

# FSIS *Listeria* Risk Assessment

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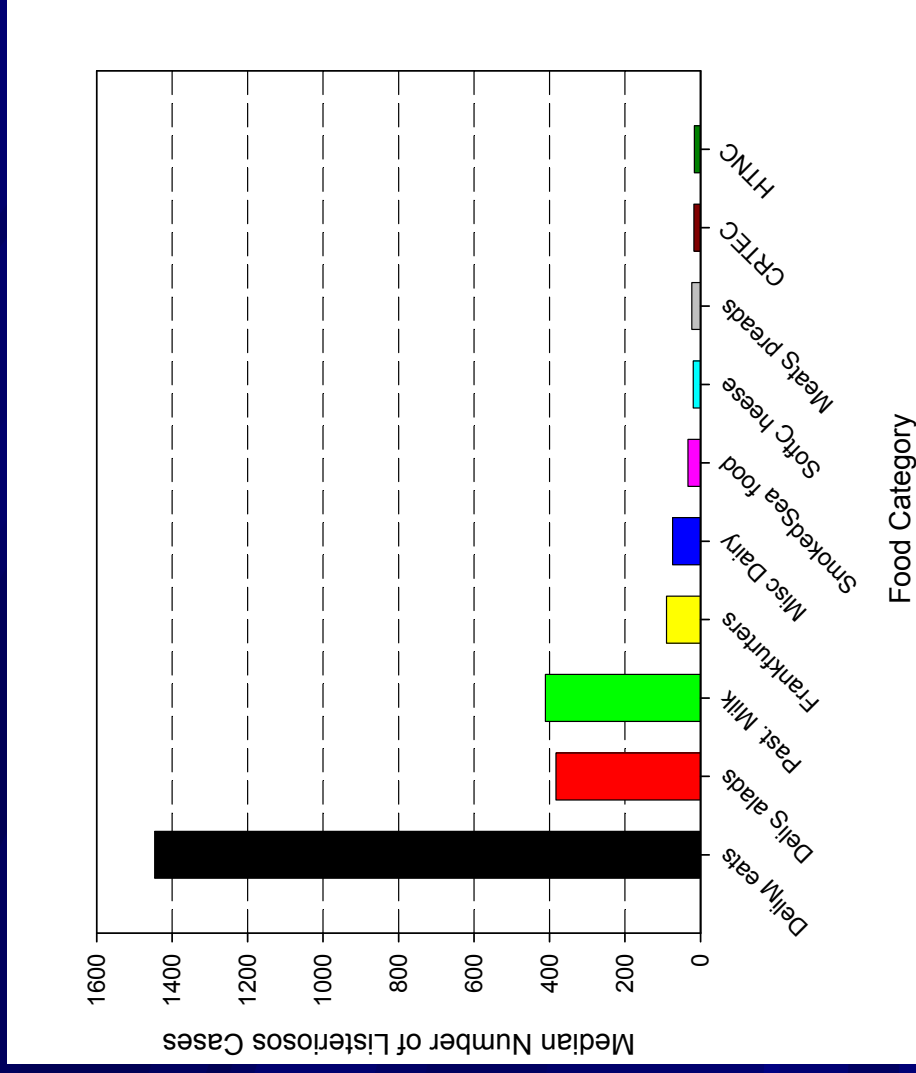
Listeria Public Meeting  
February 26, 2003

# Overview

- FDA *Listeria* risk ranking of RTE products
- FSIS Risk Management Questions
- FSIS *Listeria* Risk Assessment Model
- Data Inputs and Assumptions
- Model Implementation
- Risk Assessment Outputs
- Summary of Findings

# FDA Risk Ranking of RTE Products

- Approach: Relative Risk Ranking of Food Categories
- Purpose: Identify foods that pose the greatest public health risk and focus resources accordingly
- Evaluated Lm from retail to public health
- Available public comment
- Version 2 to be released



# FSS *Listeria* Risk Management Questions

- Examine the effectiveness of testing and sanitation of food contact surfaces on mitigating product contamination, and reducing the subsequent risk of illness
- Evaluate the effectiveness of other interventions (e.g., pre- and post-packaging interventions)
- Provide guidance on how frequently to test and sanitize food contact surfaces for *Listeria* spp.

# Possible Sources of Lm in RTE Products at Retail

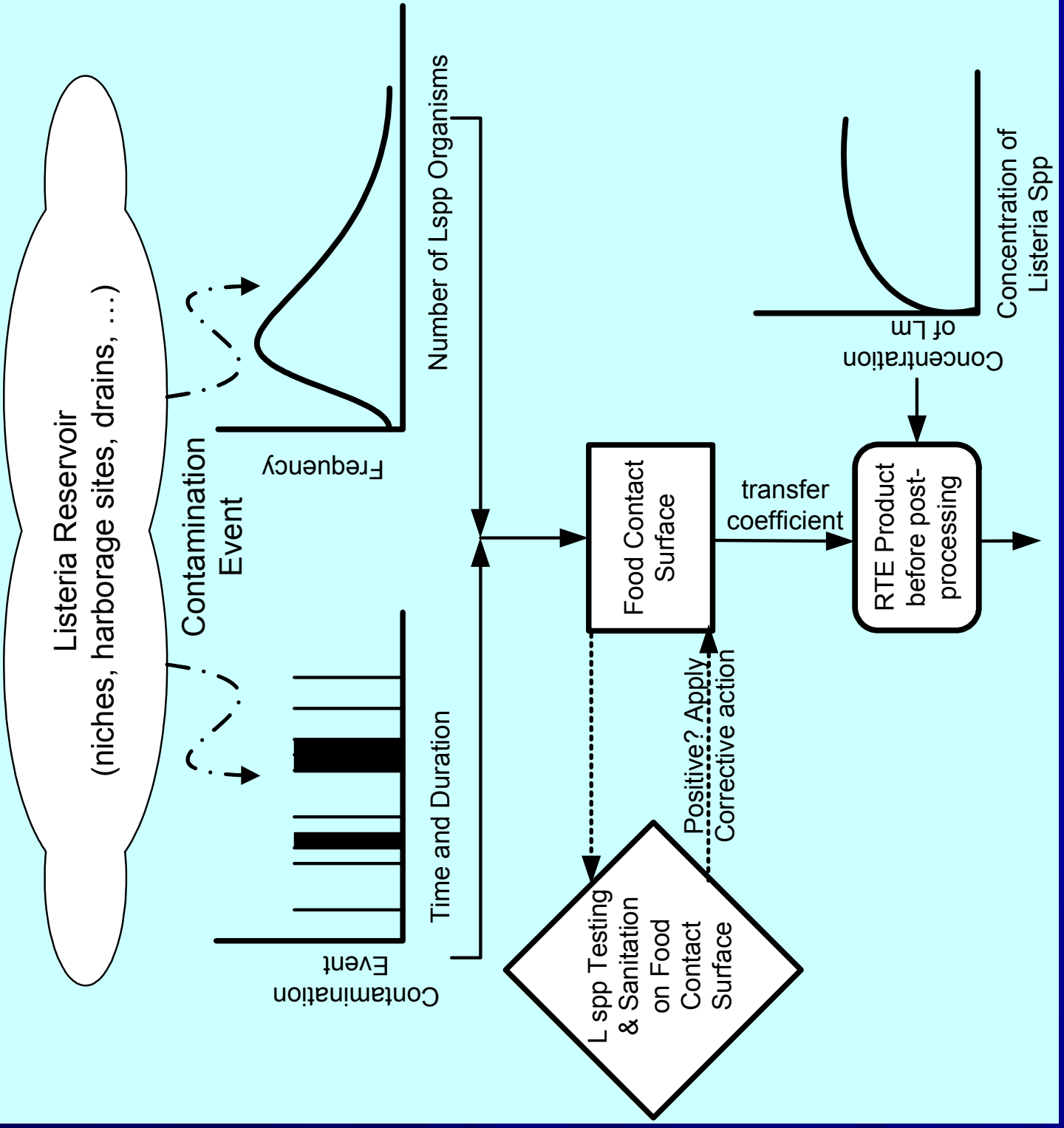
- Inadequate lethality during processing
- Direct deposition from non-food contact surface
- Transfer from food contact surface

⇒ Focus on food contact surfaces as the source of Lm

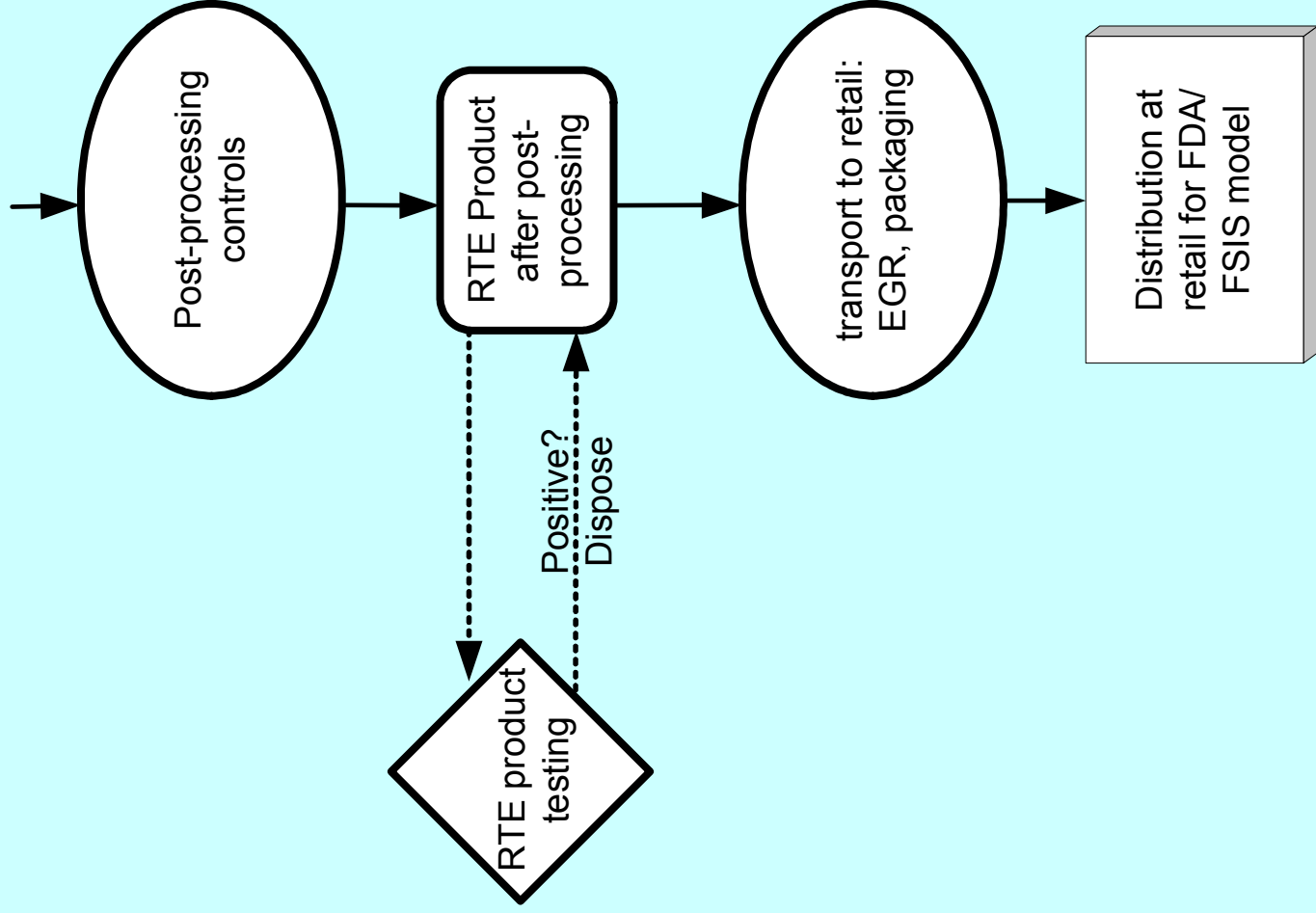
# Model Description

- Dynamic “in-plant” *Monte Carlo* model predicts Lm concentrations at retail
- Coupled with an updated version of the FDA *Listeria* risk assessment model to predict human health impacts
- Mass balance approach –track bacteria as move from one media to another
- Incorporates FCS testing, product testing, sanitation, pre- and post-packaging interventions, growth inhibitors
- Conducted on deli meats (“high risk”)

