2009

Economic Impact of Bovine Tuberculosis on Minnesota's Cattle and Beef Sector

Brian Buhr
bbuhr@umn.edu

Kyle McKeever

Kenji Adachi

Economic Impact of Bovine Tuberculosis on Minnesota's Cattle and Beef Sector

Brian Buhr*, Kyle McKeever and Kenji Adachi[†]

July 2009

*Professor and Head, [†]Graduate research assistants, University of Minnesota, Department of Applied Economics, 231 Classroom Office Building, 1994 Buford Avenue, St. Paul, MN 55108-6040.

Corresponding Author: Brian Buhr, 612-625-0231 or bbuhr@umn.edu

Funding for this project is provided by the University of Minnesota Extension Rapid Agricultural Response Fund.

Introduction

In September 2005, the first case of bovine tuberculosis (BTB) in 34 years was discovered in Minnesota and led to a loss of Minnesota's bovine TB free status. In October 2007 and January and February 2008, four additional cattle herds and deer infected with BTB were discovered in Roseau and Beltrami counties and Minnesota's BTB status was changed from "modified accredited advanced" to "modified accredited" in April 2008. Each of these designations has increased regulatory requirements (and costs) for animal testing, record keeping, eradication practices, slaughtering and shipments of cattle within state and across state lines.

As a result of the large anticipated costs of a Minnesota statewide designation of modified accredited status for bovine tuberculosis, Minnesota applied to the USDA Animal and Plant Health Inspection Service (APHIS) for split state status. The split state status would allow the northwest part of Minnesota where the BTB cases were found to remain classified as modified accredited for BTB and the rest of the state to be classified as modified accredited advanced, a less restrictive and less costly designation. The State of Minnesota completed a management plan and APHIS completed their risk assessment study (USDA, APHIS, June 24, 2008) informed by Minnesota's management plan. In October 2008, Minnesota was granted "split state status" (Federal Register, Oct. 10, 2008). Parts of four counties (Beltrami, Roseau, Marshall and Lake of the Woods) approximate the region in Minnesota now designated as modified accredited (MA). The rest of the state is now designated as modified accredited advanced (MAA). This designation will greatly reduce the cost impacts of BTB on the Minnesota cattle industry. The APHIS report included the expected costs to the state of

managing and eradicating bovine TB, but did not evaluate what the expected cost of bovine TB would be to the beef industry itself.

This report quantifies the economic impacts of BTB on Minnesota beef cattle producers and related industries. Representative cattle production systems are simulated and the costs of BTB response are incorporated into these systems using a partial budgeting approach. A partial equilibrium market model is then used to simulate the impact of these cost increases on the production of cattle and the prices received by the beef industry in Minnesota. This model also allows for changing assumptions regarding price discounts cattle producers might face given the BTB positive status. Finally, an input-output analysis using IMPLAN is used to evaluate the total economic impacts on related sectors and employment will for the counties affected and Minnesota.

Many other sectors are affected and not modeled here. The dairy industry is not included, other than to evaluate direct testing costs because this would require a completely separate modeling framework to be developed. Wildlife and associated recreation such as hunting are affected because deer and to a lesser extent other species can also be infected by bovine tuberculosis. Again, this requires another complete context of analysis, but is importantly linked to beef cattle because of the disease transmission linkage. Costs also extend to government agencies and taxpayers as they respond and assist with disease management and eradication plans.

The economic modeling of diseases is dependent on underlying assumptions regarding the transmission of the disease itself, policy and regulatory responses to the disease and the behavior of buyers and sellers of cattle. However, the modeling framework developed is useful for analyzing changes that occur depending on assumptions made about the disease, response by

policy makers and actions that can be taken to reduce its impact and help inform those decisions. Once constructed it is particularly useful for relaxing or changing assumptions and estimating alternative scenarios. Every effort was made to account for factors affecting the economic impact of BTB, but ultimately the best interpretation of the results is to consider the 'what-if' questions that arise on a comparative 'what-if' basis rather than as absolute levels.

Overview of Minnesota's Cattle and Beef Industry

According to the 2007 Census of Agriculture conducted by the National Agricultural Statistics Service (NASS), Minnesota's beef cattle industry's value of production is ranked fifth among agricultural commodities in Minnesota. The beef sector accounts for 8.5 percent of all farm receipts in Minnesota. Minnesota's cattle and calf industry ranks tenth nationally in value of cattle and calves sold. Figure 1 shows the trend of beef cattle inventories in Minnesota.

The cow-calf sector is the largest sector, while the production of fed cattle for slaughter (cattle on feed) is a smaller component of the industry. The majority of cow calf operations are small operations and do not likely account for a large share of the operator's total income. The Agricultural Census reports 14,400 total beef cow-calf operations in Minnesota. Of those, 12,300 operations (85 percent) have between one and 49 head of cattle. These 85 percent of operations account for 49 percent of total inventories so the remaining 15 percent of operations account for 51 percent of beef cow inventories. Only 5 percent of operations, with between 100 and 500 head of beef cows, account for 26 percent of inventories.

Figure 2 shows that beef herds are broadly dispersed suggesting that economic impacts will also be dispersed statewide. This also illustrates the strong incentive to obtain split-state status so that herds distant from the region of infected cattle are not unduly affected.

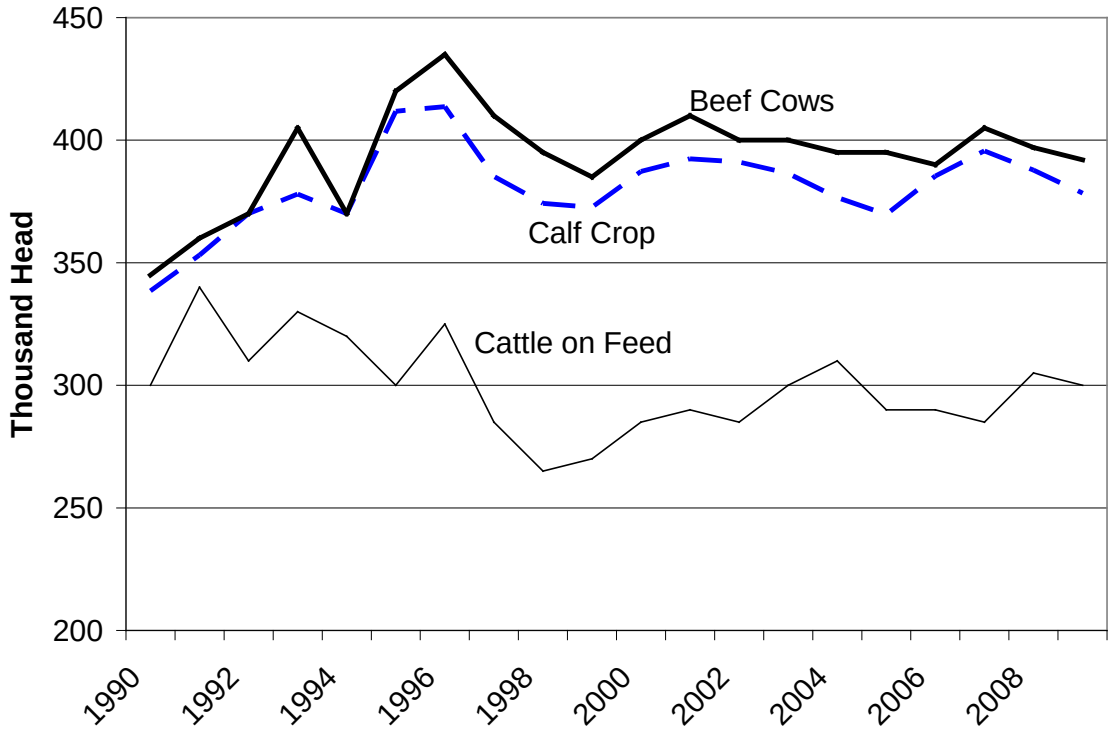

Figure 1. Minnesota Cattle Inventories (1,000 head), 1990-2009.

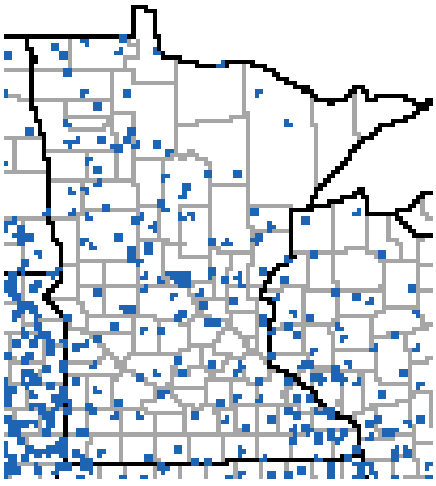

Figure 2. Distribution of Beef Cow Operations in Minnesota. Source: *USDA, NASS, 2007 Census of Agriculture.*

Table 1 provides a summary of the ranking of counties and cattle inventories by type of cattle production. This further illustrates the distribution of cattle, but also will be required to estimate the economic impacts that depend on the location of positive tuberculosis cases as well as federal classifications of bovine TB status.

The economic value of cattle is shown in Figure 3. Under normal operating conditions, the industry generates total gross income of $1.1 billion per year and has an inventory value of about $2.6 billion. For comparison, Minnesota's state gross domestic product was $263 billion in 2008[1].

Table 1. County Inventories of Cattle Ranked by Respective Size, 2008

Rank by All Cattle	All Cattle	Rank By Beef Cows	Beef Cows	Rank by Other Cattle	Other Cattle	Cattle on Feed	Cattle on Feed
0 State Total	2,400,000	State Total	397,000	State Total	1,540,000	State Total	305,000
0 Split State Zone	74,000	Split State Zone	29,700	Split State Zone	41,900	Split State Zone	700
1 **Stearns**	**189,500**	1 **Fillmore**	**18,200**	1 **Stearns**	**113,700**	1 **Nobles**	**21,800**
2 **Otter Tail**	**97,000**	2 **Otter Tail**	**17,200**	2 **Otter Tail**	**55,800**	2 **Rock**	**17,700**
3 **Morrison**	**92,500**	3 **Morrison**	**14,300**	3 **Morrison**	**51,700**	3 **Lyon**	**15,500**
4 **Winona**	**84,500**	4 **Cass**	**12,900**	4 **Winona**	**50,900**	4 **Cottonwood**	**12,500**
5 **Fillmore**	**78,000**	5 **Todd**	**12,800**	5 **Fillmore**	**47,300**	5 **Redwood**	**12,100**
6 **Goodhue**	**67,000**	6 **Beltrami**	**11,500**	6 **Nobles**	**47,000**	6 **Murray**	**11,700**
7 **Wabasha**	**64,000**	7 **Clearwater**	**11,300**	7 **Rock**	**45,600**	7 **Stearns**	**11,400**
8 **Todd**	**63,000**	8 **Stearns**	**9,800**	8 **Goodhue**	**41,900**	8 **Dakota**	**8,300**
9 **Rock**	**55,500**	9 **Roseau**	**9,600**	9 **Lyon**	**41,500**	9 **Brown**	**7,300**
10 **Nobles**	**55,000**	10 **Houston**	**9,100**	10 **Wabasha**	**37,400**	10 **Stevens**	**6,800**
28 Beltrami	28,500	19 Marshall	6,800	37 Beltrami	16,200	57 Beltrami	700
40 Roseau	24,500	67 Lake of the Woods	1,800	45 Roseau	13,300		
53 Marshall	17,000			59 Marshall	10,200		
82 Lake of the Woods	4,000			83 Lake of the Woods	2,200		

Source: USDA, National Agricultural Statistics Service

Shade indicates counties classified as Modified Accredited in split state status

Bold indicates top 10 county for class of cattle

[1] Source: Bureau of Economic Analysis, U.S. Department of Commerce. *GDP by State*. Accessed at: http://www.bea.gov/newsreleases/regional/gdp_state/2009/xls/gsp0609.xls> on June 30, 2009.

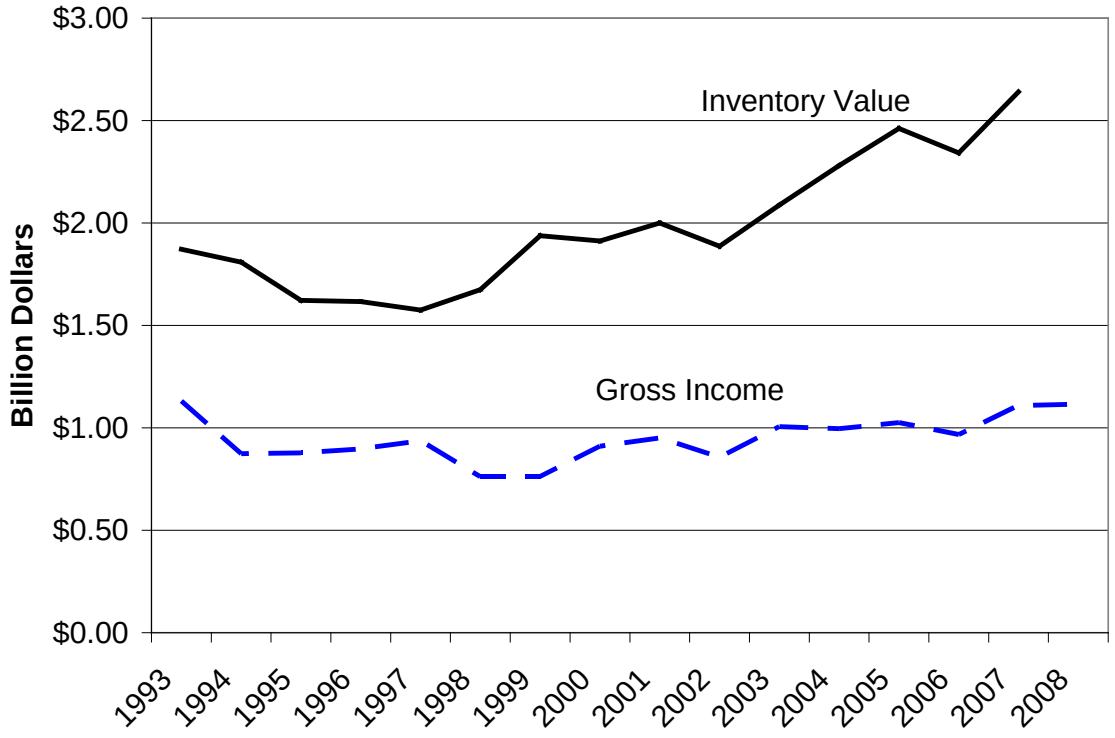

Figure 3. Value and Gross Income of Cattle in Minnesota. Source: *USDA, NASS. Beef Production, Disposition and Income.*

Direct Economic Costs of Bovine Tuberculosis

The direct economic cost of bovine TB on producers will depend on the status of the herd (infected, suspect or susceptible) as well as the location of the herd (in an modified accredited advanced zone, a modified accredited zone or a BAH management zone) and include:

- Costs to herds infected: testing costs, depopulation and repopulation costs, lost revenue due to possible lower prices for cattle sold, potential loss of feed inventories which may need to be destroyed, increased identification, tracking and reporting costs, carcass disposal costs, facility cleanup and disinfection costs.
- Costs to susceptible but uninfected herds: record keeping costs, testing costs, potential loss of value (either real or risk premiums), increased costs of feed storage including fencing costs to keep disease carriers such as deer away from susceptible cattle, potential

need to spay heifers and castrate bulls (for purebred which may otherwise be in-tact males).

