

<b>Project Title:</b>	Examination of Potential Predictors of <i>Salmonella enterica</i> Contamination in Cattle Feedlot Environments
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### Background

Bovine peripheral lymph nodes (LNs) have been identified as a potential source of human exposure to *Salmonella enterica*, when adipose trim containing contaminated LNs is incorporated into ground beef. Results of recent studies suggest that excessively high levels of *Salmonella* in cattle environments and on cattle hides provide the opportunity for *Salmonella* to gain entry to bovine peripheral LNs via transdermal abrasions such as insect bites and wounds. Once located within the bovine lymphatic system, many *Salmonella* have the ability to persist or even thrive, without obvious negative impact on cattle health and performance. Furthermore, at harvest *Salmonella* located within bovine tissues are protected from current carcass antimicrobial interventions. Thus, pre-harvest interventions will likely be needed to circumvent this point of entry for *Salmonella* into the human food chain. In order to evaluate the efficacy of pre-harvest interventions it will be necessary to identify reliable methods for monitoring *Salmonella* prevalence and levels in feedlot environments. Thus, the objective of the research described here was to determine if a reliable “predictor” or “environmental marker” could be identified, that could be used to determine *Salmonella* prevalence in a given feedlot setting and then further, for a given cohort of cattle, to examine the possible correlation between the level of environmental *Salmonella* contamination, *Salmonella* fecal shedding status, and the prevalence of *Salmonella* in peripheral lymph nodes of cattle at harvest.

The objectives of the study were to: 1) identify a “predictor” or “environmental marker” that can be used to determine *Salmonella* prevalence in feedlot environments and examine the efficacy for the predicting *Salmonella* prevalence in peripheral lymph nodes; and 2) for a given cohort of cattle, examine the correlation between environmental *Salmonella* contamination, *Salmonella* fecal shedding status, and prevalence of *Salmonella* in peripheral lymph nodes.

### Methodology

Samples were collected from three feedlots, one in BIFSCo Region 3 and two in Region 5 (Fig. 1). Hide, fecal and environmental samples were collected in October 2012, January 2013 and May 2013 in Region 3, while those in Region 5 were collected in May and June of 2013.

Matched hide swab and fecal swab samples were collected from 405 cattle in Region 3 and from 95 cattle in Region 5. On average 24% of cattle per pen were sampled from a total of 10 pens, and average pen size was 224 head. Hide and fecal samples were collected from cattle restrained in a squeeze chute, as they were being processed for growth promoter re-implant (approximately 75 days post arrival at the feed yard). Environmental samples from 5 pens per yard, including pen floor surface material, water tank, feed, and flies, also were collected from each of the three participating yards. Approximately 90 days post re-implant, cattle were shipped to a commercial abattoir for harvest and a subset of cattle sampled at re-implant in October 2012 and January 2013, were selected for lymph node and fecal swab collection. Samples



were analyzed for *Salmonella* prevalence and level. LN samples from a third set of cattle (n=15 head) originating from Region 3 were collected in March 2013. For each carcass, six lymph nodes were collected, three from each carcass half, including the superficial cervical, subiliac, and popliteal.

## Findings

Results indicate that *Salmonella* fecal shedding status is not directly related to LN contamination within a given animal. Instead, peripheral LN contamination appears to be related to the percent of *Salmonella* super shedders present in a pen, and the resultant hide contamination levels of cohorts within that pen (Table 1 and Figure 2).

Enumerable levels of *Salmonella* in tank water and measurable prevalence in feed are potential indicators of aberrantly high levels of *Salmonella* in a given feedlot. While *Salmonella* could be detected on hides, in feces, and in pen surface material in both Regions 3 and 5, only in Region 3 was *Salmonella* found present in feed and enumerable in water samples (Table 1).

## Implications

The data collected in this study suggest that aberrantly high levels of *Salmonella* contamination on cattle hides (defined here as hides contaminated at  $\geq 10^3$ CFU/100cm<sup>2</sup>) are directly related to peripheral lymph node contamination with *Salmonella*. Analysis of feedlot environmental samples including surface material, tank water, feed and flies, suggests that enumerable levels of *Salmonella* in tank water and measurable prevalence in feed are possible indicators of aberrantly high levels of *Salmonella* in a feedlot. Given the ease of collection and processing of these sample types, they may represent good candidates for reliable “predictors” of feedlots that could benefit from a *Salmonella* intervention.