# Conceptual Model, Part I



# Conceptual Model, Part 2





# Risk Assessment Outputs

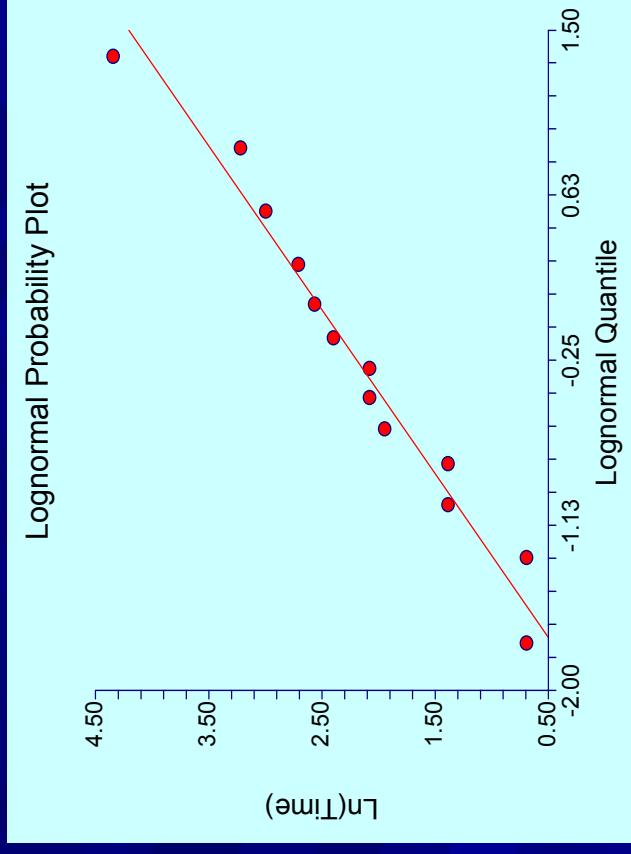
- The risk of illness or death on a per annum basis from Lm in deli meat as a function of:
  - Testing (*Listeria* spp.) and sanitation frequency (based on plant size) of food contact surfaces
  - Testing (Lm) and disposition of RTE product
  - Pre- and post-packaging interventions
- The likelihood of detecting Lm in a product lot if a FCS tests positive for *Listeria* spp.

# Key Data Requirements

- Contamination Events
  - frequency, duration, levels
- Transfer coefficients from FCS to product
- Lm to Lspp ratios
- Line production levels by plant size

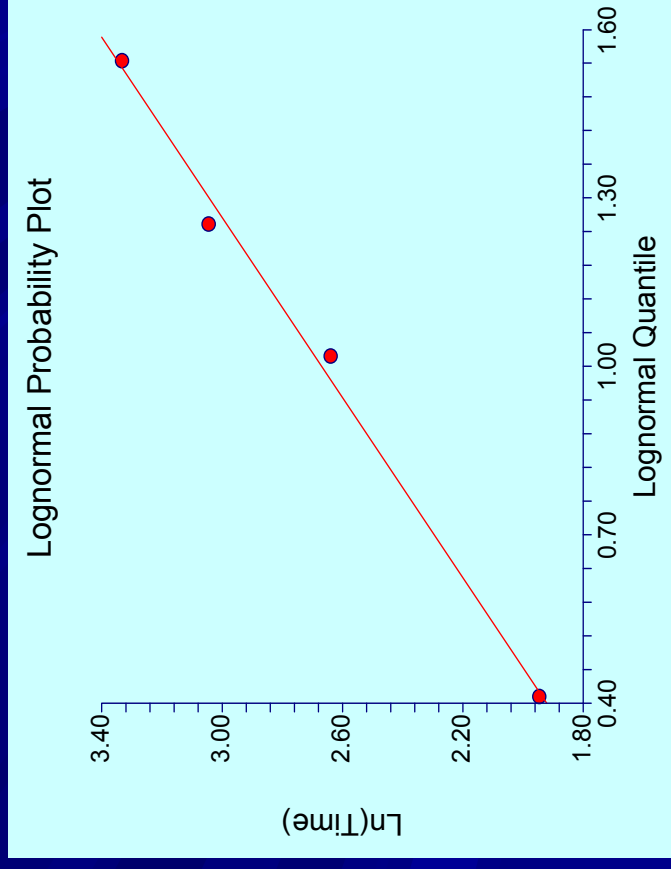
# Contamination Event: Frequency

- Data source: FSIS IDV data
- Date description: Lspp prevalence over time for various food contact surfaces
- Method: Fit with survival analysis
- Results: Log normal distribution
  - Mean time between contamination events: 23.1 days
  - Standard deviation: 38 days



# Contamination Event: Duration

- Data Source: Tompkin 2002
- Data description: Sequential weekly Lspp positives for food contact surfaces
- Method: Fit with survival analysis
- Results: log normal distribution
  - Mean: 8.8 days
  - Standard deviation: 2.1 days



# Transfer Coefficients

- Data Source: published literature
- Results:
  - Montville et al. (2001) and Chen et al. (2001) found that transfer coefficients of bacteria were log normally distributed. Range: 0.01% to 10% Standard deviation  $\sim 1$  log
  - Midelet & Carpentier (2002) found that after 12 contacts, 60%-100% of initial Lm transferred,  $\sim 100\%$  of other bacteria.
- LMRA uses a log mean of  $-0.14$  with a log SD of 1. Truncate to 100% at max.

# Lspp to Lm Ratio

- Data Source: prevalence data provided in Tompkin (2002) and blinded industry data (no available *Listeria* level data)
- Assumption: prevalence ratio used for level ratio
- Results: ratios fit (truncated) normal distribution
  - Mean: 52.6%
  - Standard deviation: 26.7%

# Production Levels/ Lot Volumes by Plant Size

- Data source: FSIS RTE Survey
- Lot size per line per shift varies by plant size:
  - Large: 48%, 19000 lb  $\pm$  14000
  - Small: 48%, 7100 lb  $\pm$  10600
  - Very Small: 4%, 2800 lb  $\pm$  9500
- Assume that FCS area varies proportionately.

# Contamination Event Added Lspp to Food Contact Surface

- Source: No available data (calibrated data input)
- Assumption: Added levels are log normally distributed
- Method: Calibrate the added levels so that the predicted Lm distribution at retail matches the FDA retail distribution



# Model Calibration

- FDA Lm concentration distribution at retail
- Prevalence of Lm in product
  - Levine et al. (2001) found prevalence from 0.52% - 5.16% in RTE meat and poultry. Generally decreasing with time. Generally 1-3% in 1999.
  - Luchansky (in press) found 1.6% prevalence in frankfurter packages
  - NFPA (2002) found 0.9% prevalence in RTE meat

# Preliminary USDA Data CY 2002

- HACCP code 03G (fully cooked, not shelf stable)
- subcategory: sliced, diced, shredded (e.g. sliced ham, sliced bologna, sliced chicken breast, diced chicken)
- 23 Lm positives out of 997 samples
- ⇒ prevalence of 2.3%

# Model Implementation and Baseline Data

# Data Entry Screens and Baseline Data

**Listeria monocytogenes risk assessment**


File Edit Help

Project Plant Data Contamination Data Post-Processing Data Advanced Data Simulation Graphs Output Stats

## Listeria monocytogenes Risk Assessment

**Model Run Information**

Run Name:	Base RTE Data Set
Authors:	Dan Gallagher
Date:	1/3/02
Description:	



Example Data

# Data Entry Screens and Baseline Data

Listeria monocytogenes risk assessment

File Edit Help

Project Plant Data

Contamination Data

Post-Processing Data

Advanced Data

Simulation

Graphs

Output Stats

## Plant Size Distribution

	Fraction produced (0-1)	Mean Lot Mass (lb)	Std. Dev. Lot Mass (lb)
Large:	<input type="text" value="0.48"/>	<input type="text" value="19371"/>	<input type="text" value="14000"/>
Small:	<input type="text" value="0.48"/>	<input type="text" value="7100"/>	<input type="text" value="10600"/>
Very Small:	<input type="text" value="0.04"/>	<input type="text" value="2800"/>	<input type="text" value="9500"/>

## Sanitation Data

Wipe Down Btw Lots Efficiency (0-1):	<input type="text" value="0.5"/>
End of Day Cleaning Efficiency (0-1):	<input type="text" value="0.75"/>
Enhanced Cleaning after FCS positive (0-1):	<input type="text" value="0.95"/>
Sequential FCS Positives to trigger enhanced cleaning	<input type="text" value="1"/>

## Food Contact Surface Testing

No. Tests / month	Test and Hold Product?
Large Plants <input type="text" value="4"/>	<input checked="" type="checkbox"/>
Small Plants <input type="text" value="2"/>	<input checked="" type="checkbox"/>
Very Small Plants <input type="text" value="1"/>	<input checked="" type="checkbox"/>

### Positive Result Actions

- Enhanced Cleaning
- Test Lot

### Testing Type:

- Systematic
- Random

## Product Testing

No. Tests / month	
Large Plants <input type="text" value="0"/>	
Small Plants <input type="text" value="0"/>	
Very Small Plants <input type="text" value="0"/>	

### Positive Result Actions

- Dispose product

### Testing Type

- Systematic
- Random

# Data Entry Screens and Baseline Data

Listeria monocytogenes risk assessment

File Edit Help

Project | Plant Data

Contamination Data

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Output Stats

## Contamination Event Timing (Normal log scale)

Mean Time btw Contamination Events (log10 d):

1.0768003

Std Dev for Time btw Contamination Events (log10 d):

0.4563359

## Transfer Coefficients (Normal Log scale)

Mean Transfer Coef (log10 fraction/lot):

-0.14

Std Dev Transfer Coef (log10 fraction/lot):

1

## Contamination Event Duration (Normal log scale)

Mean Contamination Event Duration (log10 d):

0.6019546

Std Dev Contamination Event Duration (log10 d):

0.5728621

## FCS Tested Area (Uniform)

Min FCS swabbed per test (cm<sup>2</sup>):