- Costs to other supply chain participants: This may include impacts on auction markets and slaughter plants, feedlots, breeding and equipment supply companies, trucking and brokerage firms.
- Costs of susceptible and infected wildlife populations: Direct costs may be due to loss of value of recreational opportunities but also the loss in value of meat products obtained from hunting deer. Costs will also include population reduction and management strategies to eradicate the disease from the natural population.
- Associated public costs: The government is directly involved in monitoring and testing, managing public health (both human and animal) strategies to eliminate Bovine TB and costs of compensating or indemnifying producers for costs they incur which is a cost shift from the private sector to the public sector in the interest of overall public gains from eradication of bovine TB. Minnesota BAH has estimated a budget of $20,371,620 over ten years to manage and eradicate bovine TB (APHIS, *Risk Assessment*, 2008). The Minnesota legislature has appropriated $2,644,000 to BAH in 2008 and 2009 for these programs and allocated $3.35 million for herd buyout and fencing assistance programs. None of these costs include the direct costs of BTB to cattle producers.

Specific cost impacts depend on the status of the herd. For example a herd with a positive TB test is required to depopulate regardless of its location relative to TB positive herds (USDA, APHIS 91-45-011). However, a susceptible herd has different responses depending on its accredited status determined by regional classification. Table 2 gives a summary of the actions that must be taken depending on the herd and state status in regard to BTB.

Quantifying the Costs of Bovine Tuberculosis

To begin the modeling process the direct economic impacts on various cattle systems are evaluated using a partial budgeting approach. Partial budgeting is often used to estimate the profit or loss from a change in an activity (Boehlje and Eidman, 1984). For simplicity, the cattle production system is broken into two components: the cow-calf sector and the feedlot sector.

The cow-calf sector is the beginning production stage of the beef production process. Cows are bred and produce approximately one calf per year. The calves are kept with the cows for approximately 5 months at which point they are weaned from the cow. The calves may be retained by the cow-calf producer and fed or 'backgrounded', or sold to a backgrounder or directly to a feedlot.

The feedlot sector feeds out the feeder cattle from the cow-calf or backgrounding sector to market weights at which time they're harvested for beef products. Assuming feeder cattle remain in the same feedlot until slaughter, there is little impact on the feedlot sector as the animals do not need to be tested. The only cost would be in the case of an infected animal in which case the feedlot would be required to depopulate its herd.

Downstream sectors such as beef processing and retailing will also be affected to the extent that volumes or product quality change, but for purposes here they are not included because the changes are an indirect consequence of the disease.

Table 2. Impact Scenarios Dependent on Herd Infection Status and Accredited Status

Status Herd/Region	Infected	Susceptible Herd
Accredited-Free States or Zone (FREE)	• Depopulate herd • No movement except to approved slaughter • Disinfect feeders, pens, facilities, etc. • No Repopulation for 30 days	• No restrictions or testing
Modified Accredited Advanced States (MAA) (Status of herds outside Modified Accredited region.	• Depopulate herd • No movement except to approved slaughter • Disinfect feeders, pens, facilities, etc. • No Repopulation for 30 days	• No Restrictions Feeder Cattle • Breeding Cattle TB test within 60 days of movement • No test for cattle moving directly to slaughter
Modified Accredited (MA) States or Zones (current status in roughly Beltrami, Lake of the Woods, Roseau and Marshall Counties)	• Depopulate herd • No movement except to approved slaughter • Disinfect feeders, pens, facilities, etc. • No Repopulation for 30 days	• Feeder cattle – Negative TB test within 60 days of shipment. Sexually intact animals only moved to approved feedlots. • Breeding Cattle – negative whole herd TB test within 12 months of shipment and negative individual animal TB test within 60 days
Management Zone (MZ) – Minnesota BAH requirement	• Depopulate herd	• TB whole herd test every 12 months for all animals older than 12 months • Movement within Minnesota must have Board approved movement certificate • Must be identified by official ear tag • Animals must test negative for TB within 60 days of movement outside control zone unless < 2months old or for slaughter • Risk assessment conducted • Maintenance of herd records

Baseline Partial Budgets

Baseline partial budgets for a representative cow-calf operation (Table 3), a representative calf backgrounding operation (Table 4), and a representative feedlot operation (Table 5) are the basis for evaluating the cost impacts of BTB. A representative budget is for an 'average' operation. Differences in operations may exist due to management, operation size or types of production systems (pasture versus drylot versus confinement, etc).

The partial budgets are from farms participating in the Minnesota Farm Business Management programs reported by the University of Minnesota's Center for Farm Financial Management FINBIN database of farm enterprise records (http://www.finbin.umn.edu/). Data is for the northwest region of Minnesota consistent with the current situation, except in cases where the sample size was too small for the northwest Minnesota region (e.g., feedlot data). Data was collected for 1998 through 2007, but the data reported and used is only for the 2007 year. This is because of the recent dramatic change in prices of feed and livestock and the assumption that the next few years' prices will be more in line with these more recent prices than with prices from earlier years.

In the cattle finishing budget used, feeder cattle are placed at 644 pounds, approximately equal to the average marketing weights from cow-calf operations. If the entire state remained modified accredited then all cattle would need to be tested prior to movement and independent backgrounding would add one additional movement, potentially doubling testing costs. This would reduce incentives for backgrounding given that the returns to backgrounding (about $20 per head) would be nearly eliminated by costs of testing and record keeping. Hence, backgrounding is not included as a separate segment from cow-calf in the analysis.

Table 3. Partial Budget Beef Cow-Calf Production, Northwest Minnesota Region[a]

Returns per cow					
Cows Culled	1175 lb	@	$ 50.00	/100 lb	$ 94.00
Steers Sold	602 lb	@	$ 104.85	/100 lb	$ 234.76
Heifers Sold	602 lb	@	$ 104.85	/100 lb	$ 234.76
Gross Returns Per Cow					**$ 563.53**
Direct Costs Per Cow					
Corn Silage			$ 41.63		
Hay, Alfalfa, Grass & Other			$ 167.74		
Pasture			$ 37.44		
Hay, Grass, Organic			$ 8.55		
Complete Ration			$ 11.48		
Protein Vit Minerals			$ 16.68		
Other feed stuffs			$ 16.66		
Total Feed Costs					**$ 300.18**
Breeding fees			$ 1.32		
Veterinary			$ 23.83		
Supplies			$ 9.56		
Fuel & oil			$ 26.81		
Repairs			$ 22.63		
Livestock leases			$ 0.03		
Hauling and trucking			$ 5.00		
Marketing			$ 4.13		
Bedding			$ 2.26		
Operating interest			$ 6.14		
Other Direct Costs				$ 101.71	
Total Direct Costs				$ 401.89	
Return over Direct Costs					**$ 161.64**
Overhead Costs per Cow					
Hired labor			$ 5.48		
Machinery leases			$ 3.62		
RE & pers. property taxes			$ 3.77		
Farm insurance			$ 10.57		
Utilities			$ 11.71		
Dues & professional fees			$ 3.43		
Interest			$ 23.01		
Mach & bldg depreciation			$ 25.69		
Miscellaneous			$ 9.43		
Total overhead expenses				$ 96.71	
Total dir & ovhd expenses				$ 498.60	
Net return					**$ 64.93**

Source: University of Minnesota, Center for Farm Financial Management, FINBIN Farm Financial Database. <http://www.finbin.umn.edu/default.aspx>

[a] Includes counties: Becker, Beltrami, Clay, Clearwater, Kittson, Mahnomen, Norman Otter Tail, Polk Red Lake, Roseau

Table 4. Partial Budget Backgrounding Calves, Northwest Minnesota Region[a]

Returns per calf					
Calves Purchased	548 lb	@	$ 108.71 /100 lb		$ 595.73
Calves Sold	777 lb	@	$ 99.92 /100 lb		$ 758.79
Gross Returns Per Calf					**$ 163.06**
Direct Costs Per Calf					
Corn and Corn Silage			$ 30.50		
Hay, Alfalfa, Grass & Other			$ 28.28		
Pasture			$ 2.52		
Small Grains (barley, wheat, oats)			$ 2.48		
Complete Ration			$ 8.12		
Protein Vit Minerals			$ 8.80		
Other feed stuffs (creep, beets)			$ 12.04		
Total Feed Costs					**$ 92.74**
Contract Production			$ -		
Veterinary			$ 7.94		
Supplies			$ 2.65		
Fuel & oil			$ 7.00		
Repairs			$ 4.77		
Livestock leases			$ -		
Hauling and trucking			$ 2.13		
Marketing			$ 3.71		
Bedding			$ 1.61		
Operating interest			$ 9.09		
Other Direct Costs				$ 38.90	
Total Direct Costs				$ 131.64	
Return over Direct Costs					**$ 31.42**
Overhead Costs per Calf					
Machinery leases			$ 0.03		
RE & pers. property taxes			$ 0.21		
Farm insurance			$ 1.03		
Utilities			$ 2.66		
Dues & professional fees			$ 1.15		
Interest			$ 3.73		
Mach & bldg depreciation			$ 1.55		
Miscellaneous			$ 1.27		
Total overhead expenses				$ 11.63	
Total dir & ovhd expenses				$ 143.27	
Net return					**$ 19.79**

Source: University of Minnesota, Center for Farm Financial Management, FINBIN Farm Financial Database. <http://www.finbin.umn.edu/default.aspx>

[a] Includes counties: Becker, Beltrami, Clay, Clearwater, Kittson, Mahnomen, Norman Otter Tail, Polk Red Lake, Roseau

Table 5. Partial Budget Finishing Calves, Minnesota[a]

Returns per finished calf					
Yearling Purchased	644 lb	@	$ 112.26	/100 lb	$ 722.95
Finished Cattle Sold	1294 lb	@	$ 89.41	/100 lb	$ 1,146.27
Gross Returns Per Calf					**$ 423.32**
Direct Costs Per Finished Calf					
Corn and Corn Silage			$ 194.60		
Hay, Alfalfa, Grass & Other			$ 22.30		
Corn Distillers and Gluten			$ 13.20		
Complete Ration			$ 8.62		
Protein Vit Minerals			$ 43.72		
Other feed stuffs			$ 2.84		
Total Feed Costs					**$ 285.28**
Contract Production			$ -		
Veterinary			$ 10.94		
Supplies			$ 4.80		
Fuel & oil			$ 10.38		
Repairs			$ 17.57		
Custom Hire and labor			$ 7.74		
Machinery leases			-		
Hauling and trucking			$ 8.70		
Marketing			$ 5.42		
Bedding			$ 3.07		
Operating interest			$ 23.71		
Other Direct Costs				$ 92.33	
Total Direct Costs				$ 377.61	
Return over Direct Costs					**$ 45.71**
Overhead Costs					
Custom Hire and labor			$ 9.81		
Machinery leases			$ 1.03		
RE & pers. property taxes			$ 1.85		
Farm insurance			$ 4.68		
Utilities			$ 7.58		
Interest			$ 12.22		
Mach & bldg depreciation			$ 21.23		
Miscellaneous			$ 6.04		
Total overhead expenses				$ 64.44	
Total dir & ovhd expenses				$ 442.05	
Net return					**$ (18.73)**

Source: University of Minnesota, Center for Farm Financial Management, FINBIN Farm Financial Database. <http://www.finbin.umn.edu/default.aspx>

[a] Includes counties: Becker, Beltrami, Clay, Clearwater, Kittson, Mahnomen, Norman Otter Tail, Polk Red Lake, Roseau

Area Dependent Cost Impacts of Bovine TB

Cost impacts depend on several different states of the operation. These states can generally be defined by the type of operation (cow-calf v feedlot), the infection status of the operation (infected, susceptible or latent), or location of the operation relative to regulations (BAH management zone v MA zone v MAA zone v accredited free zone).

Modified Accredited Advanced

This is currently the status of Minnesota outside the northwest modified accredited region (Figure 4). In this region cattle do not need to be tested unless they are shipped out of state. Cattle can be shipped out of state if they are moved directly to an approved slaughter establishment, if they are steers or spayed heifers moved to a feedlot and identified by premises of origin, or if they have been tested negative within 60 days prior to movement. In most cases the only requirement will be identification of animals so record keeping may be the only additional costs and this would apply only to animals shipped out of state which is a small share of animals (USDA, APHIS 91-45-011).

Modified Accredited Areas

With the successful application for split-state status, only a small area in the northwest corner of Minnesota is currently classified as modified accredited (Figure 4). The only circumstance that would require *no* testing would be a herd with no out-shipments of cows or calves. This would happen if the cow-calf producer retained ownership of all calves through slaughter and then only transported cattle directly to an approved slaughter plant. In this case no additional costs from TB would be incurred because no cattle are shipped to other operations. It is highly unlikely this circumstance occurs, so it is ignored in the calculations of aggregate loses

for this region. However, it does offer an avenue for a cow-calf operation to reduce cost impacts if they have the possibility of retained ownership to slaughter.