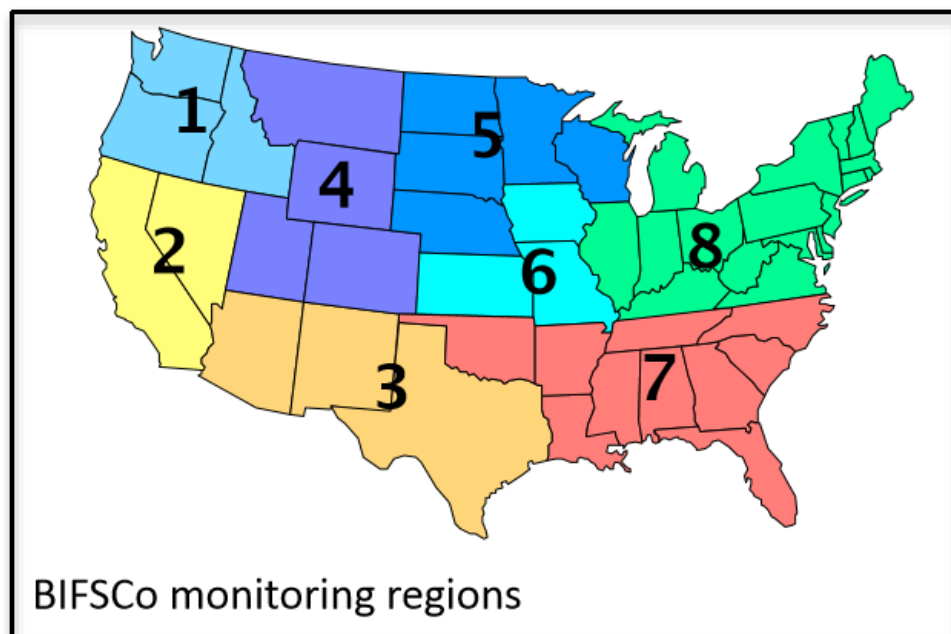


Figure 1. Map of BIFSCo monitoring regions in the U.S.

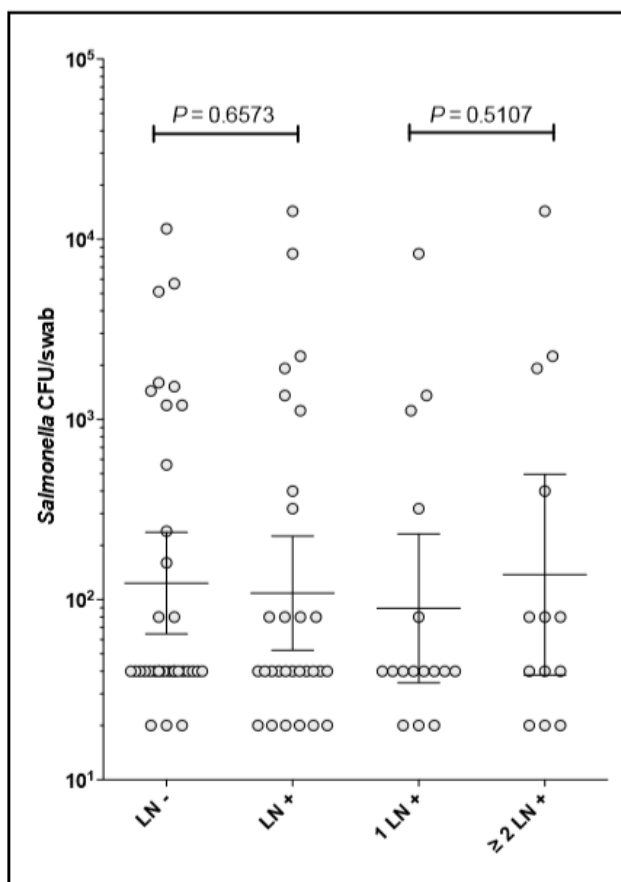


Figure 2. Comparison of *Salmonella* fecal shedding as measured by fecal swab at harvest, and peripheral lymph node (LN) contamination. Shedding levels detected for carcasses negative for *Salmonella* contamination (LN -) (n=34); carcasses positive for LN contamination (LN +) (n=29); carcasses found with one LN positive (1 LN +) (n=16); and carcasses found with more than one LN positive ( $\geq 2$  LN +) (n=13).

Table 1. Summary of *Salmonella* prevalence and levels in hide, fecal and environmental samples, in settings with high (BIFSCo Region 3), moderate (Region 5), or low (Region 5) levels of *Salmonella*. No SF indicates that no stable flies were present on traps; Aug/Sept 2013\* - indicates time period that sample collection is anticipated to occur; Month superscripts indicate the month that cattle went to harvest and LN samples were collected; - indicates that environmental samples were not able to be collected in that time period.

Salmonella Prevalence in Cattle and Environmental Samples	Hide swabs % prevalence (%>10^3 CFU/100cm2)	Fecal swab % prevalence (% super shedders)	Surface material % positive (avg. Log10 CFU/g)	Water tank (n=5 per sample date)			Fly traps (n=4 per yard)			% of carcasses with Salmonella positive lymph nodes at harvest
				Side wall 1000cm2 - % positive (% enumerable) level (log10 CFU/100cm2)	Water grab (25 ml) - % positive (% enumerable) level (CFU/gallon)	Feed (n=5) % positive (% enumerable)	Stable flies - % of traps positive (% enumerable)	Random flies - % of traps positive (% enumerable)		
High										
October 2012	100% (58.9%)	98.2% (35.1%)	-	-	-	-	50% (50%)	100% (75%)		29.2 <sup>JAN</sup>
January 2013	100% (14.7%)	87.5% (9.5%)	-	-	-	-	-	-		58.3 <sup>MAY</sup>
May 2013	100% (36.2%)	81.4% (12.4%)	100% (2.68)	100% (40%)	60% (60%)	40% (0.0%)	No SF	100% (50%)		Aug/Sept 2013*
				0.6	2.74					
Moderate										
June 2013	-	-	100% (2.82)	80% (0.0%)	0.00%	0%	0.0% (0.0%)	75% (50%)		Aug/Sept 2013*
				-	-					
Low										
June 2013	14.7% (0.0%)	0.0% (0.0%)	20% (1.20)	40% (0.0%)	0.0% (0.0%)	0%	0.0% (0.0%)	0.0% (0.0%)		Aug/Sept 2013*
				-	-					