1000

Max FCS swabbed per test (cm<sup>2</sup>):

3000

Number of Swabs composited per sample:

1

## Contamination Event Levels (Normal log scale)

Mean Levels (log10 cfu/cm<sup>2</sup>):

-6

Std Dev for Levels (log10 cfu/cm<sup>2</sup>):

3.5

## RTE Sampled Mass (Uniform)

Min RTE Mass Sampled (g)

25

Max RTE Mass Sampled (g)

25



# Data Entry Screens and Baseline Data

**Listeria monocytogenes risk assessment**

File Edit Help

Project | Plant Data | Contamination Data | **Post-Processing Data** | Advanced Data | Simulation | Graphs | Output Stats

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### Post Processing Treatment

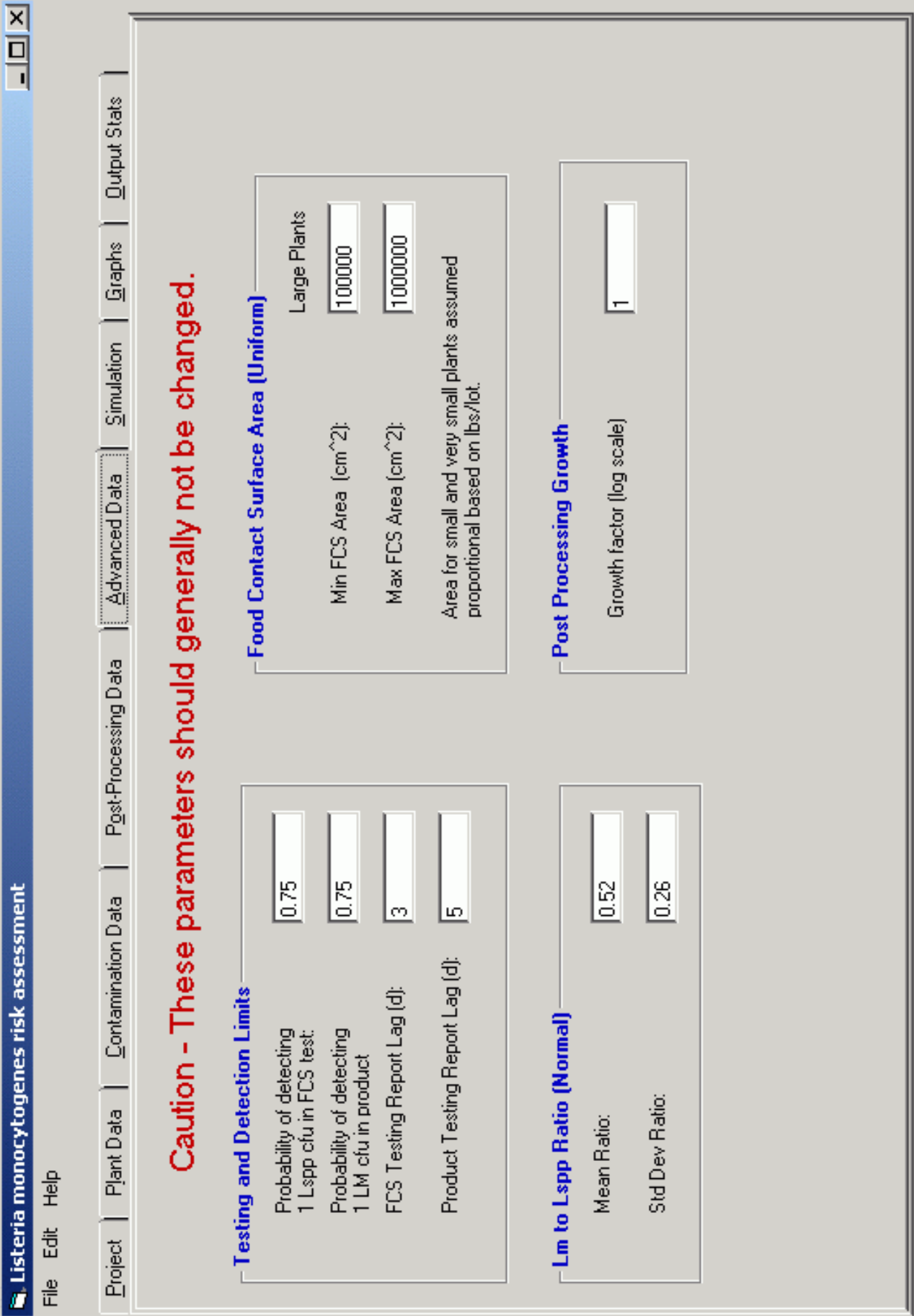
	Fraction of Plants Applying	Reduction in LM (Uniform)	
		Minimum	Maximum
Large:	<input type="text" value="0"/>	<input type="text" value="0.9"/>	<input type="text" value="0.95"/>
Small:	<input type="text" value="0"/>	<input type="text" value="0.9"/>	<input type="text" value="0.95"/>
Very Small:	<input type="text" value="0"/>	<input type="text" value="0.9"/>	<input type="text" value="0.95"/>

### Growth Inhibiting Packaging

	Fraction of Plants Applying	Fraction Efficiency (uniform)	
		Minimum:	Maximum:
Large:	<input type="text" value="0"/>	<input type="text" value="0.9"/>	<input type="text" value="0.95"/>
Small:	<input type="text" value="0"/>		
Very Small:	<input type="text" value="0"/>		

# Data Entry Screens and Baseline Data





# Data Entry Screens and Baseline Data

**Simulation Data**

No. Lots to Simulate: 1000000

Output file:

**Run Model**

**Calibration Choice**

RTE Deli Meats

Frankfurters

Log SSR: 1.02E+00

**Calibration Basics - Retail LM/g**

Percentile	FDA	Retail	PP Large
80th	7.4E-06	1.61E-06	2.20E-07
85th	3.7E-05	1.69E-05	2.22E-06
90th	2.7E-04	2.24E-04	2.87E-05
95th	5.5E-03	7.02E-03	9.12E-04
99th	1.5E+00	2.80E+00	3.62E-01
99.5th	1.1E+01	2.25E+01	3.01E+00
99.9th	7.9E+02	1.84E+03	2.52E+02
99.99th	1.4E+05	3.37E+05	3.77E+04
max		2.68E+09	3.22E+09

# Output Screens

Listeria monocytogenes risk assessment

File Edit Help

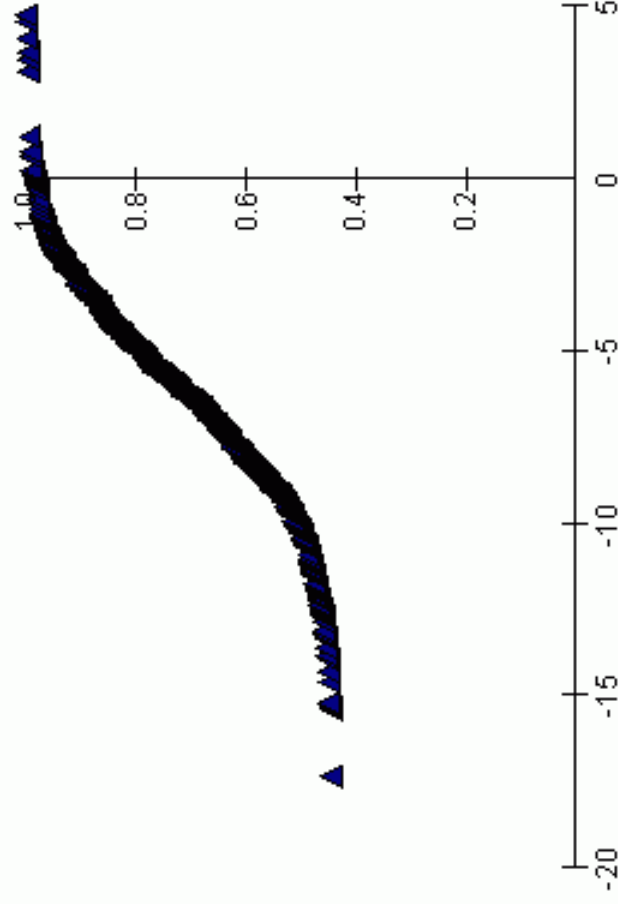
Project | Plant Data | Contamination Data | Post-Processing Data | Advanced Data | Simulation | Graphs | Output Stats

## Graph Selection

LM concentration in RTE product

Lspp concentration on FCS (large)

### Cumulative Probability



log10 Lm Conc (cfu/gm) at Retail

# Output Screens

Listeria monocytogenes risk assessment

File Edit Help

Project | Plant Data | Contamination Data | Post-Processing Data | Advanced Data | Simulation | Graphs | Output Stats

Statistic	Large	Small	Very Small	Selected
No. Lots Produced	1000000	1000000	1000000	
No. Lots Selected	480000	480000	40000	
No. Lots to Retail	480000	480000	40000	1000000
No. Lots Tested	0	0	0	0
by Routine	0	0	0	0
by FCS Positive	0	0	0	0
No. Lots Failed				
Q90 (cfu/gm)				2.24E-04
Q95 (cfu/gm)				7.02E-03
Q99 (cfu/gm)				2.80E+00
No. FCS tests	66667	33333	16667	
No. FCS tests failed	9283	4563	2264	

Contingency Table

	Lot pos	Lot neg	Lot not tested
FCS pos	0	0	9283
FCS neg	0	0	57384
FCS not tested	0	0	933333

Large Plant Results.  
Simultaneous tests.

Large Plant Results.  
Lagged tests.

	Lot pos	Lot neg	Lot not tested
FCS pos	0	0	9283
FCS neg	0	0	57384
FCS not tested	0	0	933330