It is assumed that nearly all cow-calf operations will have some out shipments of cattle, either cows for breeding purposes or feeder calves to other locations. To move cattle from a herd a whole herd caudal fold test (CFT) must be completed within 12 months (USDA, APHIS) for all animals 12 months of age or older and for all animals greater than 2 months of age that are to be moved within 60 days (USDA, APHIS 91-45-011).

Management Zone, Susceptible

The management zone is defined by the Minnesota Board of Animal Health as shown in Figure 5 as of April 8, 2008. This zone includes cattle herds that have had animals test positive for Bovine TB (shown as dots in zone) and also deer that have tested positive.

All herds on premises in this area must be tested regardless of cattle movement (BAH, "Control of Tuberculosis in Management Area", April 15, 2008). All animals must be tested, as in the case of modified accredited herds every 12 months, and all animals to be moved must have a negative TB test within 60 days of movement. All animals moving from the area must have an animal movement certificate approved by BAH and be identified with an official ear tag.

All herds kept in the TB management area must conduct a risk assessment and recommendations to limit interaction between cattle and wild cervidae must be implemented. This includes fencing and feeding requirements to be discussed later.

Finally, producers in the management zone must keep herd records for ten years that include an inventory of animals, the date of acquisition and source of each animal not born into the herd, the date of disposal or destination of any animal removed from the herd, all individual identification numbers associated with each animal and contact information for all owners.

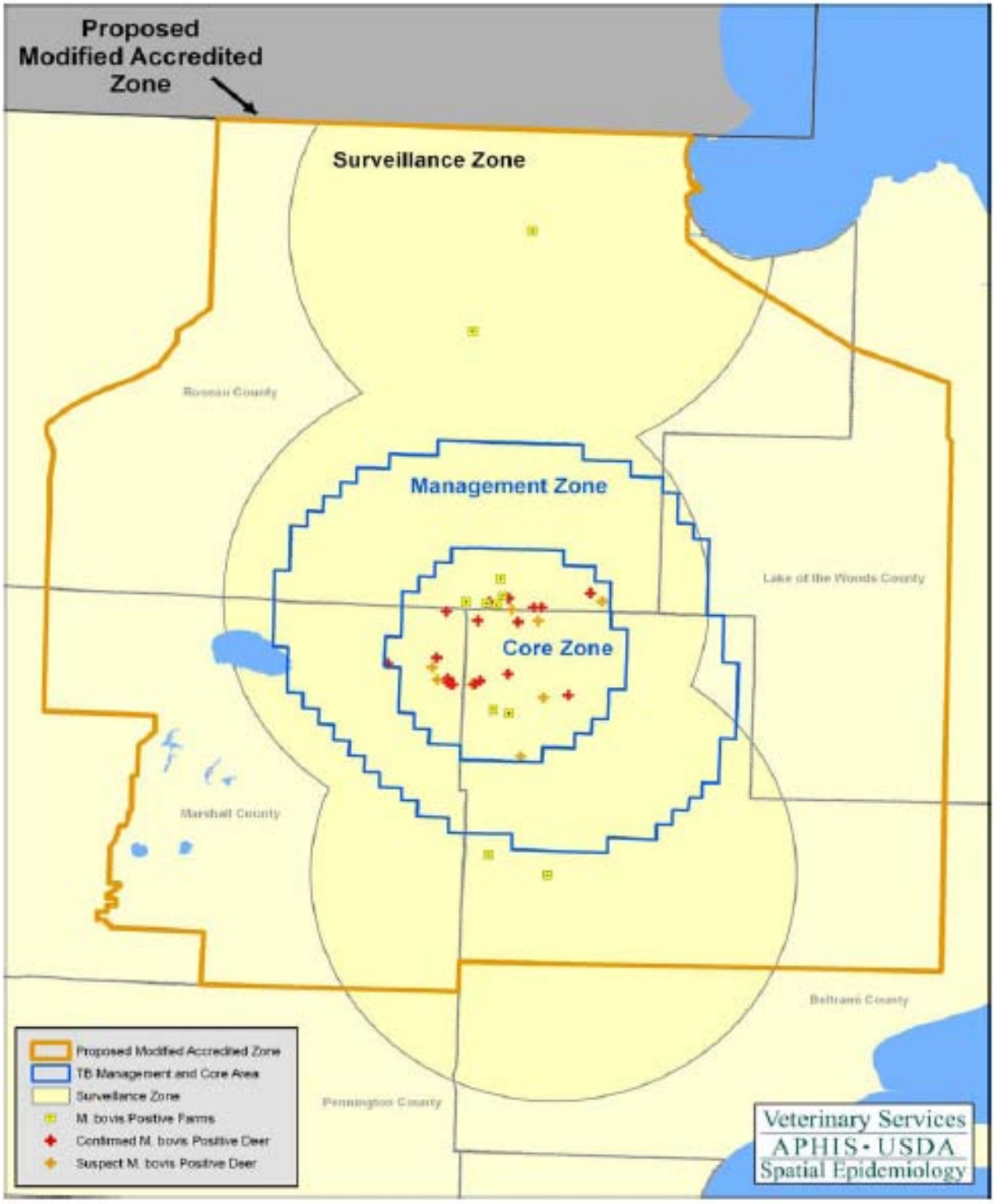

Figure 4. Modified accredited zone shown in bold outer lines, BAH management zone shown in inner circle.

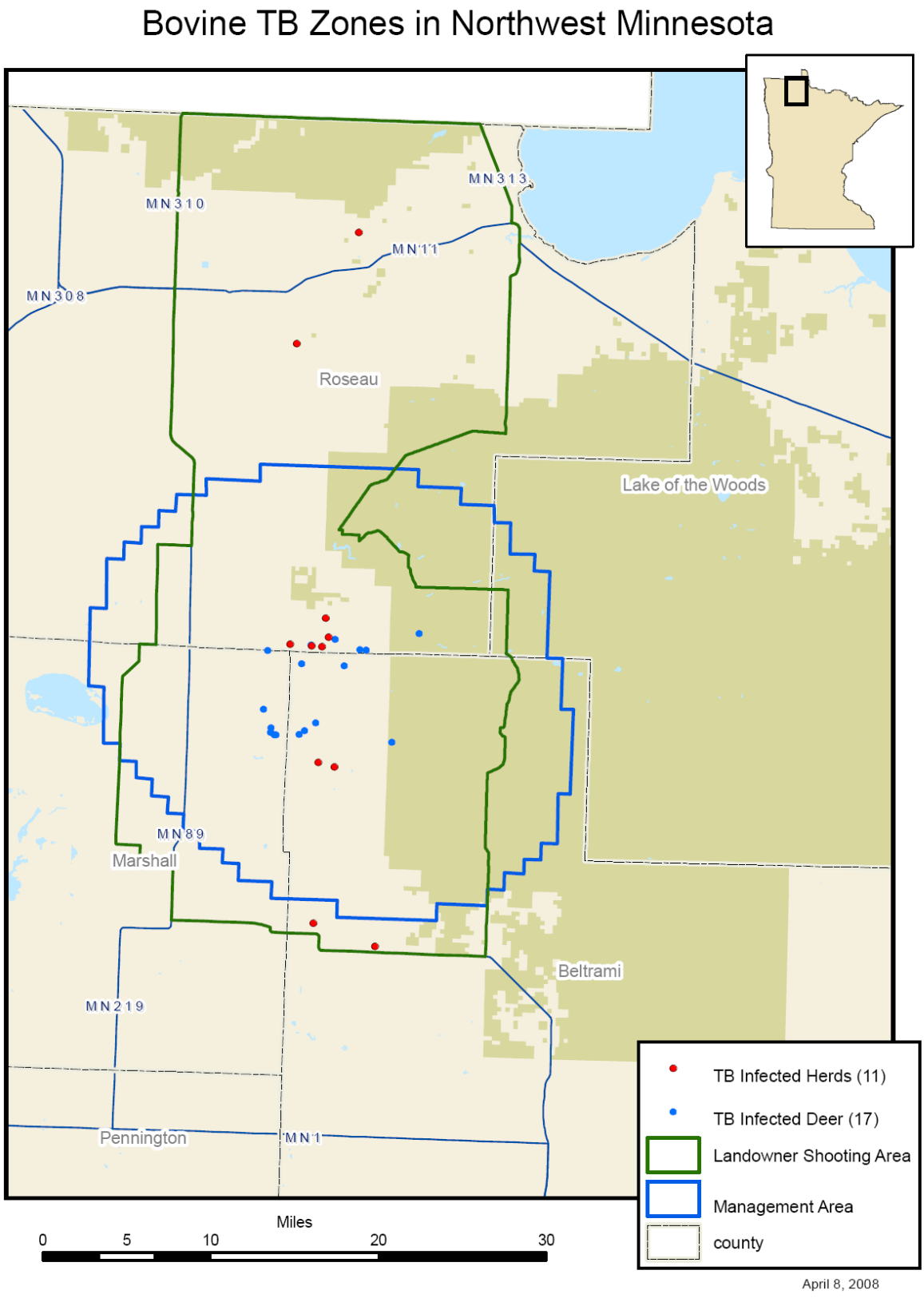

Figure 5. Management Zone, April 8, 2008. Cattle subject to testing and risk assessment.

Management Zone, Infected

An actual infected animal is the most serious possible direct costs scenario for a beef herd. In this case the cattle herd is depopulated and tested and the cattle herd may not be replaced until cleared by the Bureau of Animal Health. In this case the producer may gain value for the cattle slaughtered if they are free from TB upon inspection. However, they will incur losses from business interruption for the period they do not raise cattle and will likely incur higher costs if they choose to repopulate their herd, less any indemnity payments made by state herd buyout programs.

Operational Dependent Cost Impacts of Bovine TB

Clearly an infected herd will incur the costs of lost animals as the herd is depopulated. However, given testing requirements and other restrictions, herds that are susceptible but not infected can also face cost increases due to management changes. Major potential costs include: testing costs, record keeping costs, and preventative costs of fencing. Table 6 shows the associated costs per head in the column labeled "value per head". Other columns are used to aggregate the per head costs to the expected number of cattle affected by each cost and will be discussed later. As described above not all farms will incur these costs. The costs will depend on the type of operation and in some cases the location of the operations as well.

Modified accredited status requires caudal fold testing. To determine the cost of testing, a small sample telephone survey of certified veterinarians was conducted in August 2008. A list of veterinarians approved to perform caudal fold testing was provided by BAH. Of fifty veterinarians contacted, 20 responded. The average cost per head is estimated to be $10.19/head.

On a state wide basis it is conceivable that the demand for the testing may exceed the supply of veterinarians available for testing. As of July 24, 2008, BAH reported that 522

veterinarians were certified to test for bovine TB in Minnesota. There are 2.4 million head of cattle in Minnesota. Assuming an annual test, that means each veterinarian would be required to test approximately 4,600 head of cattle per year or about 20 cattle per work day assuming a 240 work day year. We also asked veterinarians how much time it would take them to complete the tests and how much time they would have available to complete the tests in light of their other responsibilities. The implication of this is that the cost may increase if there is an increase in cases requiring all cattle to be tested, but this response is not included in the analysis.

The results of the survey for this study compare favorably to a survey of veterinarians conducted in Michigan (Wolf and Ferris, 2000). Surveying 461 veterinarians in Michigan, they found test costs ranged from $11.33 per head to $5.77 per head. The difference depended on the TB zone the veterinarians were located, with those in infected zones charging $10 - $11 per head, while those in TB free zones charged between six and seven dollars per head. The surveyors, provided no information of why the differences existed, although the sample sizes were much smaller for the infected herds.

A second cost item is the cost of fencing to keep cervidae out of feed storage areas and to avoid direct contact with cattle. Brad Peterson of BAH provided estimates of the costs of fencing given BAH's direct experience working with producers who are putting up fencing. The estimated average cost per linear foot is approximately $15 and the average installation will be about 1,500 - 2,000 linear feet for a total of about $30,000 per farm. The state of Minnesota has offered a 90% cost share up to $75,000 of fencing. Therefore, it's expected that few producers would go over about $83,000 in total costs which would be about 5,500 linear feet of fencing which would sufficient to accomplish containment on most farms.

