildlife hosts would occur, eventually removing this reservoir from the United States. Reduced wildlife infections should also translate into increasing marginal benefits across time for wildlife interests, including hunting and wildlife viewing. Nevertheless, wildlife interests will face increasing costs to achieve these reductions. These costs are not included in VS annual appropriations and would likely involve increased surveillance of wildlife populations in known reservoirs and additional surveillance to identify new reservoirs of *Mycobacterium bovis*. This program would also cost livestock producers more time and money, as it would require additional producer responsibility to ensure physical biosecurity barriers are erected and maintained in endemic areas.

Vaccination
Once a safe and effective vaccine is approved, vaccination of wildlife should be considered to remove this TB reservoir as a potential source of TB in cattle. In addition, it is also possible that a vaccination strategy should be considered for high risk cattle once a safe and effective vaccine is available. Increased funding for research would also be needed to develop and validate new diagnostic tests and vaccines. Current research has identified potential promising tests and vaccines. Without higher levels of research funding, these tools may not be ready for decades. Implementing a vaccination strategy would mitigate spread to cattle and aid in the removal of this reservoir as a potential source of TB in cattle.

Depopulation and regionalization
Depopulation of affected herds would continue to be an available option to herd owners and would be encouraged for several reasons, as discussed below, allowing states to retain their TB status if depopulation and epidemiological investigations were conducted in a timely manner. States may opt to request regionalization, but such requests would only be granted when based upon sound epidemiological criteria and logic.

The depopulation strategy included in this program, while more costly to VS than a test and slaughter program, has significantly lower indirect costs to the cattle industry and increased animal health benefits when compared to a test and slaughter program. In a choice between depopulating a 3,000 head dairy herd or using test and slaughter to manage TB in the herd, depopulation is the preferred strategy. The total cost of depopulation is $8 million less than the cost of test and slaughter. Total costs include VS expenditures and cattle industry losses resulting from a drop in state TB status from Accredited Free to Modified Accredited Advanced.

Depopulation is the preferred strategy for managing TB because the test and slaughter option affects thousands of cattle movements. Owners of uninfected herds in the state pay for TB testing of a portion of all interstate cattle movements. Because depopulation for TB affected herds is not mandatory, a single producer can choose to follow a test and slaughter management option that imposes millions of dollars of losses upon a state's cattle industry.

VS developed a model to determine the total costs of depopulation compared to test and slaughter. The model reflects a state with a large cattle population, where most of the cattle are beef animals. The results of this analysis suggest that total cost of depopulation is less than total cost of test and slaughter. Based on this analysis, the depopulation option has a lower total cost than the test and slaughter option. The depopulation option does have a higher cost for VS, but the test and slaughter option passes significant costs to producers when state TB status drops from Accredited Free to Modified Accredited Advanced. The net difference between depopulation and test and slaughter is $7,949,721. Given the parameters of this model, the choice to test and slaughter an affected herd results in a net loss of almost $8 million.

Moreover, quarantine does not equate with 100 percent containment of disease. Herds under quarantine still pose some small degree of risk for exposure and spread of infection to other herds. A depopulation strategy advances the program goal of disease eradication faster than any other option. In support of this point, the NRC concluded in 1994 that "although a test and slaughter program may be capable of achieving an eradication goal, a depopulation program may offer considerable savings in the total number of animals sacrificed, in time, and in money." They also concluded that "given the limitations of the disease detection process at the individual animal

level, there may be no reasonable alternative to depopulation to ensure that the last vestiges of disease have been removed" (National Research Council, Committee on Bovine Tuberculosis Board on Agriculture, Livestock Disease Eradication. Evaluation of the Cooperative State–Federal Bovine Tuberculosis Eradication Program, National Academy Press, Washington, D.C., 1994).

Timeline

Once all the elements of the progressive program are implemented, we estimate eradication could be accomplished within the following 10 years. Such an assumption is based on the current knowledge of natural history and epidemiology of *M. bovis* infection in the United States. Delays in implementing this program could result in dramatic changes in the U.S. situation. For example, the white-tailed deer wildlife reservoir is now limited to a small area of Michigan. If this reservoir expands, another reservoir develops, or the biology and epidemiology of the disease within the United States changes, then the progressive program may not achieve eradication within 10 years of the program's full implementation.