# Results: Lot Timeline

Microsoft Excel - temp.csv

Type a question for help

100%

	A	B	H	I	K	L	M	N	O	Q	R	T	Z	AA
1	Plant Size	Lot	FCSLsspp	FCSSamp	FCSRResult	Lot Sampled by Rule	Lot Sampled by FCS	TC	Ratio	LM	LotResult	LM PP	EGRGIP	LMRetail
160	1	159	1.40E-07	#FALSE#	#FALSE#	#FALSE#	#FALSE#	0.715142	0.668024	2.47E-08	#ALSE#	2.47E-08	3.314167	5.09E-05
161	1	160	3.31E-08	#FALSE#	#FALSE#	#FALSE#	#FALSE#	0.526962	0.354752	1.41E-08	#ALSE#	1.41E-08	1.173214	2.10E-08
162	1	161	3.01E-05	#TRUE#	#TRUE#	#FALSE#	#TRUE#	0.550059	0.404765	1.37E-05	#FALSE#	1.37E-05	1.409263	3.52E-04
163	1	162	4.06E-06	#FALSE#	#FALSE#	#FALSE#	#FALSE#	0.730544	0.643598	4.96E-07	#FALSE#	4.96E-07	2.890273	3.85E-04
164	1	163	4.30E-07	#FALSE#	#FALSE#	#FALSE#	#FALSE#	0.602438	0.262777	3.20E-08	#FALSE#	3.20E-08	2.465419	9.34E-06
165	1	164	9.57E-08	#FALSE#	#FALSE#	#FALSE#	#FALSE#	0.555046	0.58718	4.44E-09	#FALSE#	4.44E-09	1.226191	7.48E-08
166	1	165	1.60E-05	#FALSE#	#FALSE#	#FALSE#	#FALSE#	0.637095	2.82E-02	1.43E-07	#FALSE#	1.43E-07	1.242085	2.51E-06
167	1	166	2.88E-06	#FALSE#	#FALSE#	#FALSE#	#FALSE#	0.640086	0.537224	2.39E-07	#FALSE#	2.39E-07	2.07372	2.83E-05
168	1	167	3.79E-07	#FALSE#	#FALSE#	#FALSE#	#FALSE#	0.585492	0.490195	4.01E-08	#FALSE#	4.01E-08	2.943002	3.52E-05
169	1	168	9.23E-08	#FALSE#	#FALSE#	#FALSE#	#FALSE#	0.513764	0.863711	1.03E-08	#FALSE#	1.03E-08	4.047933	1.16E-04
170	1	169	2.69E-06	#FALSE#	#FALSE#	#FALSE#	#FALSE#	0.448338	0.30089	8.21E-08	#FALSE#	8.21E-08	4.024186	8.68E-04
171	1	170	6.02E-07	#FALSE#	#FALSE#	#FALSE#	#FALSE#	0.551965	0.57753	2.76E-08	#FALSE#	2.76E-08	1.580898	1.05E-06
172	1	171	1.12E-07	#FALSE#	#FALSE#	#FALSE#	#FALSE#	0.560612	0.305105	6.76E-09	#FALSE#	6.76E-09	1.675812	3.21E-07
173	1	172	2.71E-08	#FALSE#	#FALSE#	#TRUE#	#FALSE#	0.516871	0.649256	1.81E-09	#FALSE#	1.81E-09	5	1.81E-04
174	1	173	8.19E-07	#FALSE#	#FALSE#	#FALSE#	#FALSE#	0.49631	0.917608	1.82E-07	#FALSE#	1.82E-07	5	0.018187
175	1	174	1.69E-07	#FALSE#	#FALSE#	#FALSE#	#FALSE#	0.587628	0.961844	9.97E-09	#FALSE#	9.97E-09	2.551746	3.55E-06
176	1	175	1.43E-06	#FALSE#	#FALSE#	#FALSE#	#FALSE#	0.571188	0.334257	2.32E-07	#FALSE#	2.32E-07	5	2.32E-02
177	1	176	1.66E-07	#TRUE#	#FALSE#	#FALSE#	#FALSE#	0.768033	0.490933	5.44E-08	#FALSE#	5.44E-08	2.621284	2.27E-05
178	1	177	1.29E-07	#FALSE#	#FALSE#	#FALSE#	#FALSE#	0.435525	0.680662	4.57E-09	#FALSE#	4.57E-09	5	4.57E-04
179	1	178	3.81E-08	#FALSE#	#FALSE#	#FALSE#	#FALSE#	0.411059	0.652467	2.50E-09	#FALSE#	2.50E-09	4.628433	1.06E-04

temp

Ready

# Post processing Growth ?

- FDA model assumes about 1.9 logs of growth on average between processing and retail.

Source	% at Processing	% at Retail
FSIS	1% - 3% measured	?
NFPA	?	0.9% measured

- LMRA uses same approach as FDA but with less growth (1 log vs 1.9 logs). Lack of variability may impact growth-inhibiting-packaging conclusions.



# Analysis of growth

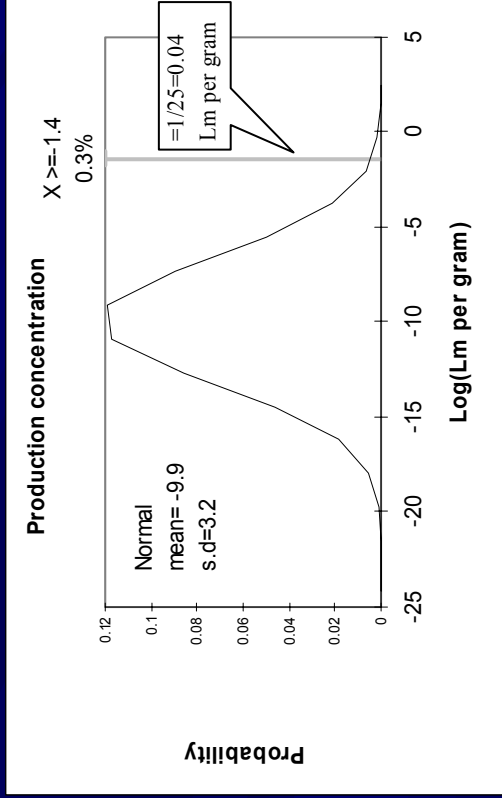
$$\begin{array}{l} \text{Production} \\ \text{Log(Lm per gram)} \end{array} + \begin{array}{l} \text{Growth} \\ \text{Log(Growth)} \end{array} = \begin{array}{l} \text{Retail} \\ \text{Log(Lm per gram)} \end{array}$$

$$\text{Normal}(\mu_1, \sigma_1) + \text{Normal}(\mu_2, \sigma_2) = \text{Normal}(\mu_1 + \mu_2, \sigma_1^2 + \sigma_2^2)$$

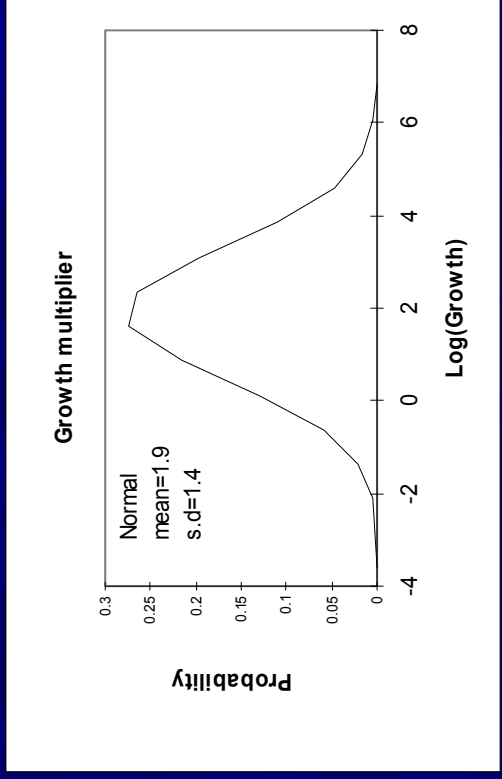
Given a retail distribution,  
solve for production distribution  
for different assumed growth distributions.

*Then examine implied sample prevalence levels  
assuming a test positive threshold of 1 Lm organism  
in 25 gram samples.*

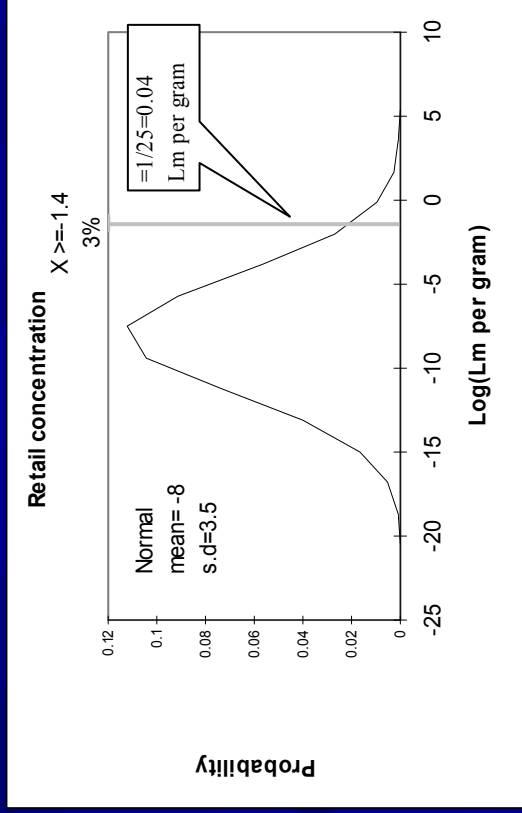
# Case 1



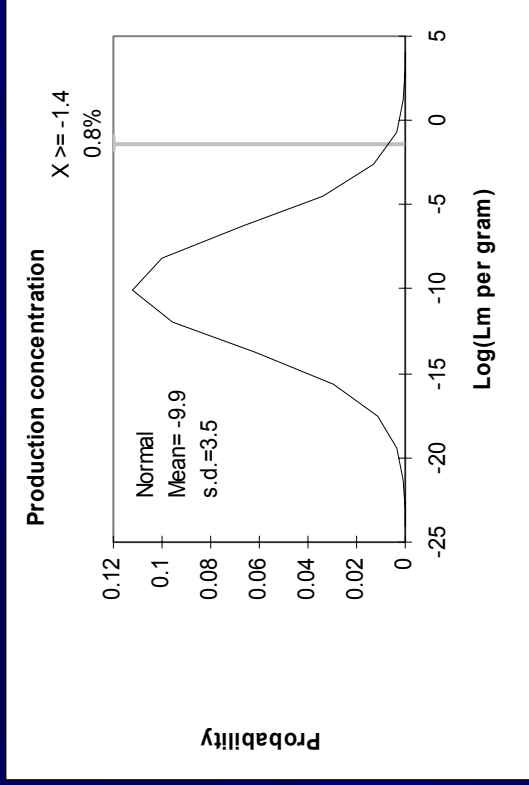
+



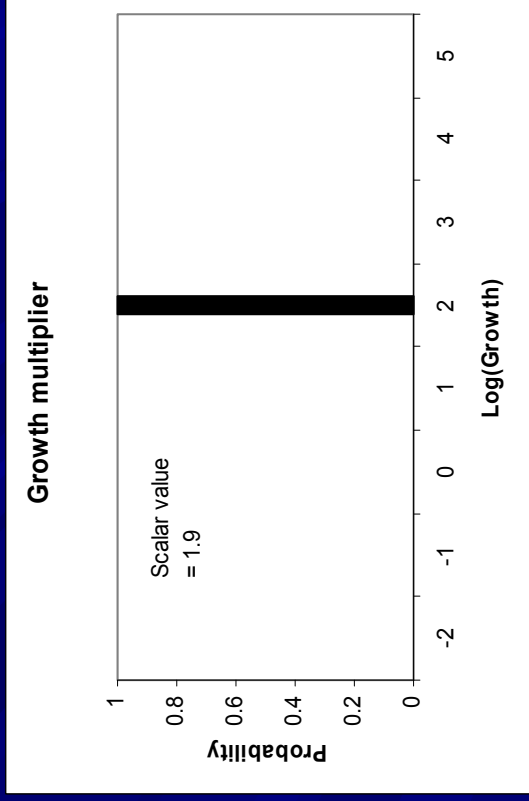
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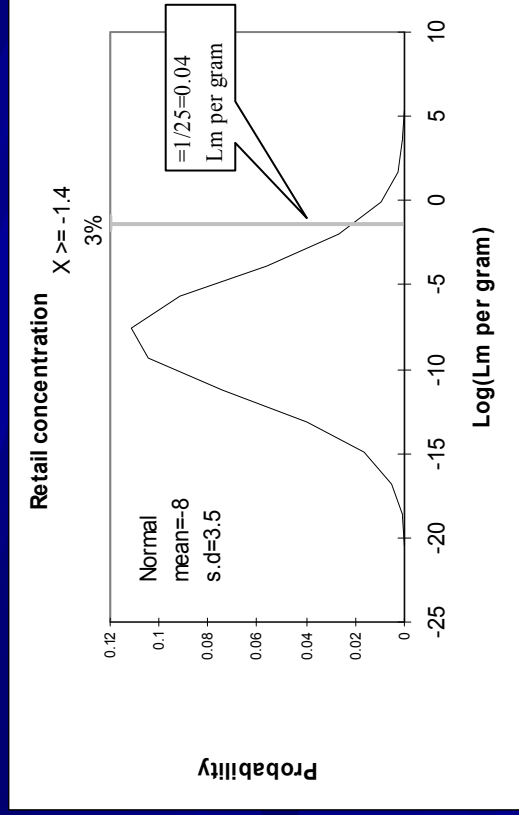
# Case 2