Table 6. Estimated Total Costs As Modified Accredited Status

	Value Per head			Beef Cows	Dairy Cows	Feeder Cattle	MA Total Cattle	MA Beef Cows	MA Dairy Cows	MA Cattle On Feed	MA Other Cattle	Total Aggregate Estimated Cost	Aggregate Beef Industry Cost
Annual Cattle Tested Assumptions				**405,000**	**455,000**	**840,000**	**74,000**	**29,700**	**2,400**	**700**	**41,900**		
Cost Assumptions						387,770							
Caudal Fold Test						beef calves							
Test Cost	$ 7.13												
Travel and Flat	$ 0.23												
Chute Fee	$ 0.42												
Animals per hour	$ 51.00												
Average Test Time	$ 1.96												
Average Wage/hour	$ 15.00												
Number workers	$ 3.00												
On Farm Labor Costs	$ 0.88												
Average Head per visit	$ 100.00												
Single Visit Caudal Fold Test	$ 8.66												
Two Visit Costs Total	**$ 10.19**		**Aggregate**	**$ 4,128,856**	**$ 4,638,591**	**$ 8,563,553**	**$ 754,408**	**$ 302,783**	**$ 24,467**	**$ 7,136**	**$ 427,158**	$ 18,846,953	**$ 9,573,542**
						$ 3,953,201					$ 737,077		
Fencing Costs													
Fencing Materials	$3-8	/linear foot			26 farms with fencing								
Labor Costs	$4.5 - 12	/linear foot											
Average Fencing	1,500 - 5,500	linear feet											
Average Fencing Costs	$ 15.00	/linear foot	**Aggregate**	**$ 1,365,000**								$ 1,365,000	**$ 1,365,000**
Annual Repair	$ 25.00	lifespan	**Aggregate**	**$ 54,600**								$ 54,600	**$ 54,600**
Tagging and Record Keeping Costs													
RFID Tag Costs	$ 2.00	/tag	**Aggregate**	**$ 1,976,400**	**$ 2,220,400**	**$ 4,099,200**	**$ 361,120**	**$ 144,936**	**$ 11,712**	**$ 3,416**	**$ 204,472**	$ 9,021,656	**$ 4,582,662**
	$ 20.00	applicator				**$ 1,892,318**							
Sparks/CBW Estimates of Cool Costs													
Cow Calf Sector	$ 4.88	/head											
Feedlot Sector	$ 4.75	/head											
USDA upper bound for cattle	$ 10.00	/head											
Spaying Heifer Costs			**Aggregate**	**na**	**na**	**16,800**	**na**	**na**	**na**	**na**	**838**		
Spaying Costs	$ 6.00												
Travel and Flat	$ 0.23												
Antibiotics Costs	$ 3.00												
Animals per hour	$ 21.00												
Average Test Time	$ 2.38												
Average Wage/hour	$ 15.00												
Number workers	$ 3.00												
On Farm Labor Costs	$ 1.07												
Average Head per visit	$ 50.00												
Death loss (1%)	$ 5.00												
Total Spay Cost	**$ 15.30**		**Aggregate**	**$ -**	**$ -**	**$ 257,064**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 12,823**	$ 269,887	**$ 124,688**
Depopulation Costs													**$ 147,512.00**
Industry Wide Total Cost							**$ 1,189,528**	**$ 477,419**	**$ 38,579**	**$ 11,252**	**$ 3,249,979**	**$ 29,558,095**	**$ 15,848,004**
Baseline Direct Costs of Production ($/hd)				$ 401.89	$ 2,203.64	$ 377.61							
Estimated Aggregate Annual Cost of Production				$162,765,450.00	$1,002,656,200	$ 317,192,400		146,542,888.80 = beef calf portion				$ 1,482,614,050	$ 309,308,339
Share of Cost of Production Increase Due to BTB for EDM Simulation											**1.1%**	**2.0%**	**5.1%**

Fencing is required only in the BTB management zone. Therefore only 72 herds are currently eligible for the fencing payment from the state and so it's unlikely others will include it at this time. As of January 30, 2009, 46 herds in the management zone have signed up for the buyout, suggesting that a maximum of around 26 herds will put up fencing. Therefore, the total cost of fencing to the cattle industry is about 26 herds times 3,500 feet (between 5,500 max and 1,500) times $15 per linear foot for a total of $1,365,000. This is a relatively minor cost as long as no additional herds are added to the management zone.

A third broadly applicable cost is the cost of record keeping. Assuming bovine TB testing is done the animal will have a tag number associated with the test on the Federal Reporting Form (Figure 6). Acceptable tags include: USDA silver metal ear tags, brucellosis vaccination ear tags, Dairy Herd Improvement Association (DHIA) ear tags, or Electronic (RFID) ear tags.

A sample of required record keeping for animals within the modified accredited zone is shown in Figure 7 and must be maintained for 10 years. The main cost of this simple form of record keeping is the time required to record the information. However, computerized systems may require additional hardware and software maintenance. Another issue is the question of the *change* in record keeping required by Bovine TB status. For example, most breeding livestock will be tagged and recorded for monitoring ongoing production practices such as health treatments, breeding information, calving rates, and so on. In this case, the records are likely to be sufficient for compliance with BTB regulations and would require no additional costs for the producers.

The costs of record keeping are difficult to determine as it depends on the flow of animals, animal numbers and type of equipment. Rather than derive new estimates based on

assumptions, estimates obtained from research related to mandatory Country of Origin Labeling (COOL) regulations are used. These estimates have the advantage of having been vetted by USDA in consideration of the cost estimates of implementing COOL. There is a good deal of controversy over these cost estimates based on the issues described here, but USDA settled on the figure of $10/head for record keeping costs related to COOL as a reasonable estimate and this will be used for the this report.

A final potential management cost of Bovine TB is the cost of heifer spaying. The testing requirements in a modified accredited zone are the same so there is no testing cost advantage to spaying a heifer. However, heifers which are not spayed can only move to 'approved' feedlots, thus limiting their marketability beyond what might occur from regular concerns regarding TB transmission. The concern is that intact heifers may be moved out of an uncontrolled feedlot for further breeding, while a spayed heifer only has a single use as a slaughter animal.

Heifers can be spayed relatively easily with limited anesthesia. Veterinary respondents to the testing cost survey also responded that heifer spaying is estimated to be about $10/head. However, an offsetting benefit may be that heifers that are spayed and then implanted have a 10-22 percent increase in daily gain during the grow-finish phase of production. Depending on feed costs, this can be substantial but is estimated to be $17 per head. This begs the question of why heifers aren't spayed as an ongoing practice. There may be two explanations: one is that it may not be possible to capture this increased productivity if the heifer is sold to a feedlot rather than retained, and the other is that there is an option value for intact heifers to be used as breeding stock with a higher value than for finishing heifers.

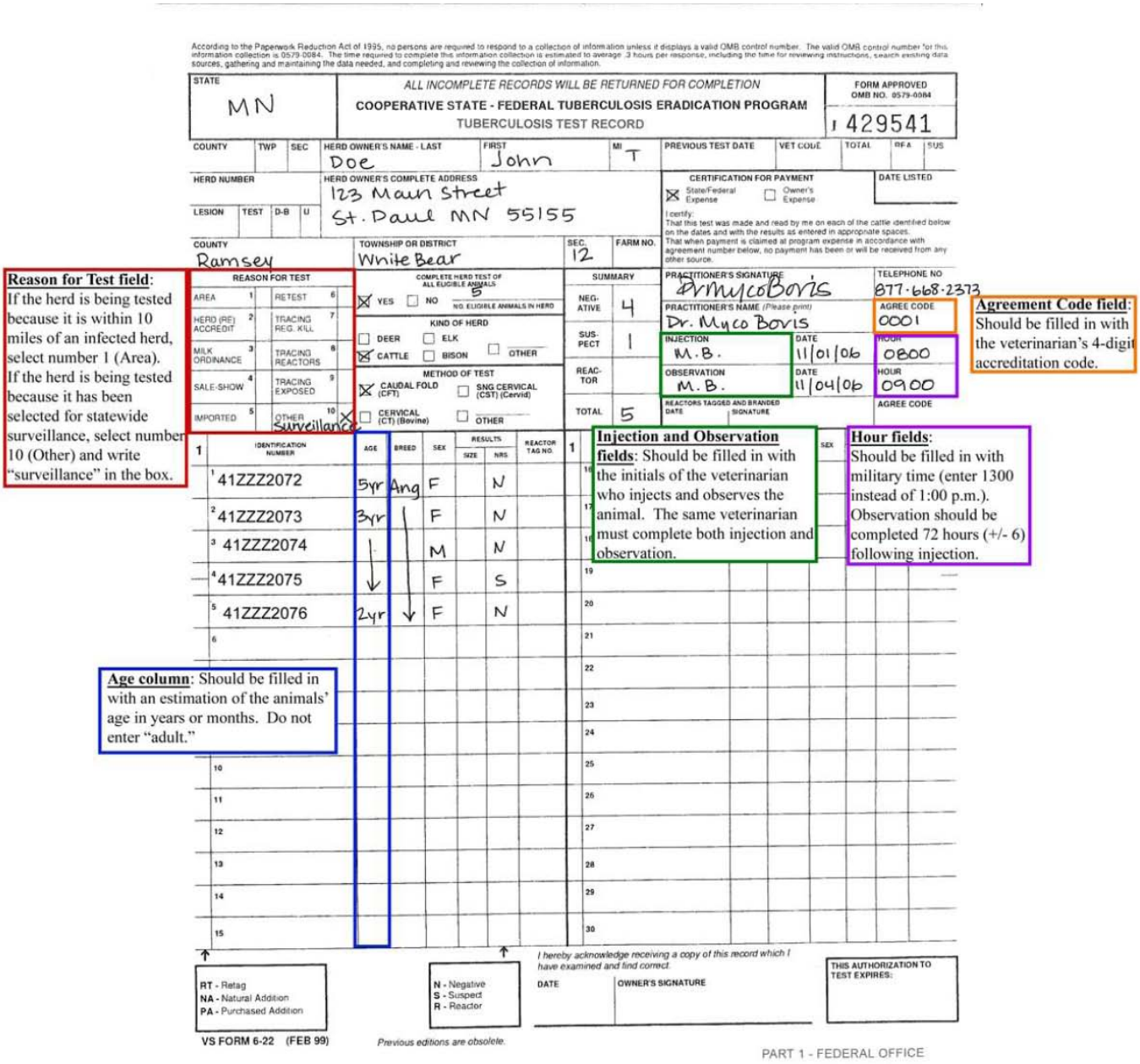

Figure 6. Sample of Bovine TB Federal Reporting Form.

Cattle Inventory Worksheet

Management/ Herd ID	Date of Birth	Description/ Breed	Sex	Official ID (Tags, tattoos, electronic ID)	Date Entered Herd	Arrival From (Name, Address, Phone)	Date Left Herd	Departing To (Name, Address, Phone)

Please note: The above records must be maintained for at least 10 years.

Sheet Number: _____

Figure 7. Sample of record keeping required for animal movement with Bovine TB testing.

Another dimension of the costs is the duration of the increased costs until the bovine TB status is upgraded. According to the Congressional Federal Register (Oct. 2008), from the last infected herd it will take a minimum of 2 years to reach modified accredited advanced status and it will take an additional five years of zero tuberculosis in cattle to reach accredited free status as a state or zone. This is because Minnesota is moving from a status of modified accredited to modified advanced accredited so Minnesota would not be eligible to move into accredited free until after 2 years of MAA. Therefore, in a best case, assuming no new TB cases, the state would incur the costs of testing all herds annually (2 tests) under MA status in northwest Minnesota and then for five years have restrictions on testing breeding animals only, reducing costs over that period.

Cost of Cow-Calf Herd Depopulation

As indicated earlier, herd depopulation is mandatory if an infected animal is found within the herd. However, herd depopulation may also be voluntary. The following analysis applies to the costs of herd depopulation. It is useful for assessing total economic impacts but also as a potential template for a producer to evaluate the individual costs of depopulation.

Whether mandatory or voluntary, depopulation will result in some income for the producer. In some cases (in the control zone or infected) the producer will receive indemnity payments from the government. If voluntary, the producer would receive at least salvage value for the animals unless they must be destroyed.

There are three depopulation-repopulation periods: 1) the depopulation period, 2) the disinfection and quarantine period and 3) the repopulation period. The depopulation period is the initial period and the producer will receive any payments for culls or indemnities during this period. During depopulation the following events occur:

- Cattle are either sold and slaughtered or destroyed and buried.
- Indemnity income or salvage value is paid.
- Income and indemnity payments depend on type of animals in inventory at the time of depopulation.

With mandatory depopulation the producer will not likely be able to manage timing to their economic advantage. However, according to the USDA, UMR (page 17, section J.2), "feeder calves under 12 months of age that have passed a CFT test within 60 days may be permitted to move intrastate to an approved feedlot". This may mitigate some loses although it would be expected that these cattle may face severe price discounts. If a producer is voluntarily depopulating, it would be possible, for example, to wait until calves are sold, avoid breeding costs and perhaps even condition cows for slaughter if timing permits. This can substantially impact individual payoffs but is difficult to analyze in a general fashion.

Disinfection and quarantine is assumed to begin immediately following depopulation. Bovine TB is a difficult bacterium to kill and requires specific disinfectants to eliminate (Grooms and Mecklem) and there will be expense associated with this. In addition, manure, soils and feedstuffs may need to be removed or destroyed imposing additional costs as well as the lost value of those items. According to the UMR, a depopulated premises may be repopulated after 30 days (UMR page 16, Section F). However, MN H.F. 4075 Section 1 states that a cattle owner who participates in the Minnesota state buyout in the management zone may not repopulate the site until the area receives a bovine TB free status and the Minnesota Board of animal health authorizes cattle to be located in the zone. This may entail a much longer period of quarantine on animal stocking. During the quarantine and depopulated period, the producer will lose the net returns that would have been possible if the operation had not depopulated.

In the final stage, the herd is repopulated. Animals are brought into the farm to reconstitute the herd. This may occur gradually or all at once depending on the availability and types of livestock. In the management zone for TB it would be necessary to test these animals on an ongoing basis as any other situations. In cow calf operations, the costs of repopulation occur prior to the revenues generated by the new herd. For example, light weight replacement heifers may be purchased in which case it may be two years before revenue from calf sales is received. Alternatively, bred cows may be purchased in which case revenues may begin as quickly as 6 -10 months after repopulation. The cost of the replacement animals varies depending on their age, pregnancy status and quality. Figure 8, shows a representative sequence of depopulation and repopulation and the associated costs.

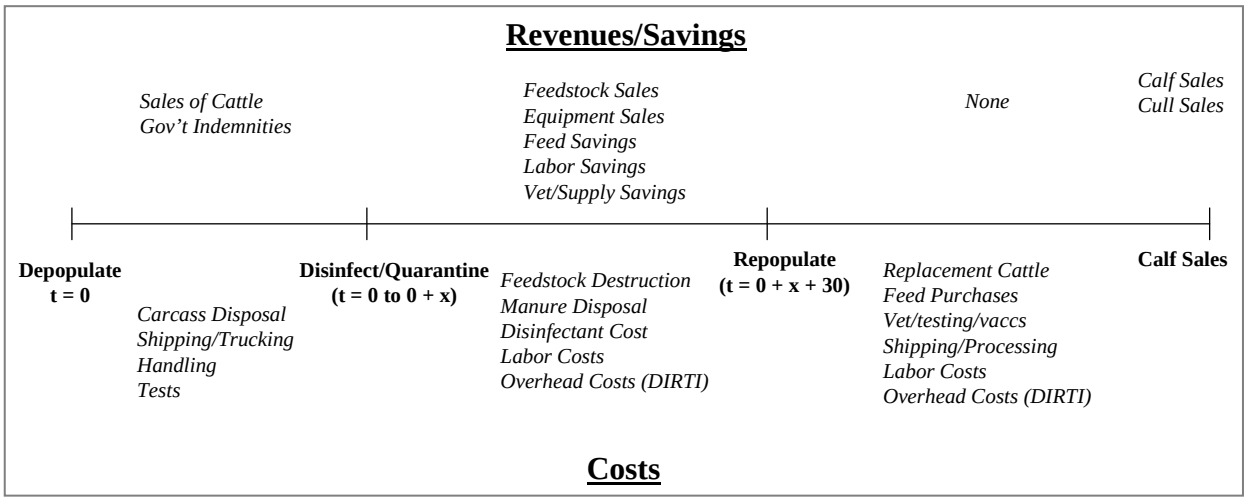

Figure 8. Depopulation – repopulation time sequence.