+

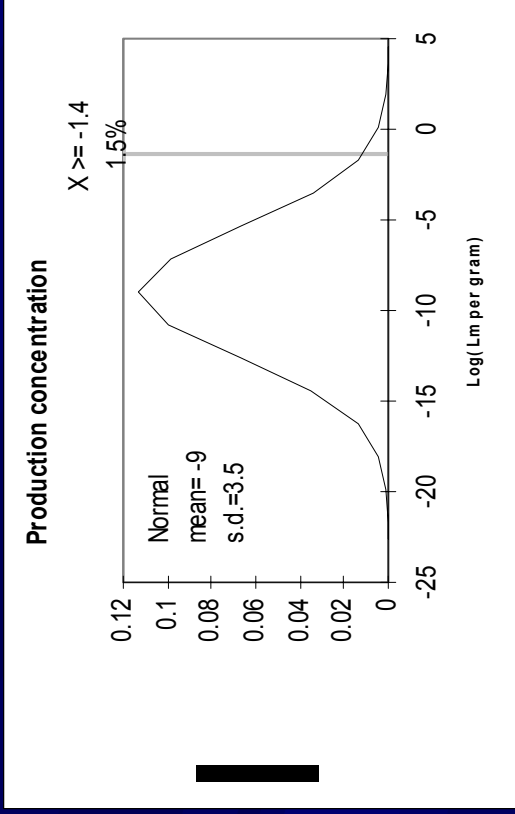


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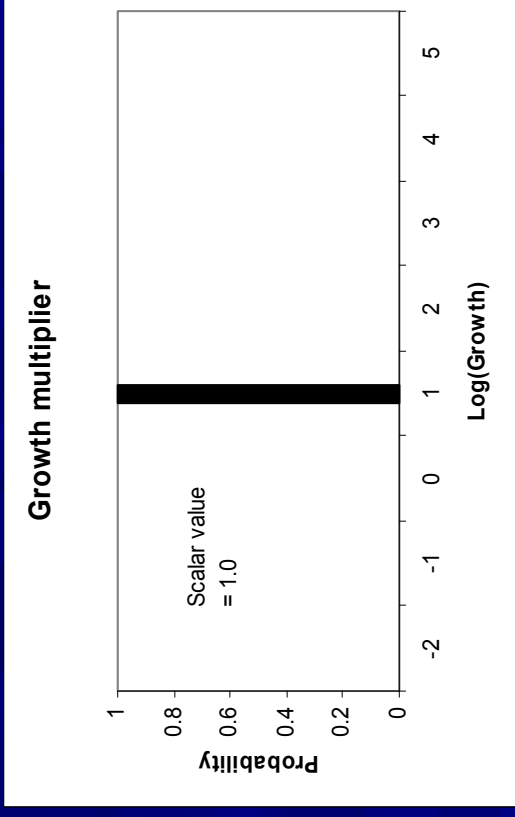




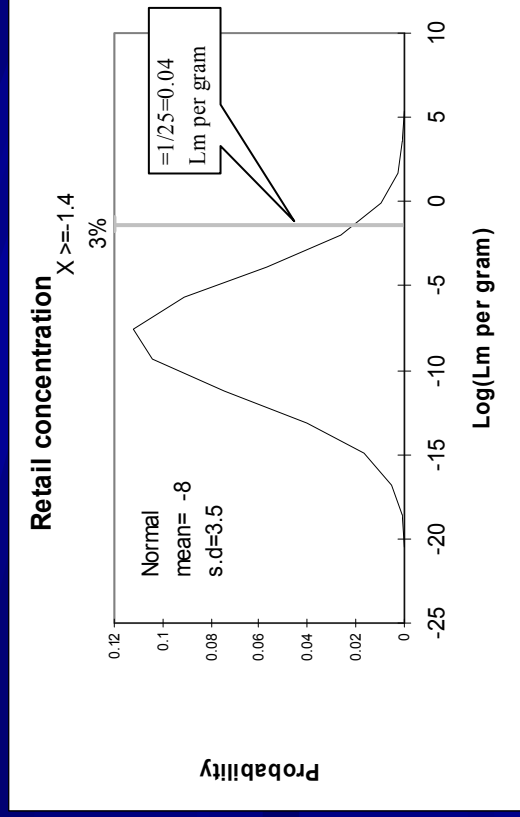
# Case 3



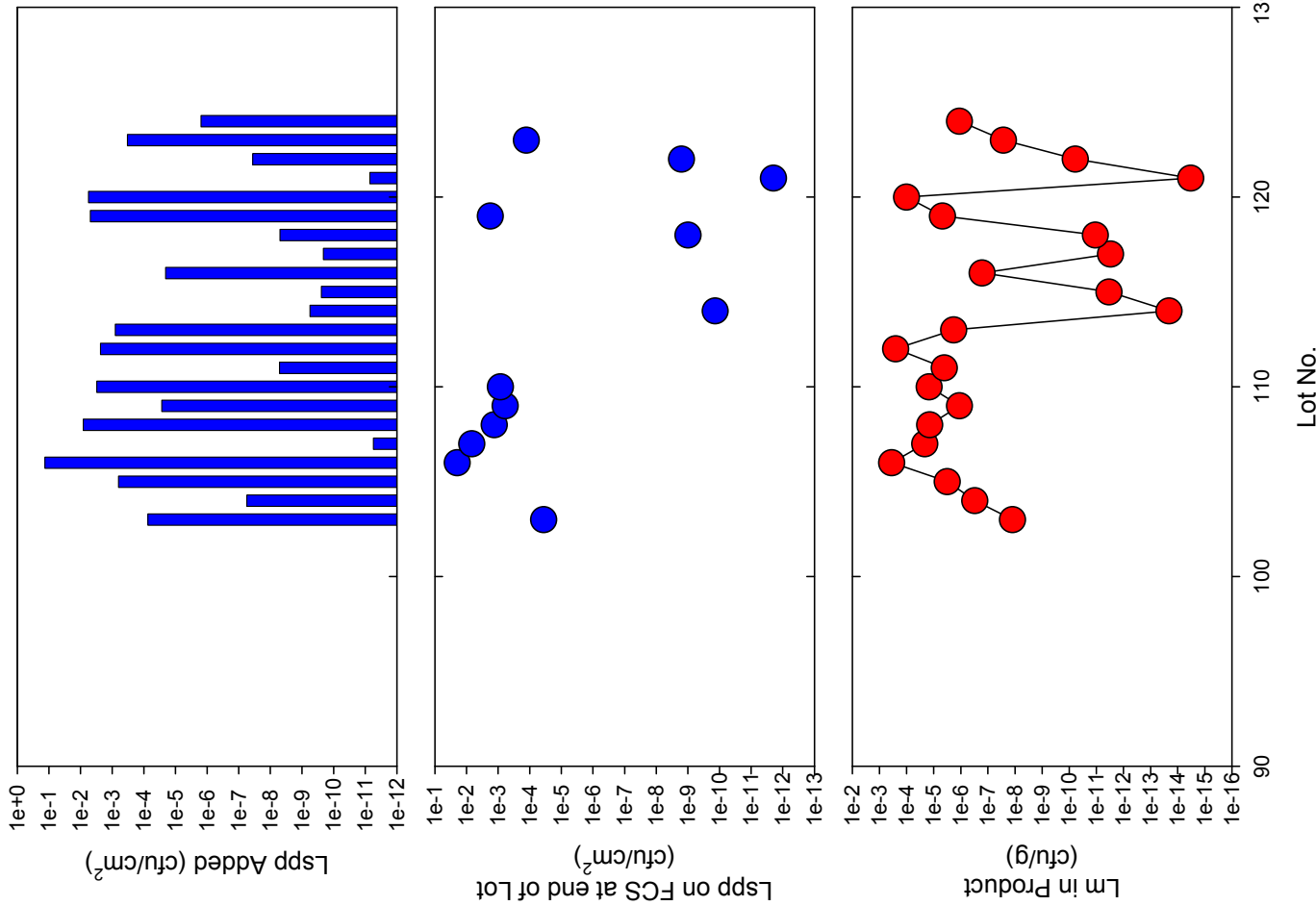
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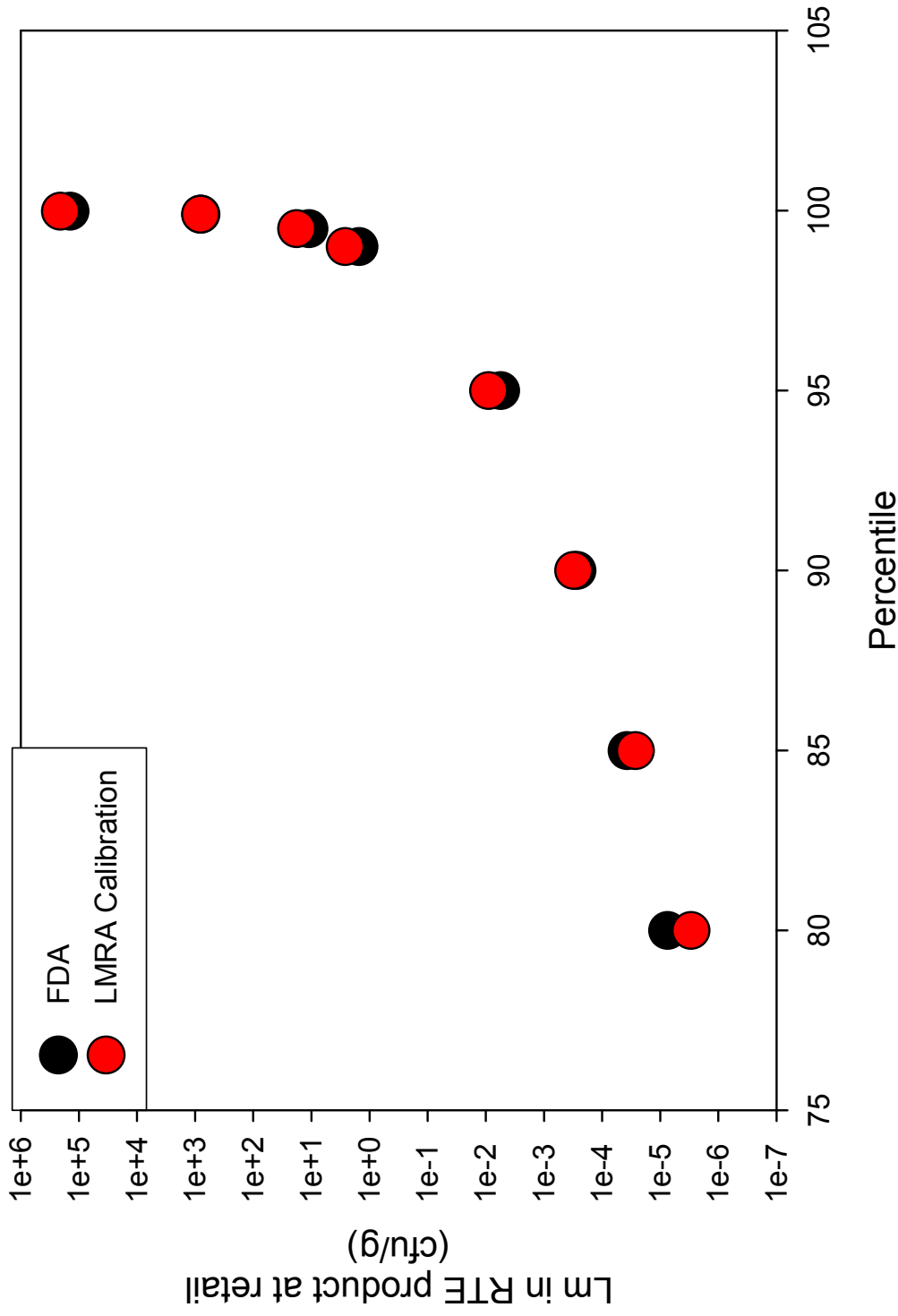


# Mass Balance: Tracking Lsp on FCS



# Model Evaluation

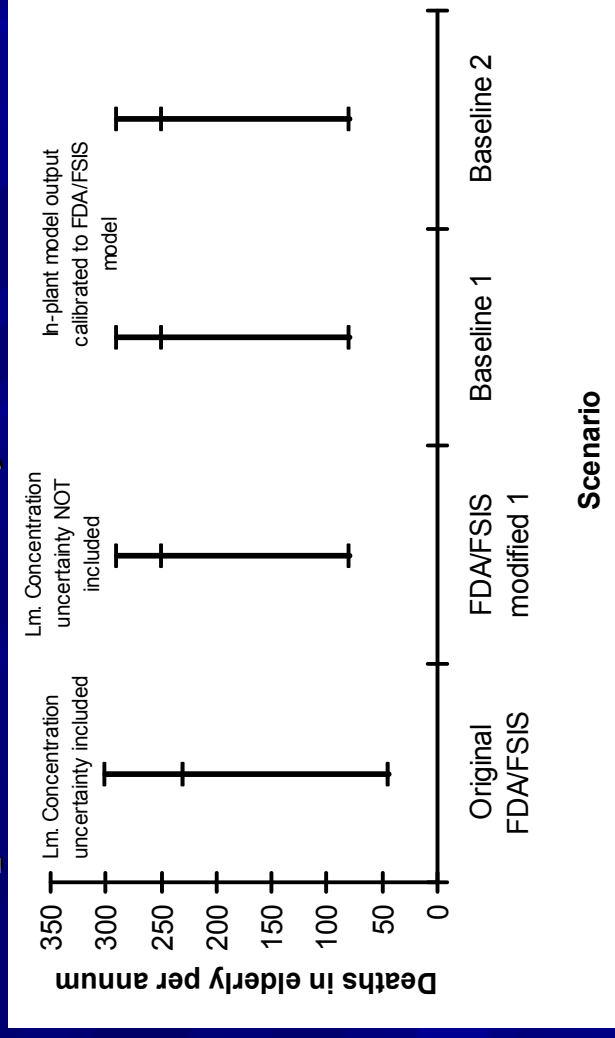
# Comparison of FSIS Model Outputs to FDA Risk Assessment Inputs



# Baseline predictions

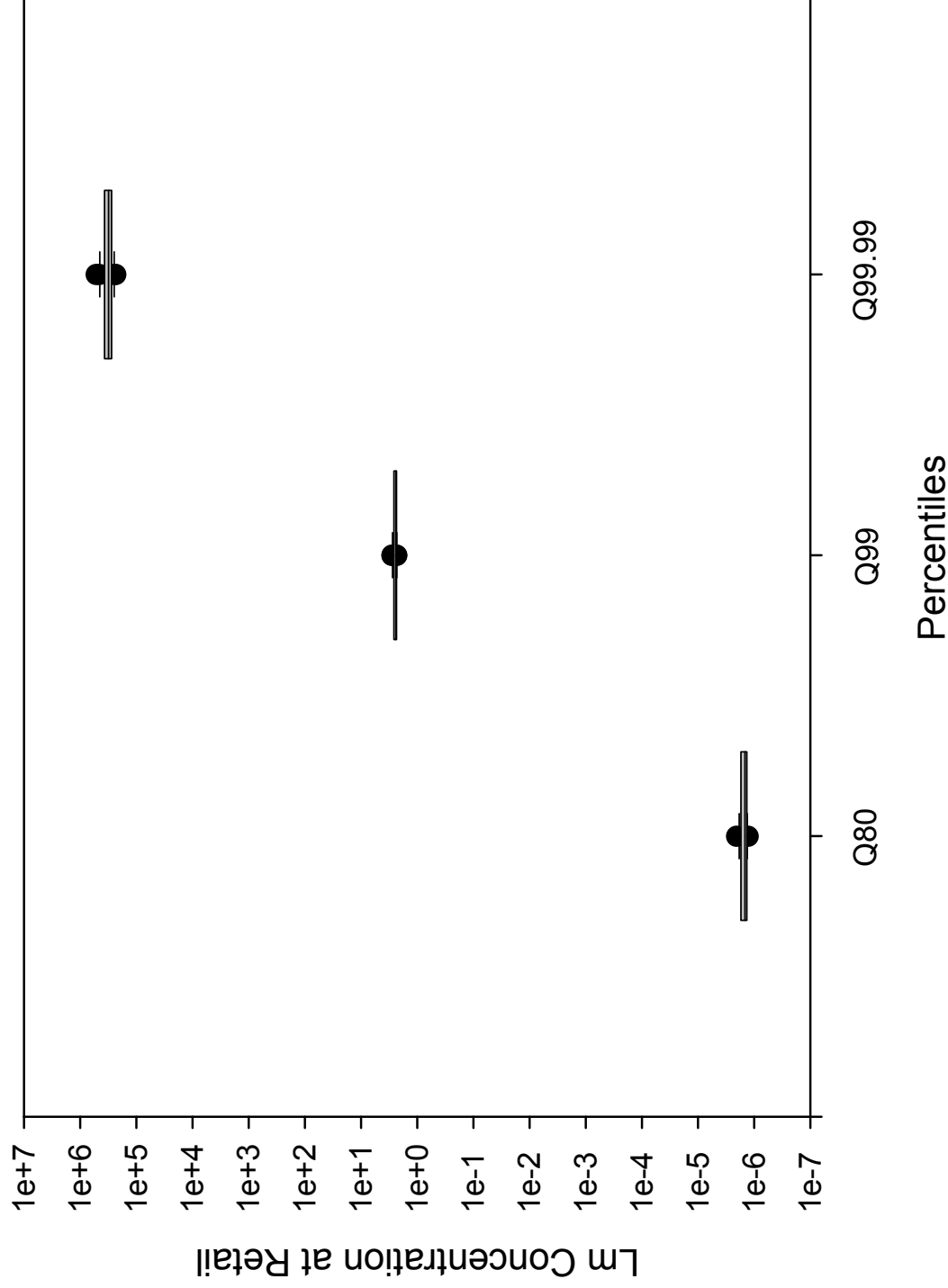
Median, 5<sup>th</sup> and 95<sup>th</sup> percentiles  
in predicted elderly deaths

- Calibration to “average” updated FDA/FSIS model Lm concentration in retail deli meat distribution
- Lack of uncertainty about concentration has small effect on uncertainty about public health predictions
- In-plant baseline predictions repeatable



# Model Stability

Variability of 20 runs of 4-2-1 scenario  
(1,000,000 lots per run)



# Model Results

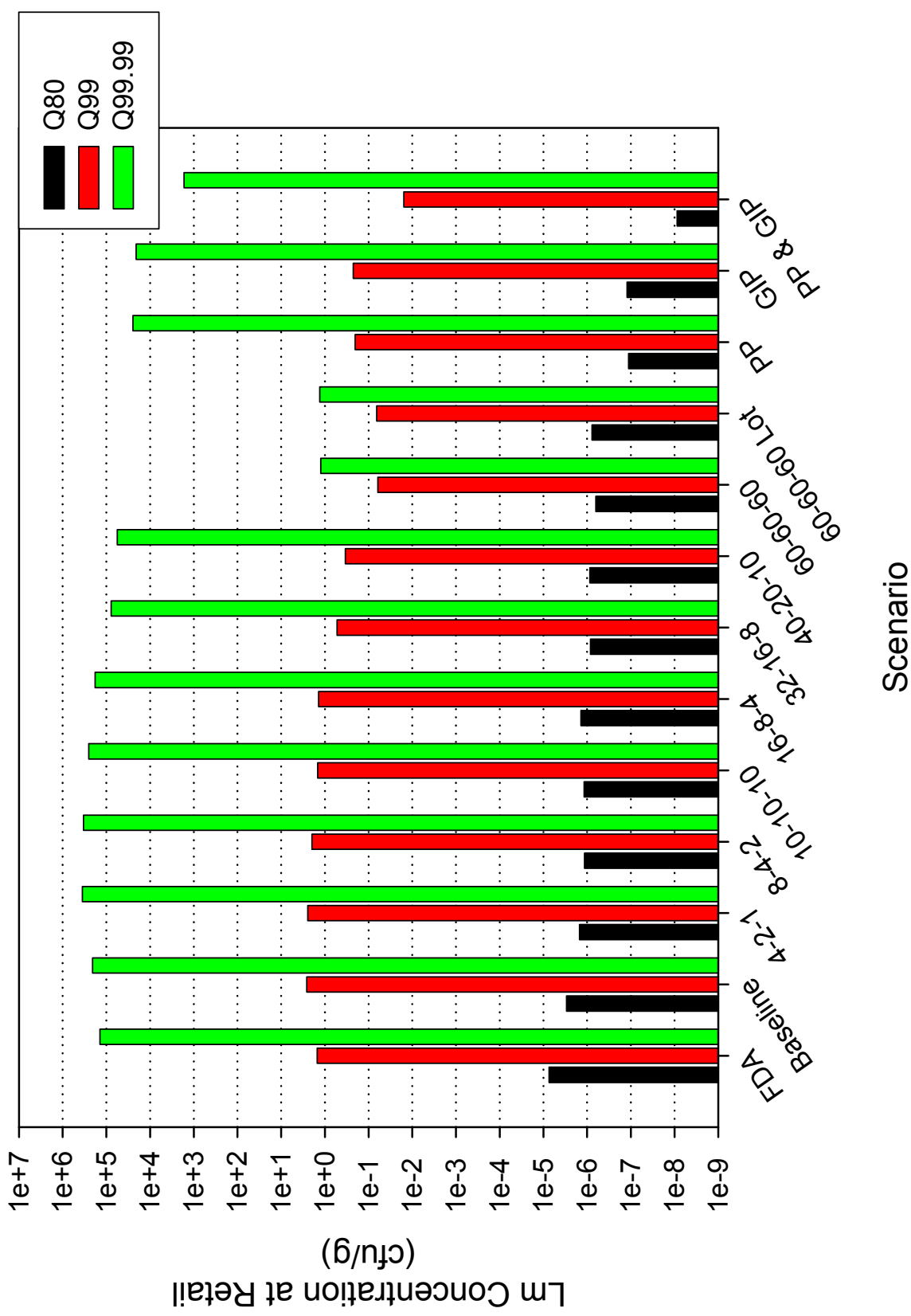
# Scenarios Tested

- Baseline calibration: no testing, no interventions, no post-processing, no GIP
- FCS Testing Levels, test and hold yes, dispose product yes, test lot yes, enhanced cleaning yes (No. tests per line per month for large, small, very small plants)
  - 4-2-1
  - 8-4-2
  - 10-10-10
  - 16-8-4
  - 32-16-8
  - 60-60-60
- 60-60-60 Lot testing, dispose product yes
- 100% post-processing treatment (90% - 95% effective) for all three plant sizes, no testing
- 100% growth-inhibiting packaging (90% 95% effective) for all three plant sizes, no testing

All scenarios tested for production of 1,000,000 lots.