Tables 7.1 - 7.4 provide estimates of the impacts of cow-calf depopulation and repopulation. Estimates were also completed for feedlots but these are not included. The first impact is the liquidation of the herd and associated costs (Table 7.1). In the case of bovine TB,

only infected cattle need to be destroyed so cattle not infected may be shipped directly to slaughter. Since the cattle are slaughtered, they can be inspected at the plant for TB and would not incur testing costs. The key question is the type of discounts that might apply. It would be expected that any condemned carcasses would not be paid for by the slaughter plant and that the plant may further discount other cattle for any potential handling requirements or just concern about the association with potentially infected cattle. For now, there is no assumed discount. Depopulation creates a first period positive cash flow, but later reduces income because of the herd loss.

Table 7.2 shows the business interruption loss during the period that no cattle are being produced. The average farm with a herd of 118 head is anticipated to lose approximately $22,135 per year during this period. Table 7.3 shows the costs of repopulating the herd. The assumption is made that repopulation is made with bred replacement heifers. Alternatives include bred cows and unbred heifers or cows.

Altering these assumptions will change the costs for this period and also affect the time to which revenue is received for the calf crop produced by these replacement heifers or cows. This large negative net cash flow largely offsets the first year's positive cash flow. Because of this time dimension to losses the net loss is discounted to a present value and then annualized to a per head basis as shown in Table 7.4. The positive total net present value of $25,133 under depopulation shows that an average herd under these assumptions would potentially re-enter the beef industry if given the opportunity. However, if the producer cannot repopulate for an additional 2.5 years, the net present becomes negative and they should not enter production again. This demonstrates the importance that timely eradication of BTB will have on herd decisions.

Table 7.1 Economic Value of Depopulation: Depopulation Stage

Revenue From Cow Depopulation			
Cow Beginning Inventory (head)	118		
Cows Infected (head)	2		
Average Cow Weight (lbs)	1175		
Average Cow Price ($/cwt)	$ 50.00		
State Payment to Producer ($/head)	$ 500.00		
Revenue from Cow Depopulation		**$**	**127,150**
Revenue From Calf Depopulation			
Length of time calves in Inventory (months)	7		
Calf Inventory (head)[a]	47		
Average Calf Weight (lbs)	320.00		
Average Calf Price ($/cwt)	$ 140.37		
Revenue Calf Depopulation		**$**	**21,111.65**
Revenue From Bull Depopulation			
Bull Inventory (head)	5		
Bull Price ($/cwt)	$ 50.00		
Bull Weight (lbs)	1700		
Bull Salvage Receipts		**$**	**3,400.00**
Feed Sales[b]		**$**	**9,921.82**
Total expected Receipts from Depopulation		**$**	**161,583.5**
Expected Indemnity Payment	500	**$**	**86,000.00**
Direct Costs of Depopulation			
Trucking and Shipping ($/head)	5		
Animal Disposal Costs - burial, incineration ($/hd)	$70		
Total Costs of Depopulation		**$**	**850.00**
Net Revenue Depopulation Stage		**$**	**160,733.5**

[a]Assume annual average of calves on hand at final market weight.

[b]Assumes feed is not contaminated and has proper biosecurity. 1/2 annual usage

Table 7.2 Economic Value of Depopulation: Disinfection and Cleanup

Business Interruption Loss ($/year) (recurring)			
Lost Revenue ($/head/year)	$ 563.53		
Fixed and Overhead Costs ($/head/year)	$ 96.71		
Total Direct Cost Savings ($/head/year)	$ 401.89		
Business Interruption Loses ($/head/year)	$ 258.35		
Costs of Disnifection and Quarantine			
Disinfection (total costs) non-recurring	$500		
State Annual Payment until MN-TB Free	$ 75.00		
Net Revenue During Business Interruption		**$**	**(22,135.24)**

[a]Assume annual average of calves on hand at final market weight.

[b]Assumes feed is not contaminated and has proper biosecurity. 1/2 annual usage

Table 7.3 Economic Value of Depopulation: Repopulation Stage

Replacement Heifer Costs Bred at 12 Months			
Heifer Beginning Inventory	118		
Replacement Heifer Price ($/head)	$ 1,000.00		
Total Cost of Bred Heifers		**$**	**118,000.00**
Other Costs Prior to Calving at 21 months			
Direct Costs	$ 401.89		
Overhead Costs	$ 96.71		
Total first year costs		**$**	**176,834.80**
Net Revenue Repopulation First Year		**$**	**(176,834.80)**

After period 3 return to normal returns of $64.93/hd/year (Table 3).

To place the cost of depopulation into a common context with other costs such as annual testing or record keeping, it is necessary to annualize the results shown at the bottom of Table 7.4. This conversion shows that the current annual cost of depopulation of the 6,800 head removed is $147,512. This number obviously can easily increase if there are additional incidences beyond herds that have already depopulated.

Table 7.4 Time Value Depopulation/Repopulation

Item	Value	
Initial Depopl ulation Net Cash Flow	$	160,733.47
Number of Years of Business Interruption		5
Business Interruption Losses per year	$	(22,135.24)
Number of Years of Repopulation		1
Net Cash Flow of Repopulation	$	(176,834.80)
Net Cash Flow After Repopulation	$	7,681.16
Discount Rate		7%
Depopulation Net Present Value	$	160,733.47
Business Interruption Net Present Value	$	(90,758.84)
Repopulation Net Present Value	$	(117,832.49)
Present Value of Normalized Operations	$	72,991.80
Present Value Without Depopulation or Disease	$	117,285.49
Total Net Present Value Under Depopulation	$	25,133.94
Annualized Loss of Bovine TB in MA Zone From Depopulation		
Net Present Value Loss in Northern Minnesota ($/head)	$	(780.95)
Annualized NPV loss in Northern MN	$	(130.16)
Annualized Number of Cattle Disposed		1,133.33
Total Economic Loss	$	(885,071)
Number of Years Before Normalization		6
Annualized Loss		**(147,512)**

Other Costs: State Restrictions on Imports of Minnesota Cattle

The direct costs are relatively contained in their impact. However, the greatest risk exposure from TB may be the potential for reduced demand for cattle in a modified accredited zone. This reduced demand likely depends on the type of cattle, breeding versus slaughter mainly because the value of a breeding animal is greater and the potential loss to other cattle exposed (see depopulation/repopulation) are higher than for slaughter animals which have a limited lifespan and lower depopulation-repopulation costs.

The other factors affecting this value are the level of retained ownership and the location of finishing. If cattle are retained in a vertically integrated operation, the potential demand impact for cattle (assuming processors don't distinguish cattle) should hypothetically be zero as there is no demand beyond the slaughter stage. For animals that are sold even within the MA zone, there may be demand considerations given that the risks of infecting a susceptible herd may be greater and buyers in the zone may prefer to import cattle from outside the zone which are from TB free areas.

It is expected that the demand for cattle from the MA zone will be lower in other TB free states due to the risk of importing infected cattle – and also because states are able to place their own restrictions on cattle in addition to USDA federal restrictions on testing and movement. As of August 5, 2004, North Dakota, South Dakota and Wisconsin have implemented specific requirements for importing cattle from Minnesota. The key issue is that these restrictions apply to the state, regardless of the application for split state status and so are certain to impact imports of all cattle from Minnesota. Secondly, they generally have greater requirements for age of testing and date of last test as well as quarantine requirements once cattle from Minnesota enter their states. For more information on their requirements visit http://www.mntbfree.com

It is too early in the change of Minnesota's TB status to Modified Accredited to determine if there will be an impact on prices of cattle from Minnesota. Prior research in Michigan by Wolf and Ferris suggests that there is little impact on prices of cattle. However, there are two key caveats to that research: (1) the research was done in within a short time of their move to modified accredited status and more importantly (2) Michigan is not a significant exporter of cattle to other states so that the impacts may have been more limited than for Minnesota.

Government Cost Mitigation

Federal and state governments are heavily involved in issues related to animal health and disease. The primary economic reason is that the control of the spread of a disease and its eradication is dependent on collective actions beyond what any individual can do. Therefore, programs which compensate producers for costs incurred to prevent disease or eliminate it from their private herds are warranted. Government compensation provides incentives to adopt practices (e.g., fencing or testing) that reduce spread but also offset some of the private costs a producer otherwise faces. However, the costs are shifted from the producer sector to the consumer/taxpayer sector so the losses to society are the same.

Producers testing for tuberculosis are eligible for a tax credit for up to ½ the costs of testing, including veterinarian fees, labor expenses and any rental equipment. This assists with the incentives to test all cattle to help identify potential infected animals but also to improve the ability to ship cattle out of state. In May 2008, Minnesota passed a bill including a herd buyout offer for animals within the Bovine Tuberculosis Management Zone (MN H.F. 4075). The state will pay $500 per animal for animals more than one year old that are slaughtered, for animals less than one year old that are slaughtered or moved out of the BTB management zone, and if the livestock owner does not allow livestock on the site until there is board approval. The state also will provide a $75 per head annual payment for each animal slaughtered until the BTB management zone receives a BTB free status.

The bill also allows for producers who keep cattle on feed within the Bovine TB management zone to implement fencing that would prevent deer or other hooved animals from interacting with cattle or feed in the bovine TB management zone. The state of Minnesota will share 90 percent of the cost of fencing up to a total of $75,000.

The state legislature has appropriated funds as part of the control of BTB. They appropriated $472,000 for fiscal year 2008 and $2,172,000 in fiscal year 2009 to the Board of Animal Health for monitoring, testing education and other purposes related to the control and eradication of Bovine TB. They also allocated $3.35 million to BAH for the herd cattle buyouts, annual payments and fencing cost share programs. This at least suggests a temporary cap on total payments.

Aggregating Direct Costs of Bovine TB

The number of cattle impacted will affect the total economic impacts in Minnesota. The number of cattle affected depends on trade patterns because of out-of-state shipping restrictions and the applicable regulatory requirements based on the cattle location and status of the location (management area vs. modified accredited zone vs. split state zones). Most obviously it also depends on the type of cattle (breeding v feeder) and their intended usage.

As of January 1, 2008 there are a total of 2.4 million cattle in Minnesota. Of those 463 thousand are milk cows and 397 thousand are beef cows. Table 8 provides the values of cattle inventories by class in Minnesota since 1995 as well as the share of inventories relative to the U.S. share of inventories in 1998. The beef sector in Minnesota accounts for approximately 1.2 percent of the U.S. beef market as measured by beef cows. The dairy sector meanwhile accounts for a larger share relative to the U.S. market.

Table 1 shows the county rankings and inventories by type of cattle in Minnesota. The split zone counties (Beltrami, Roseau, Marshall and Lake of the Woods) are shaded in for all types of cattle. Beltrami and Roseau enter the top 10 counties for beef cows. However, in terms of total cattle, the highest ranking county is 28th by Beltrami. Relative to the state of Minnesota,

the proposed split state zone counties represent only 3% of total cattle. However, they represent about 7.5% of the states beef cow inventories.

From the previous discussion, the disposition or movement of animals is critical to evaluating costs because it is movement that triggers testing and inter-state trade is also a key trigger for costs and impacts. Of the cattle marketed in Minnesota, 85 percent were reported to the Minnesota Beef Council which tracks marketings by type of market (Table 9).

Table 10 shows the disposition of cattle exports from Minnesota to other states. About 300,000 head of cattle are shipped out of state each year and would be required to be tested.

Table 8. Annual Cattle Inventories in Minnesota (thousand head)

Year	Cows That Calved - Beef	Cows That Calved - Milk	Cows & Heifers That Calved	Bulls 500+ Lbs	Heifers 500+ Lbs - Beef Repl	Heifers 500+ Lbs - Milk Repl	Heifers 500+ Lbs - Other	Steers 500+ Lbs	Calves Less Than 500 Lbs	Cattle & Calves - All	Minnestoa Calf Crop	Estimated Beef Calf Crop	Estimated Dairy Calf Crop
1995	420	600	1020	35	90	305	195	495	560	2700	1000	412	588
1996	435	585	1020	40	95	310	195	510	580	2750	970	414	556
1997	410	580	990	40	90	320	180	470	560	2650	930	385	545
1998	395	555	950	35	85	290	165	455	520	2500	900	374	526
1999	385	545	930	35	90	290	170	455	530	2500	900	373	527
2000	400	540	940	40	100	290	180	460	540	2550	910	387	523
2001	410	520	930	40	100	290	180	470	540	2550	890	392	498
2002	400	500	900	35	100	290	170	465	540	2500	880	391	489
2003	400	480	880	35	100	295	180	460	500	2450	850	386	464
2004	395	465	860	35	100	280	190	450	485	2400	820	377	443
2005	395	460	855	40	95	270	190	440	510	2400	800	370	430
2006	390	445	835	35	95	265	170	450	500	2350	830	388	442
2007	405	455	860	35	100	270	175	460	520	2420	840	396	444
2008	397	463	860	40	100	270	175	445	510	2400	840	388	452
2008 MN pct. of US Inventories	1.22%	5.02%	2.06%	1.81%	1.76%	6.06%	1.77%	2.57%	3.32%	2.48%			

Source: USDA, National Agricultural Statistics Service

Table 11 shows that between 2004 and 2007, total slaughter in Minnesota ranged from 644 to 765.8 thousand head per year. Four percent of total slaughter occurred in state inspected plants. Of the federally inspected slaughter, 74 percent was accounted for by cows, bulls, and stags. Ninety-nine percent of Minnesota's slaughter was accounted for by the three largest

packers. Thirty-eight percent of total slaughter in Minnesota was from Minnesota cattle. This figure was 28 percent for cows, bulls, and stags; and 55 percent for steers and heifers.[2]

Table 6 is a tableau that shows the per unit costs of impacts aggregated by the number of cattle affected. The base assumption is that the entire state is designated as modified accredited which was the case prior to the approval of split state status. The top row within the table includes the number of cattle affected by the requirements. For beef cows, it is assumed that all 405,000 cows would need to be tested annually because of whole herd testing requirements for herds with cattle that may ship interstate. This value could easily be halved depending on how many cattle are in closed herds and how many herds retain cattle in state. The assumption for the dairy industry is that only 455,000 diary cows are tested per year. By the same token 840,000 feeder cattle are assumed to be affected. This basically means that all calves born in a given year will be transferred once and require testing at least once. The share of the calf crop that is assumed to be beef cattle is based on the proportion of beef cows to total cows (46.2%) so that there are approximately 387,770 beef calves that enter the analysis. Even though dairy calves go to finishing, it is assumed that the costs of testing remain with the dairy operations rather than beef operations. The numbers for the modified accredited zone are also broken out in columns and used to evaluate the cost impacts on this region.