# FCS Testing/Sanitation Impacts



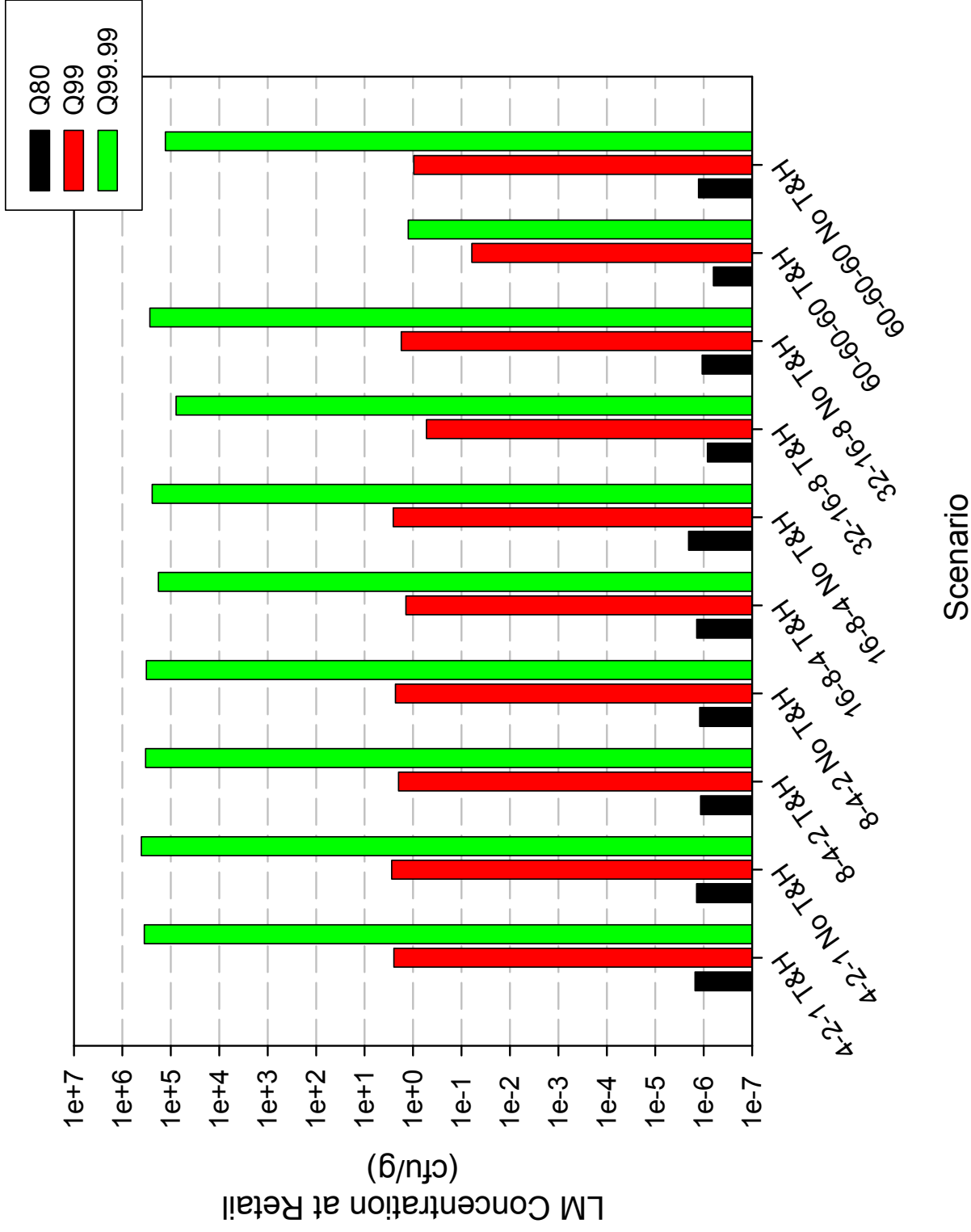
# Contingency Table: Likelihood of Detecting *Listeria* spp./Lm

	RTE +	RTE -	Sum
FCS +	21635	115940	137575
FCS -	8	862417	862425
Sum	21643	978357	1000000

- Overall FCS prevalence of ~ 13.7%
- Overall Lot prevalence of ~2.2%
- Lot prevalence when FCS is positive ~15.7%
- FCS testing improves lot testing by factor of 7

60-60-60 FCS tests, 60-60-60 lot tests, test and hold in place

# Test and Hold Comparison



# Test and Hold Evaluation

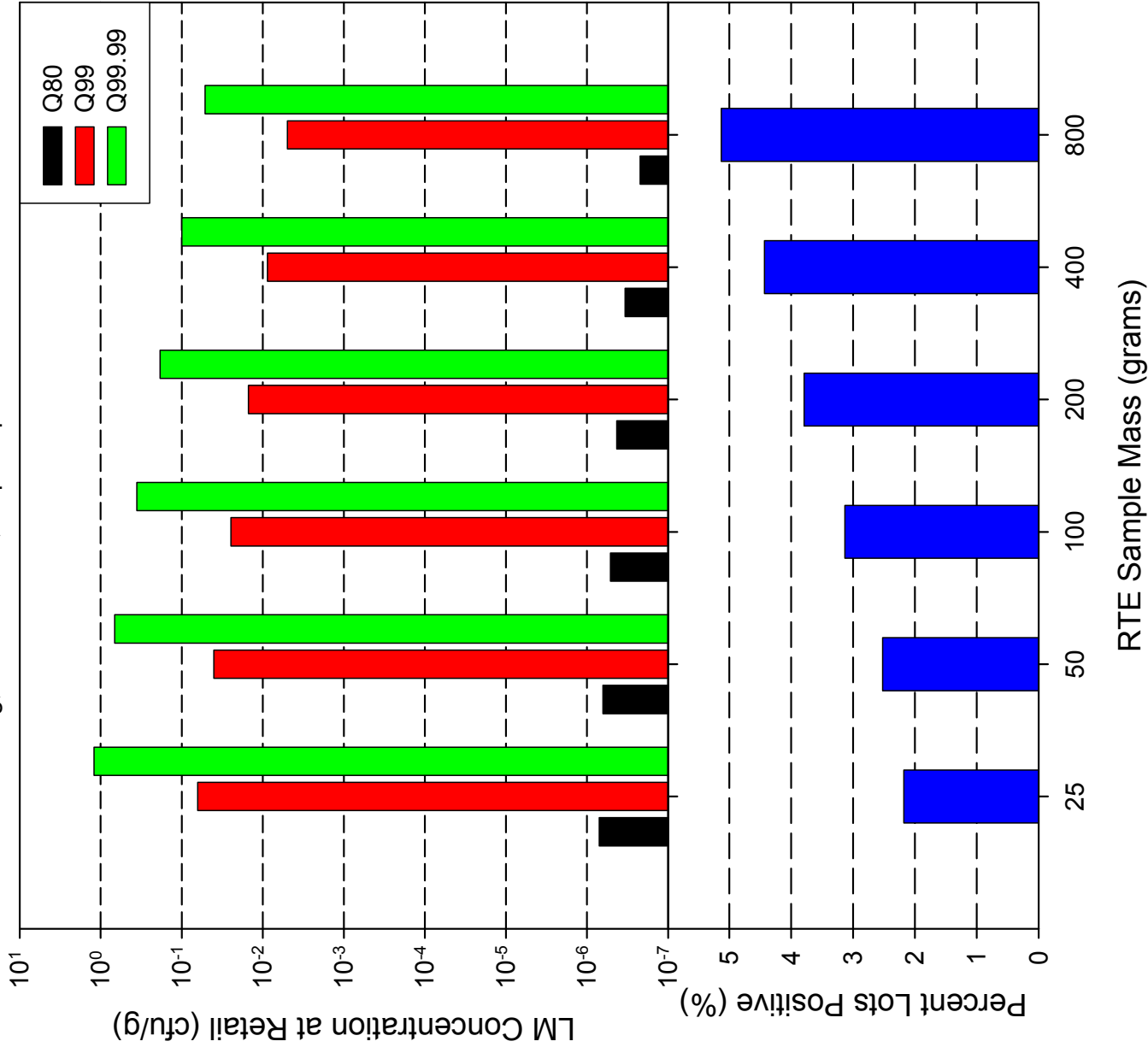
Sample Hold?	Frequency	FCS Tests	FCS Positives	Lot Tests	Lot Positives	% FCS Positives	% Lot Positives
4 Yes	66667	9171	9171	1432	13.8	15.6	
4 No	66666	9442	9442	422	14.2	4.5	
60 Yes	1000000	132914	132914	20560	13.3	15.5	
60 No	1000000	131867	131867	5268	13.2	4.0	

- Overall FCS prevalence approximately constant at ~13-14 % regardless of test and hold.
- Overall lot prevalence 15-16% if test and hold, 4-5% if not test and hold
- Recall overall lot prevalence ~2.2%
- For retail Lm, test and hold only significant at more frequent FCS testing