The number of cattle affected based on disease status and location is then multiplied by the appropriate cost figure in the first column. Summing up by columns provides the total cost. The total estimated cost if the entire state is modified accredited is $29.5 million for all cows. Removing dairy cows, the cost is $15.8 million to the beef industry. With the split state, the costs of BTB include only the management zone and modified accredited zone cattle. The cost

[2] Assumes all state inspected and small federally inspected plants slaughter only Minnesota cattle. Figures for larger plants from Curt Zimmerman, MN Dept. of Agriculture, pers. comm.. with various packers.

decreases to only $3.25 million with the split state status. Therefore, the direct estimated value of split state status based only on expected costs incurred due to BTB is slightly over $12.55 million dollars for the beef industry and a total of about $27 million of both beef and dairy cattle. This suggests the value that the state could expend to contain or eradicate bovine TB simply to prevent re-classification of the entire state to modified accredited status.

Table 9. Number of Cattle Marketed By Market Type, 2004-2007

Type	2004	2005	2006	2007	Total
Auction Market	898,623	855,760	865,887	857,481	3,477,750
Dealer/Order Buyer	38,707	34,715	40,848	35,193	149,463
Feedlot	-	76	-	351	427
Private Treaty	13,848	14,889	14,042	14,154	56,933
Packer/Processor	224,782	216,471	249,173	280,676	971,100
Special Sales	15,274	69,408	35,906	52,706	173,294
Marketings not reported to MN Beef Council	210,218	210,233	212,798	218,922	852,171
Cattle marketed in MN	**1,401,451**	**1,401,551**	**1,418,654**	**1,459,483**	**5,681,138**
Out-of-state cattle marketed in MN	309,493	312,052	307,955	333,653	1,263,153
MN cattle marketed out-of-state	481,990	460,217	460,197	479,903	1,882,307
MN cattle marketed	**1,573,948**	**1,549,716**	**1,570,896**	**1,605,733**	**6,300,292**

Source: Minnesota Beef Council and USDA, APHIS

Table 10. Number of Cattle Shipped To Various States From Minnesota, 2004-2007

State	2004	2005	2006	2007	Total
Alabama	-	-	-	102	102
Arizona	1	5	-	-	6
Arkansas	602	681	333	207	1,823
California	12	48	241	1	302
Colorado	1,635	-	124	49	1,808
Florida	120	101	30	-	251
Georgia	13	-	-	-	13
Idaho	816	69	1,141	2	2,028
Illinois	8,381	4,164	3,316	383	16,244
Indiana	8,049	6,195	8,787	4,732	27,763
Iowa	99,599	69,168	85,346	104,509	358,622
Kansas	2,561	3,178	2,491	2,573	10,803
Kentucky	946	195	977	523	2,641
Louisiana	501	43	-	2	546
Maine	151	-	-	-	151
Michigan	386	441	210	137	1,174
Mississippi	560	569	359	11	1,499
Missouri	2,516	1,714	4,655	6,450	15,335
Montana	2,363	1,153	5,388	7,654	16,558
Nebraska	24,746	10,427	13,477	27,114	75,764
New Mexico	-	65	141	2	208
New York	191	130	-	3	324
North Carolina	-	-	195	1,517	1,712
North Dakota	12,105	11,793	14,540	15,953	54,391
Ohio	789	255	237	1,076	2,357
Oklahoma	3,574	263	1,376	2,869	8,082
Oregon	-	-	69	-	69
Pennsylvania	1,007	1,529	2,651	710	5,897
South Dakota	43,211	32,020	62,785	67,539	205,555
Tennessee	38	2	33	90	163
Texas	10,885	2,897	3,297	3,780	20,859
Utah	-	-	131	3	134
Vermont	-	1	2	-	3
Virginia	5,641	4,498	3,604	5,300	19,043
Washington	1	-	-	5	6
West Virginia	-	71	42	-	113
Wisconsin	111,372	73,420	90,688	83,834	359,314
Wyoming	500	132	48	805	1,485
Totals	**343,272**	**225,227**	**306,714**	**337,935**	**1,213,148**

Source: Minnesota Beef Council

Table 11. Minnesota Cattle Slaughter by Class, 2004-2007

Year	2004	2005	2006	2007	Total
Steers	101.9	95.0	126.9	142.1	465.9
Heifers	47.2	50.3	69.2	74.5	241.2
Beef cows	310.7	318.6	363.5	395.2	1,388.0
Dairy cows	156.8	97.0	77.7	70.4	401.9
Bulls/stags	55.9	54.3	59.2	55.7	225.1
Federally Inspected Slaughter	672.4	615.3	696.4	737.9	2,722.0
State Inspected Slaughter[3]	28.7	28.7	28.3	27.9	113.6
Total Slaughter	701.1	644.0	724.7	765.8	2,835.6

Source: Federally inspected slaughter by class from FSIS. Total slaughter from USDA, NASS, Livestock Slaughter Summary for 2004-2007.

These costs can be compared to the cost of bovine TB estimated for Minnesota by USDA for the application of split state status published in the Federal Register (April 2008). That analysis estimated that the total cost of the entire state of Minnesota remaining as modified accredited would be between $19.4 million and $29.1 million. The lower value assumed that all cattle are tested with 60 days prior to animal movement so that only one test per head per year is required. The higher number assumed whole herd tests and tests for steers and heifers shipped interstate along with several other assumptions about animal movements and sales. The costs of testing in this report are estimated to be $18.8 million dollars which is very near the USDA's lower bound and is most comparable because both include only testing costs. USDA's upper bound estimate is actually due to a change in assumptions on testing costs to be $15 per head

[3] State inspected slaughter is the difference between Total Slaughter and Federally Inspected Slaughter.

rather than $10 per head. However, none of these cost increases include any accounting of potential changes in prices and trade in cattle because of restrictions in interstate transport of cattle. To complete this analysis requires the development of a market equilibrium model that accounts for price and quantity changes as markets adjust.

Market Response to Bovine TB

As costs of testing, fencing, spaying, and handling increase, it is expected that production will decrease. This in turn will cause prices to increase. There are also significant shipments of cattle in and out of the state so that as costs increase in Minnesota and cattle become more expensive, there would be less demand for Minnesota cattle by feedlots inside and outside Minnesota further impacting the cow-calf sector. Finally, the direct cost analysis cannot identify what the impacts might be of trade restrictions by other states based on animal health restrictions and possible impact on feeder prices. To analyze the market dynamics a market simulation model with supply, demand, trade and price dynamics is created.

Model Development for Market Level Impacts

The equilibrium displacement model (EDM) which originated with Muth has been widely adopted in agricultural economics for policy analysis. EDM creates a reduced form linear representation of supply, demand and marketing response based on elasticities from previously estimated econometric models of supply and demand such as in Buhr. The advantage is that the model is very easy to specify, parameters or elasticities can easily be adjusted to develop sensitivity analyses of scenarios, and economic 'shocks' such as cost increases or preference changes can be easily incorporated as shifters. The disadvantages are that the model may not be consistent if parameters drawn from different studies have different assumptions or datasets underlying their estimation and should only be used for small market changes.

The concept of the equilibrium displacement model has been widely used to estimate the economic impacts and most recently to evaluate the economic impact of country-of-origin labeling in livestock and meat (Lusk and Anderson; and Brester, Marsh and Atwood). These papers are particularly insightful for the present analysis because they are recent and contain up-to-date parameters for equilibrium displacement models in the livestock and meat sector.

Figure 9 illustrates the overall structure of the model. The top row illustrates the primary demand for meat products. Beef, Pork and Chicken are modeled as substitutes and through this interaction changes in demand for any meat product is transmitted to the other production sectors and similarly any change in production in a meat sector is linked through its demand through the other meat sectors. The model is available upon request.

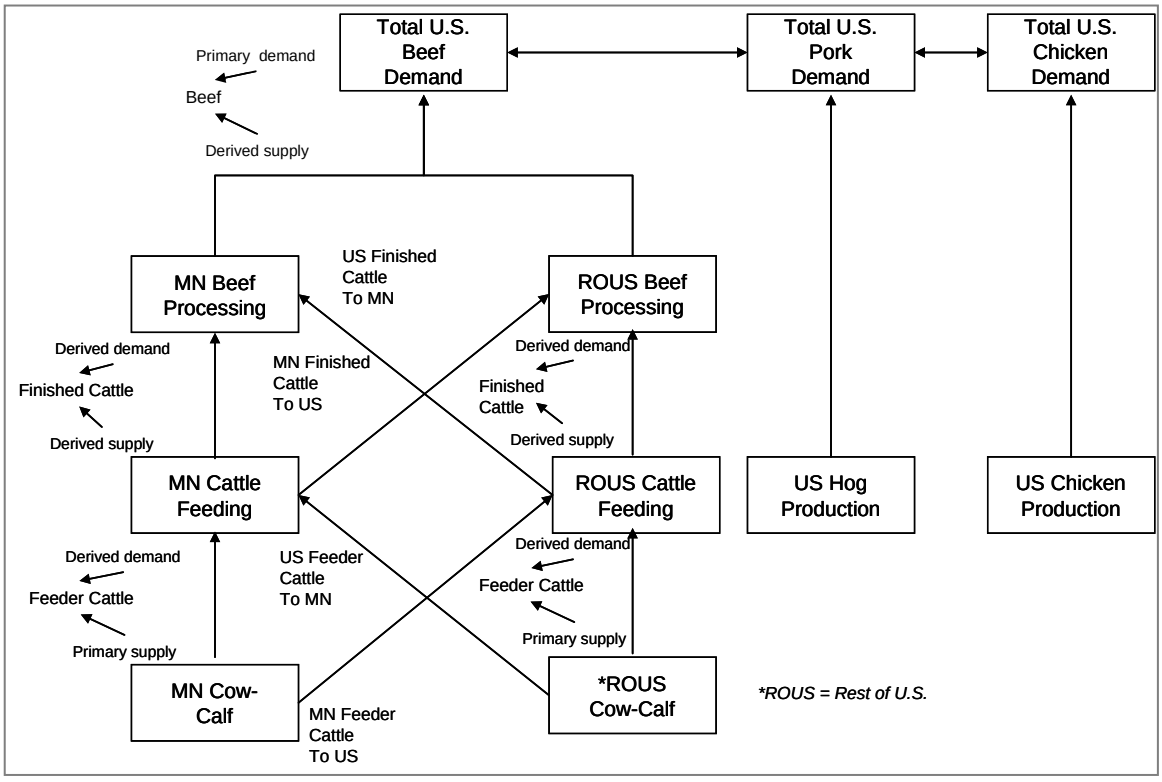

Figure 9. Schematic of Equilibrium Displacement Model (EDM) for simulating the market impacts of Bovine TB.

The rest of the model represents the production sectors. The production sectors for pork and chicken are simply represented by the supply elasticity of each of the production sectors and a margin specification that links the production and consumption parts of the model. However, more extensive modeling is necessary to simulate the impacts of Bovine TB on the beef sector.

First, it's necessary to create a vertical cattle production sector because the cost of bovine TB depends on the vertical structure of the beef industry. Therefore, rather than creating a composite cattle/beef supply, the cow calf and finished beef sectors are each modeled. In this case, the primary supply is the cow calf sector. Feeder cattle produced at the cow-calf stage are transferred into the fed cattle sector and then to the processing sector. The primary demand is for beef by the consumer, but this becomes a derived demand for fed cattle and feeder cattle. Therefore, if there is a reduced demand for cattle at any stage this can be modeled as being passed through the vertical chain.

Second, it is necessary to model the trade linkages between Minnesota and the rest of the U.S. (ROUS). Under normal market conditions, the U.S. market would be modeled as a single market with free flows between states as is done with pork and chicken. However, states have placed restrictions on the imports of cattle from Minnesota. By breaking the supply side into Minnesota and ROUS components it is possible to model any changes in demand which also may originate in other state demand for Minnesota cattle. In this way simulations can be conducted which recognize the potential for reduced demand or costs at any stage of beef production.

The majority of the elasticity parameters for the model were taken from other studies. However, parameters on vertical components of the model and for Minnesota were not available. To obtain these parameters econometric equations were estimated using annual data on

Minnesota variables. This included feeder cattle supply elasticities and fed cattle supply elasticities. The estimation and documentation of the model is too extensive for this paper and is available from the author upon request.

Market Impact Simulations

Two primary simulations are presented. One simulation is the annual economic impact assuming the entire state is modified accredited (i.e., no split state status is approved). The second is the economic impact if the state maintains split state status. All impacts are on an annual basis. However, it is important to recognize that EDM calculates full adjustments to equilibrium as though they happen immediately. In reality, the adjustments to the beef market will take time as exhibited by cattle cycles.

Within each major scenario, two sub-scenarios are analyzed. One assumes that only the cost of production increases from testing, fencing, record keeping and herd depopulation are included. The other assumes that in addition to the cost of production increases, other states ban the imports of cattle from Minnesota and that there is also a price discount for Minnesota cattle by other states.

The equilibrium displacement model is predicated on the concept of 'percent change from equilibrium'. Therefore, cost impacts calculated above must be converted to a percentage basis to be represented as a change to the equilibrium. To do this the industry wide costs of production are calculated for cow-calf and beef finishing sectors which might be impacted. The total cost estimates for each sector provided in the partial budgets (Tables 3 and 5) were multiplied by the number of cattle represented by each type to arrive at a total cost estimate for the industry. The total cost of production for the cow-calf sector is estimated to be about $162.8 million dollars per year and the total cost of production for the feedlot sector is estimated to be

about $146.5 million dollars for a total cattle sector cost of production of about $303.3 million dollars. Using the estimate of an increase in cost of production of $15.8 million dollars due to bovine TB, the percentage impact on the state is about a 5.1 percent increase, hence the estimated relative impact of the entire state being classified as modified accredited is a 5.1 percent increase in costs of production. A similar method was used to calculate the split state cost impacts, as a pro-rated share. This increase in cost of production to the state industry is only a 1.1 percent increase.

Two key terms must be defined that may not be familiar to readers. These are *producer and consumer surplus*. These terms refer to the net economic gains or losses that consumers and producers have as a result of an economic change in either supply or demand for a product – in this case cattle and beef. The surplus measures account for both price and quantity changes that result to fully account for the economic impacts and summarize these underlying quantity price changes in a single variable. The economic surpluses will be the focus of much of the explanation of the simulation results.

Simulation Results

Table 12 shows the economic costs of bovine TB, including market adjustment. The cow-calf sector, as the primary supply determinant, bears the brunt of cost impacts. For example a 5.1% increase in the cost of production with no other changes in trade or price impacts results in a $33.36 million dollar annual loss to cow-calf operations and only a $28,300 loss (nearly negligible) to the feedlot sector (results column 1). This is because the feedlot sector is a derived demand and derived supply segment between the primary supply of the cow-calf sector and the

Table 12. Market Level Impacts of Bovine Tuberculosis in the Minnesota Beef Industry

		No Split State		Split State	
		5.1% Increase in COP, No Interstate Restrictions[a]	5.1% Increase in COP, Import Restrictions Feeders, Cattle Price Discount[b]	1.05% Increase in COP, No Interstate Restrictions[c]	1.05% Increase in COP, Import Restrictions Feeders, Cattle Price Difference[d]
Variable					
Change in Producer Surplus (Net Impact)					
Feeder Cattle					
Minnesota	**Mill $**	**($33.36)**	**($122.31)**	**($6.91)**	**($14.39)**
Other States	Mill $	$5.06	$26.17	$1.04	$2.69
Net US	Mill $	($28.30)	($96.14)	($5.87)	($11.70)
Fed Cattle					
Minnesota	**Mill $**	**($0.026)**	**$89.944**	**($0.005)**	**$7.518**
Other States	Mill $	($0.752)	($3.892)	($0.155)	($0.400)
US	Mill $	($0.778)	$86.052	($0.160)	$7.117
Change in Producer Surplus Other Meats					
Pork	Mill $	$0.49	$2.51	$0.10	$0.26
Chicken	Mill $	$22.41	$115.98	$4.61	$11.93
Turkey	Mill $	$32.08	$166.04	$6.61	$17.07
Change in Consumer Surplus					
Beef	Mill $	($6.28)	($32.49)	($1.29)	($3.34)
Pork	Mill $	($0.57)	($2.96)	($0.12)	($0.30)
Chicken	Mill $	($0.11)	($0.56)	($0.02)	($0.06)
Turkey	Mill $	($0.15)	($0.79)	($0.03)	($0.08)
Change in Feeder Cattle Production					
Minnesota	percent	-1.423%	-5.323%	-0.293%	-0.611%
Other States	percent	0.003%	0.014%	0.001%	0.001%
US	percent	-0.029%	-0.106%	-0.006%	-0.012%
Change in Fed Cattle Production					
Minnesota	percent	-1.32%	-8.33%	-0.27%	-0.86%
Other States	percent	0.00%	0.03%	0.00%	0.00%
US	percent	-0.02%	-0.14%	0.00%	-0.01%
Change in Feeder Cattle Prices					
Minnesota	percent	0.018%	-13.909%	0.003%	-1.133%
Other States	percent	0.018%	0.091%	0.003%	0.009%
US	percent	0.018%	-0.224%	0.003%	-0.016%
Change in Fed Cattle Prices					
Minnesota	percent	0.012%	0.064%	0.002%	0.007%
Other States	percent	0.012%	0.064%	0.002%	0.007%
US	percent	0.012%	0.064%	0.002%	0.007%

State is Modified Accredited Status with Management Zone in Northwest. No states restrict imports. Increased cost of production (COP) is 5.1%

State is Modified Accredited Status with Management Zone in Northwest. Others ban feeder imports. Increased COP is 5.1%. Feeder price discounted 9.8%.

Split state status with Management Zone in northwest. No states restrict imports. Increased COP is 1.05%.

Split state status with Management Zone in northwest. Other states ban feeder imports. Increased COP is 1.05%. Feeder prices discounted .78%

primary demand of the beef consumer. In other words they are a margin business. As costs increase, the price of feeders increase, but the price of fed cattle also increases so that the impacts somewhat cancel out. The loses are a result of reduced quantities that do occur because of competition from other meat sectors such as poultry and pork that do not suffer an increase in costs.

The second important result is that bovine TB results in reduced competitiveness with other states. Other states' cow-calf producers actually are better off because feeder cattle prices rise slightly for them and they have no additional costs of production. However, other states' feedlots do lose because they pay a higher price for feeder cattle that is not fully offset by the increase in beef and subsequently fed cattle prices. By the same process, other meat sectors (pork, chicken and turkey) gain – in particular the poultry sectors because they are the primary competitors with beef.

Perhaps most important is the potential impact of price discounts and reduced demand for feeder cattle from Minnesota. Typically the U.S. feeder cattle market is modeled as a 'one-price' model. That is, cattle are freely traded and so any regional price differences are purely a feature of fundamental economic differences such as transportation costs, quality of cattle differentials, or capacity constraints. However, every price is determined by the national base supply and demand. This is why in the first two No Split State simulations, the prices of Minnesota and other states' cattle change by the same proportion. There is no ability to price discriminate.

However, if there are trade restrictions and Minnesota cattle are identified it is likely that there will be price differentials that emerge between Minnesota cattle and bovine TB free states. To model this, the price discount is estimated by using the demand elasticities for feeder cattle

and reducing them by 7 percent which is the net export of feeder cattle from Minnesota. This 7 percent reduction in the quantity demanded for Minnesota feeder cattle is calculated to result in a 9.8 percent reduction in prices of feeder cattle in Minnesota as an initial impact. In the case of split state status, these values are pro-rated by the quantity of cattle in the modified accredited region in Minnesota. In addition, no trade is allowed to occur (in other words there is a ban and the result is a 9.8% discount).

The assumption of a price discount for Minnesota cattle by other states dramatically increases the loss in producer surplus to Minnesota to $122.31 million dollars for cow-calf producers in Minnesota. Note that feedlots in Minnesota actually benefit now. This is because prices of Minnesota feeder cattle which are assumed to only be finished in Minnesota must drop even further and the feedlots also receive a higher price for fed cattle. One implication of this is that if price discounts occur for Minnesota feeder cattle, it makes sense for cow-calf producers to retain ownership to gain from this offset surplus. This of course assumes that there is no discount for Minnesota fed cattle or beef.

For other states, cow-calf producers benefit while fed cattle producers lose. This is because feeder cattle prices increase in other states resulting in higher costs for fed cattle producer in those states. In addition, Minnesota feedlots are still able to import those cattle. This would not occur if Minnesota were not a very small share of the national market for cattle. If the major market had a decrease in fed cattle prices all feedlots would benefit. These distributional impacts do not suggest that there is a net gain from bovine TB.

Even with transference to feedlots there is a net loss of over $10 million to the U.S. and a net loss to Minnesota of $32 million dollars with the entire state classified as modified accredited and the discounted feeder cattle prices.

Including the price discount for the feeder cattle sector in Minnesota only marginally changes the total producer surplus for Minnesota's combined feeder cattle and fed cattle sectors. In either case at a 5.1% increase in cost of production results in approximately a combined loss of about $33 million dollars. This is because the loss in feeder cattle price to the cow-calf sector is directly transferred as lower feeder cattle input costs to the feedlot sector. It must be emphasized that this relationship exists only if there are no discounts to fed cattle in Minnesota and if there are no positive bovine TB cases caused by feeder cattle brought into feedlots in Minnesota which would then trigger depopulation results. The nature of bovine TB which is a slowly progressing disease that does not present significant morbidity or mortality prior to the expected 16-18 month life span of finished cattle is what creates this outcome.

The overall impacts on consumers are relatively small, mainly because Minnesota is a small share of the beef market when one considers the national market and international trade in beef products. No distinction is made between Minnesota consumers and others because there are no distinctions in trade or product at the beef level. Consumers are estimated to lose $6.28 million in the beef market and a total loss of $830,000 in the higher prices of all other meats. For comparison, the total annual retail value of beef consumption is about $109 billion. This result has important implications for taxpayer funding of abatement strategies. Should consumers fund beyond $6 million in abatement since that is their risk exposure? Consumers should fund more because of the risk of spread to other states causing greater loses. What ought that level be? Should the beef industry as a whole fund a greater share because they stand the most to gain? What about tax receipt losses by the state from cattle losses?

Some light is shed on some of these questions by comparison to the scenarios under a split state status. The split state losses decrease dramatically because fewer cattle are required to

be tested in the modified accredited zone. The average net loss to the cattle sector is only about $6.9 million. In essence the split state approval has resulted in between a $26.45 million and $107.92 million annual savings to the state, depending on the assumption made regarding price discounts. Clearly, the successful application for split state status resulted in tremendous economic benefits to the Minnesota cattle industry and there is a clear incentive to maintain this status through effective eradication programs. Assuming that there are no more positive herds are found in Minnesota so that the time to bovine TB free status and the removal of all restrictions is six years, the total cost savings is between $158.80 million and $647.52 million dollars. This suggests a very high return on investment to the state from the approximately $20 million expected 10 year cost estimated by BAH to manage and eradicate the disease.

Multiplier Impacts of Bovine TB

The simulations provide a comprehensive assessment of the potential direct dollar value economic impacts on the beef industry with market price adjustments. However, these impacts also affect employment in the beef industry as well as indirectly impact other allied industries such as feed manufacturing, meat processing and crop production. Beyond these, there are induced impacts on other businesses and households that rely on income generated by the beef industry to support their purchases. These may include restaurants, clothing stores and other businesses not directly in the beef industry sphere but which benefit from the general economic activity. These impacts are based on input-output analysis using IMPLAN software.

The analysis uses the standard regional purchase coefficients, production functions and multipliers provided by IMPLAN. This essentially assumes that Minnesota and the Northwest modified accredited region cattle sectors are essentially the same in their economic characteristics as the national average which is used to estimate coefficients in IMPLAN.

Changing these coefficients would require substantial analysis and given the myriad assumptions in the disease these are likely only marginal errors. The baseline database used was for 2006. According to IMPLAN, in 2006 the Minnesota cattle and ranching sector accounted for a total output of $2.28 billion dollars, total employment of 15,686 people and total employment compensation $116.4 million dollars.

Only two scenarios are conducted – a split state scenario and a whole state scenario. As shown in the market simulation model, the net impact on the entire cattle sector in Minnesota is approximately the same regardless of discounts because of price transfers between cow-calf operations and feedlot operations. IMPLAN only defines the sector as 'cattle ranching and farming' which does not allow for the distinction between cow-calf production and feedlot production. This is not an issue for the state-wide analysis because all impacts are distributed at the state level, but when simulating the modified accredited zone, it is predominantly feeder cattle production and relatively little fed cattle production so that the loses to the feeder cattle industry are not be offset as much by the fed cattle industry.

Statewide Economic Impacts

As estimated in the simulation model the direct net economic impact on the beef cattle sector is an expected loss of $33.4 million dollars. However, the testing costs that comprise a large share of the loss are transferred to the veterinary services sector. Using the direct cost calculations and removing the on farm labor of testing which would be a cost to the farmer, the vet services sector receives a direct impact of approximately $8.1 million (Table 6). Because veterinary services tend to be local it is assumed that this full value is in the local economy.

Another sector directly impacted is the farm equipment sector due to increased fencing. These payments are $1.4 million (Table 6). This impact is concentrated in the management zone

and not distributed across the state. Therefore, it is likely under-represented as a very focused impact but will have a greater impact when the split state simulation is completed because it will remain at the same level.

Record keeping is another component of activities; however, it is assumed that record keeping is done by the operator so that this is an untransfered cost. There certainly will be costs of tags for identification, but these are basically assumed to be bought from outside the region so that no direct income is transferred within the state. The reason for adding back these factors is that IMPLAN treats these as indirect effects of simply reducing the scale of the beef industry by $33 million, analogous to losing a business. However, in this case the business is not lost, but only reduced in value by the additional costs.

The upper half of Table 13 shows the economic impacts of the statewide designation of modified accredited cattle. The other to ten industries affected ranked by level of indirect impact are shown in the table. In addition “maintenance and construction repair” is shown because of the direct impact of fencing. The direct impacts are as described previously. The indirect impacts of bovine TB are nearly equal to the direct impacts. The total economic impact of bovine TB on Minnesota with a statewide designation of MA is approximately $50.5 million.

Employment impacts are relatively modest mainly because the beef industry accounts for only about 15,000 employees in cattle ranching compared to total employment in Minnesota of about 3.5 million people (cattle ranching accounts for about ½ percent of total employment). Under circumstances where the entire state of Minnesota is modified accredited, the expected loss to Minnesota is about 267 jobs due to the outbreak. The slaughtering and processing sectors are not affected much because they are relatively small in Minnesota and the slaughter sector has the capability of importing cattle into Minnesota for processing for only slightly higher costs.

Veterinary services employ approximately 8,300 people, and so the transfer from the cattle sector to the veterinary sector results in about a 50 percent offset to the cattle industry losses.

This raises an important point about the economic dynamics that IMPLAN ignores. According to these results, veterinarians can gain by spreading disease. However, at some level of disease incidence veterinarians would drive themselves out of business. The same could be said of cattle feedlots. Hence, these results cannot be extrapolated to a larger scale outbreak where the loss of animals and economic damage to the beef sector would eventually drive down the demand for veterinarians. This demonstrates why it is important to simulate the market impacts for the beef industry as was done in this study.

For comparison, the split state modified accredited classification is analyzed. The four counties under modified accredited status are Beltrami, Roseau, Marshall and Lake of the Woods. A key difference for this area is that it includes all the depopulation costs. This assumes that there are no additional herds outside the modified accredited zone. If this did happen it is likely that the state would return to a whole state modified accredited and have the higher economic impacts. The MA region has a total economic output from the cattle ranching sector of about $47 million and has an employment level of 1,302. This is compared to a total regional employment level of about 44,419 (cattle is employment of about 3% of total).

Table 13. Input-Output Economic Impact Analysis

Entire State Classified as Modified Accredited

Sector	Output Impacts: Direct Impacts	Output Impacts: Indirect Impacts	Output Impacts: Induced Impacts	Output Impacts: Total Impacts	Sector	Employment Impacts: Direct	Employment Impacts: Indirect Impacts	Employment Impacts: Induced Impacts	Employment Impacts: Total Impacts
Cattle Ranching	$ (33,400,000)	$ (6,286,268)	$ (12,544)	$ (39,698,812)	Cattle Ranching	(229)	(43)	(0)	(273)
Petroleum Refineries	$ -	$ (3,472,056)	$ (69,024)	$ (3,541,080)	Ag and Forest Support	-	(25)	(0)	(25)
Other Crop Farming	$ -	$ (3,334,688)	$ (1,512)	$ (3,336,200)	Real estate	-	(16)	(1)	(17)
Real Estate	$ -	$ (2,665,496)	$ (128,819)	$ (2,794,314)	Other Crop Farming	-	(16)	(0)	(16)
Wholesale Trade	$ -	$ (1,630,438)	$ (153,783)	$ (1,784,221)	Veterinary services	122	(13)	(0)	109
Veterinary Services	$ 8,098,608	$ (889,180)	$ (7,404)	$ 7,202,025	Wholesale trade	-	(8)	(1)	(9)
Ag and Forest Support	$ -	$ (731,803)	$ (726)	$ (732,529)	Grain farming	-	(4)	(0)	(4)
Truck Transport	$ -	$ (502,235)	$ (26,000)	$ (528,235)	Truck transportation	-	(4)	(0)	(4)
Power Generation	$ -	$ (409,432)	$ (40,994)	$ (450,426)	Civic Orgs.	-	(3)	(0)	(4)
Farm Machinery	$ -	$ (408,739)	$ (272)	$ (409,011)	Warehouse & Store	-	(2)	(0)	(3)
Maint. And Const. Repair	$ 1,350,000	$ (12,718)	$ (1,871)	$ 1,335,411	Maint. And Const. Repair	20	(0)	(0)	19
Total	($24,017,683)	($23,834,664)	($2,634,778)	**($50,487,126)**	**Total**	(89)	(155)	(23)	**(267)**

Split State Status Approved

Sector	Output Impacts: Direct Impacts	Output Impacts: Indirect Impacts	Output Impacts: Induced Impacts	Output Impacts: Total Impacts	Sector	Employment Impacts: Direct	Employment Impacts: Indirect Impacts	Employment Impacts: Induced Impacts	Employment Impacts: Total Impacts
Cattle Ranching	$ (6,910,000)	$ (1,612,609)	$ (174)	$ (8,522,783)	Cattle Ranching	(191)	(44)	(0)	(235)
Other Crop Farming	$ -	$ (1,291,149)	$ (85)	$ (1,291,234)	Other Crop Farming	-	(12)	(0)	(12)
Real Estate	$ -	$ (522,262)	$ (18,847)	$ (541,109)	Real Estate	-	(5)	(0)	(5)
Veterinary Services	$ 652,149	$ (113,139)	$ (725)	$ 538,285	Ag and Forest Support	-	(4)	(0)	(4)
Ag and Forest Support	$ -	$ (100,533)	$ (54)	$ (100,587)	Veterinary Services	10	(2)	(0)	9
Wholesale Trade	$ -	$ (97,005)	$ (7,291)	$ (104,297)	Grain Farming	-	(1)	(0)	(1)
Power Generation	$ -	$ (81,010)	$ (6,830)	$ (87,840)	Civic Orgs	-	(1)	(0)	(1)
Truck Transport	$ -	$ (79,852)	$ (3,248)	$ (83,099)	Wholesale Trade	-	(1)	(0)	(1)
Credit and Deposits	$ -	$ (66,076)	$ (11,443)	$ (77,519)	Truck Transport	-	(1)	(0)	(1)
Farm Machinery	$ -	$ (57,126)	$ (14)	$ (57,139)	Sugar Beet Farming	-	(0)	(0)	(0)
Maint. And Const. Repair	$ 1,404,000	$ (2,831)	$ (333)	$ 1,400,836	Maint. And Const. Repair	23	(0)	(0)	23
Total	$ (4,853,851)	$ (4,431,272)	$ (310,634)	**$ (9,595,757)**	**Total**	(157)	(74)	(4)	**(235)**

By comparison to the whole state impacts, the impacts are relatively large for the split state analysis. This is because the cattle sector comprises a substantially larger share of the regional four county economy. Also, in the simulation the full depopulation costs are incurred in the MA region resulting in no pro-rating of those costs for the size of the region as is essentially done in the whole state analysis. The northwest region's total economic costs including indirect and induced effects are about $9.6 million dollars and the total impact on employment is a loss of 235 jobs. Again this is much higher relative to the state level because of the much higher intensity of the cattle sector in that regional economy. Still as suggested earlier, there is a substantial value to the state of eradicating bovine TB.

Summary

As shown by this analysis, bovine tuberculosis has significant economic implications for Minnesota's beef cattle industry. These costs include not only losses of cattle due to tuberculosis but also the costs that are incurred to contain and eventually eradicate the disease.

The direct economic cost on the beef industry if the entire state is classified as modified accredited and due to testing, fencing, record keeping, heifer spaying and herd losses is estimated to be $15,848,000 annually (Table 6). The split state status approved by the federal government in October 2008 cuts this estimated cost to $3,249,980 annually. Even without accounting for the other market dynamics and multiplier impacts this suggests that expenditures of up to about $12.6 million annually could be used to avoid the loss of split state status – meaning the avoid any further infected herds that could result in status changes. This is already being done through cattle management as well as wildlife management by the Board of Animal Health and Animal and Plant Health Inspection Service.

These direct costs do not account for market impacts on prices and quantities of cattle produced in Minnesota. As the cost of production increases, it is expected that prices of cattle will increase and quantities will decrease. A market simulation model developed estimates that by accounting for these market dynamics the cost of bovine TB to cattle producers escalates to $33.4 million dollars per year on a statewide basis; more than double the direct $15.8 million costs. Again, the split state status reduces this to about $7 million per year. For comparison the total annual gross value of beef cattle marketed is about $1.1 billion per year.

The market simulation model also allows for analysis of potential direct price changes for Minnesota feeder cattle due to decreased demand because of inter-state trade restrictions and general concern about disease spread. Assuming a ban on all feeder cattle exports from Minnesota (about a 7 percent demand loss) results in a 9.8 percent decrease in Minnesota feeder cattle prices. This increases the expected losses to $122 million for the cow calf sector, but this is mitigated by gains to the fed cattle sector in Minnesota because of these cheaper feeder cattle. Therefore, the net loss to Minnesota's overall beef industry remains about $32 million. Of course these distributional impacts are a concern as the loss of the feeder cattle sector would eventually harm the fed cattle sector.

As a final consideration, the IMPLAN input-output modeling software was used to estimate the expected indirect and induced impacts on economic output and employment in Minnesota. Using the market adjusted losses of $33 million for the whole state results in a total economic loss of about $50.5 million per year to the cattle industry, allied industries and associated loss of expenditure by the industry on other parts of the economy. A total of 267 jobs are lost. Simulating the current split state classification results in an estimated total economic

impact of $9.6 million per year in the four modified accredited counties (Beltrami, Lake of the Woods, Roseau and Marshall) and an employment loss of 235 jobs.

As of July 2009, the current bovine TB status for Minnesota is a split state with a northwest area classified as modified accredited and the rest of the state classified as modified accredited advanced. Therefore, the current estimated economic impact is a total annual loss of about $9.6 million and 235 jobs to the beef cattle sector and the indirect and induced impacts. Even assuming complete eradication and no other cases, it will take about six years to be classified as bovine TB free with total losses then approaching $58 million. The whole state scenario demonstrates that there is significant risk to further spread and emphasizes the need for vigilant monitoring and eradication.

The estimates do not approach the comprehensive economic impacts of bovine TB. Although only direct impacts are calculated for the dairy industry, those impacts represent approximately another $15 million annual direct impact. There are also impacts on wildlife and recreation because of the transmission of bovine TB to cervidae and other species. Finally, there are the public sector costs for increased regulation and enforcement of compliance that are not included.

Finally, this analysis is based on numerous assumptions regarding costs, number of cattle affected, price levels, price responses, all assumptions underlying the economic models and duration of the bovine TB status downgrades. The absolute values calculated vary depending on these assumptions and the suggested way to use this analysis is in a baseline comparison of alternatives which with the modeling structure created can be more readily analyzed.

References

Boehlje, M.D. and V.R. Eidman. *Farm Management*. John Wiley & Sons, New York. 1984.

Brester, G.W., J.M. Marsh, and J.A. Atwood. 2004 "Distributional Impacts of Country-of-Origin Labeling in the U.S. Meat Industry." *Journal of Agricultural and Resource Economics.* 29:206-227.

Buhr, B.L. 1993. "A Quarterly Econometric Simulation Model of the U.S. Livestock and Meat Sector". Staff Paper 93-12, Department of Agricultural and Applied Economics, University of Minnesota, St. Paul, MN 55108.

Federal Register (CFR). *"Tuberculosis in Cattle and Bison; State and Zone Designations; Minnesota.* Volume 73, No. 198. October 10, 2008.

Federal Register. *Tuberculosis in Cattle and Bison; State and Zone Designations; Minnesota.* Department of Agriculture, Animal and Plant Health Inspection Service. Vol. 73, No. 69, April 9, 2008.

Federal Register. *Tuberculosis in Cattle and Bison; State and Zone Designations; Minnesota.* Department of Agriculture, Animal and Plant Health Inspection Service. Vol. 73, No. 198, October 10, 2008.

Grooms, D. and R. Mecklem. "Bovine TB Disinfectants". Bovine TB Notes. Extension Bulletin E-2773, December 2000. Accessed on June 25, 2008 at http://cvm.msu.edu/alumni-friends/continuing-education/extension/beef/articles-bulletins-beef/bovine-tb-notes/E-2733TB.pdf

Minnesota IMPLAN Group, Inc., IMPLAN System (2006 data and software), 1725 Tower Drive west, Suite 140, Stillwater, MN, www.implan.com, 1997.

Lusk, J.L. and J.D. Anderson. 2004. "Effects of Country-of-Origin Labeling on Meat Producers and Consumers." *Journal of Agricultural and Resource Economics.* 29:185-205.

Minnesota Board of Animal Health. *"Control of Tuberculosis in the Management Area."* Effective April 15, 2008 (Revised April 2, 2008). Accessed online at: <http://www.bah.state.mn.us/tb/files/management_herds.pdf> on July 14, 2009.

Minnesota Legislature. *"Bovine Tuberculosis Control Provided in Certain Areas, and Money Appropriated"*. MN H.F. 4075, December 2, 2008.

Muth, R.F. 1964. "The Derived Demand Curve for a Productive Factor and the industry Supply Curve." *Oxford, Econ. Pap.* 16:221-34

Muewissen, M.P.M, S.H. Horst, R.B.M. Huirne, A.A. Dijkhuizen. "A model to estimate the financial consequences of classical swine fever outbreas: principles and outcomes. *Prev. Vet. Med.* 42(1999):249-270.

Sparks Companies, Inc., "Cool Cost Assessment," Prepared for the Sparks/CBW Cool Consortium, Memphis, TN. April 2003.

United States Department of Agriculture, Agricultural Marketing Service. "Mandatory Country of Origin Labeling of Beef, Lamb, Pork, Fish, Perishable Agricultural Commodities and Peanuts; Proposed Rule." *Federal Register*. 68, no. 210 (30 October 2003):61944-61985.

USDA, National Agricultural Statistics Services. *2007 Census of Agriculture.* Accessed online at < http://www.agcensus.usda.gov/Publications/2007/index.asp>, July 14, 2009.

USDA, Animal and Plant Health Inspection Service. "*Bovine Tuberculosis Eradication. Uniform Methods and Rules (UMR), Effective January 1, 2005*." APHIS 91-45-011.
Minnesota Legislature. "*Bovine Tuberculosis Control Provided in Certain Areas, and Money Appropriated*". MN H.F. 4075, December 2, 2008.

USDA, Animal and Plant Health Inspection Service. "*Assessment of Risk Associated with the Minnesota Proposed Plan for Split-State Status for Mycobacterium bovis (Bovine Tuberculosis)*" Veterinary Services, Centers for Epidemiology and Animal Health, Centers for Emerging Issues. Fort Collins, CO. June 24, 2008. Accessed at: <http://www.regulations.gov/fdmspublic/ContentViewer?objectId=090000648073c530&disposition=attachment&contentType=pdf> on July 15, 2009.

Vansickle, J., R. McEowen, C.R. Taylor, N. Harl, and J. Conner. "Country of Origin Labeling: A legal and Economic Analysis." Paper No. PBTC 03-5, International Agricultural Trade and Policy Center, University of Florida, Gainesville, May 2003.

Wolf, C. and J.N. Ferris. "Economic Consequences of Bovine Tuberculosis for Michigan Livestock Agriculture." Report to Michigan Department of Agriculture. Michigan State University. December 2000.