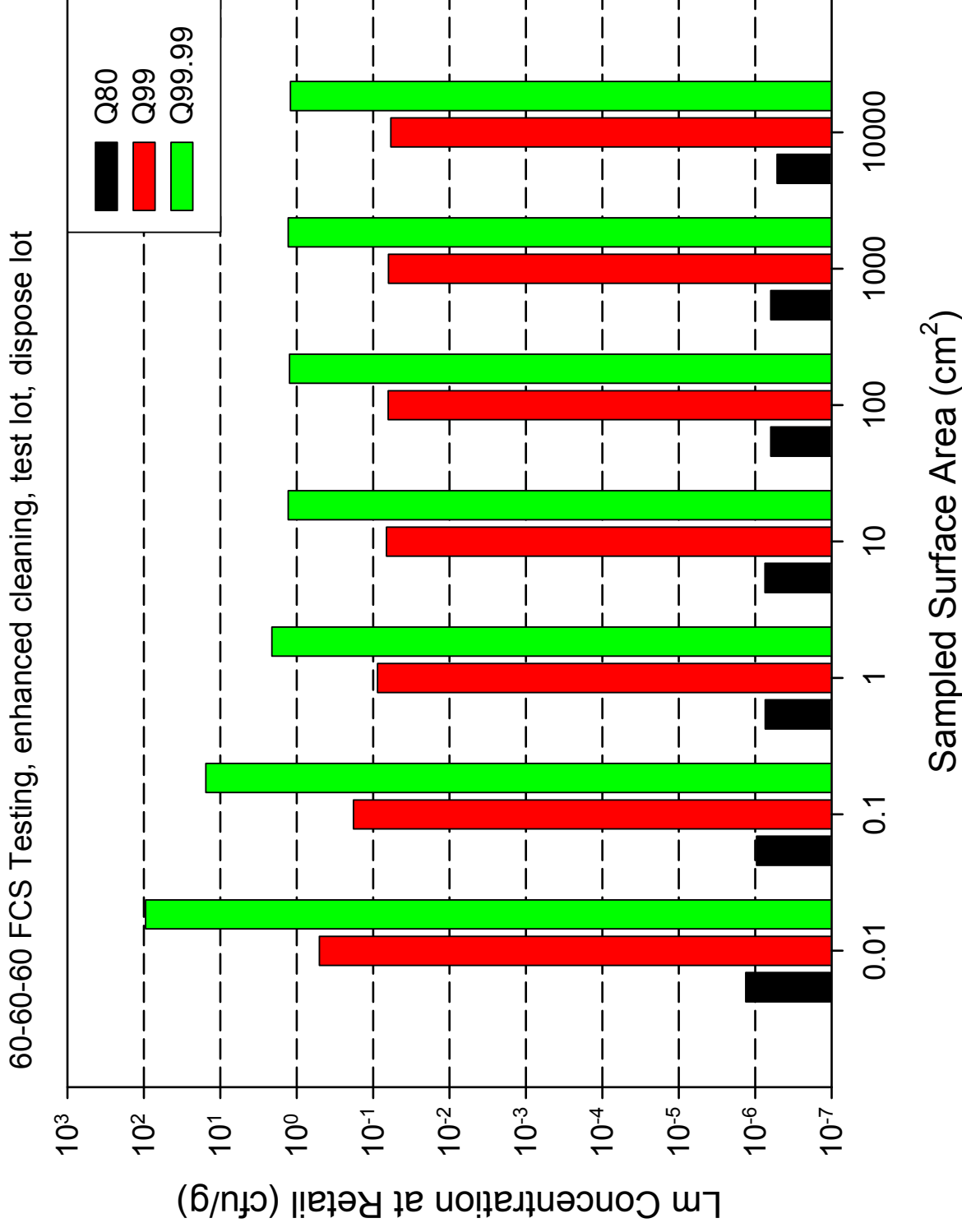
# Sensitivity Analysis

# Sensitivity Analysis: Sampled RTE Mass

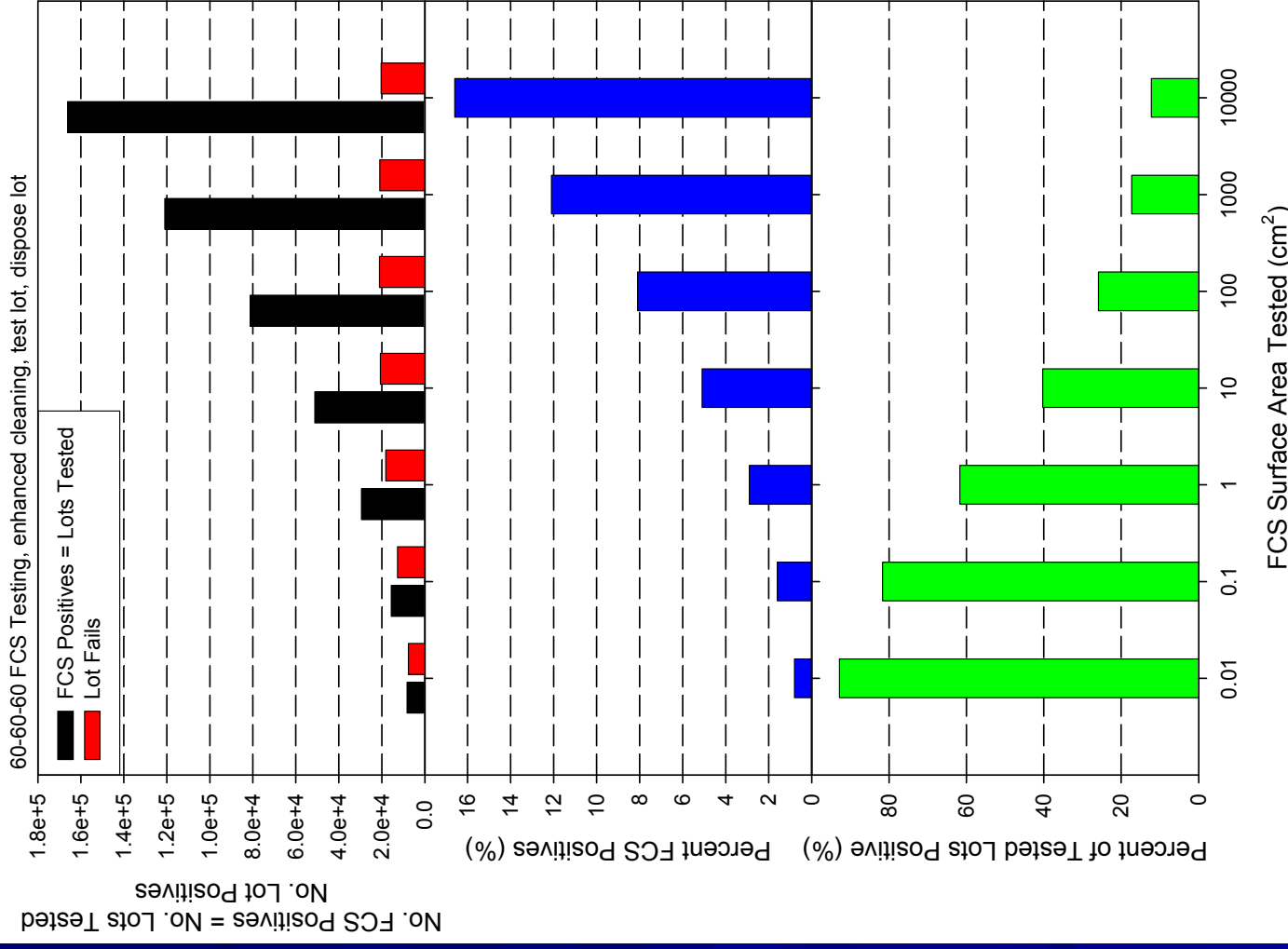
60-60-60 Lot testing, test and hold, dispose product



# Sensitivity Analysis: FCS Area Tested

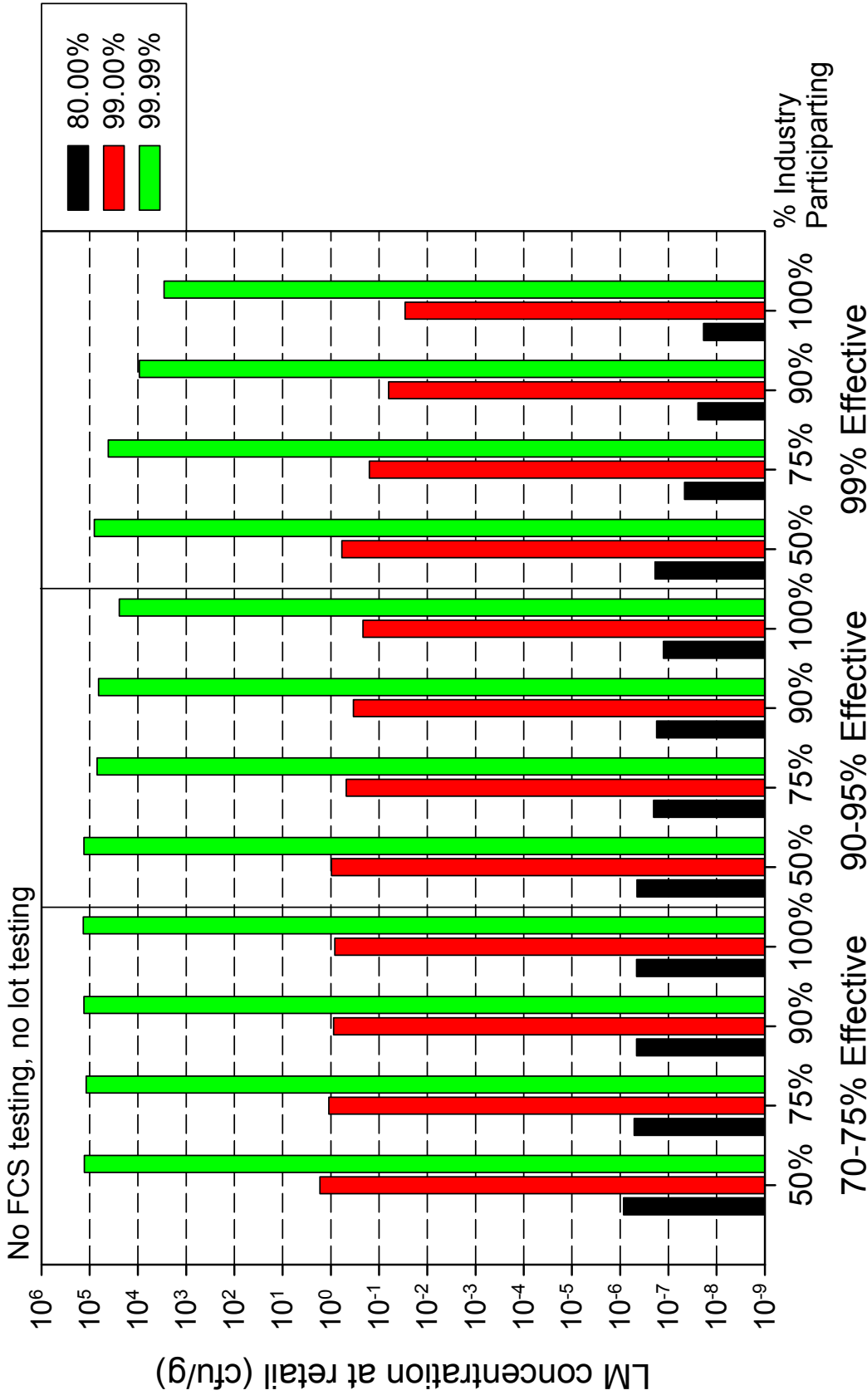


# Sensitivity Analysis: FCS Area Tested





# Sensitivity Analysis: Post processing



**Post processing (Industry participation, effectiveness)**

# Evaluation of prevalence for different Lm/Lspp ratios

Each new ratio requires a recalibration to match the observed Lm distribution at retail. These results are preliminary

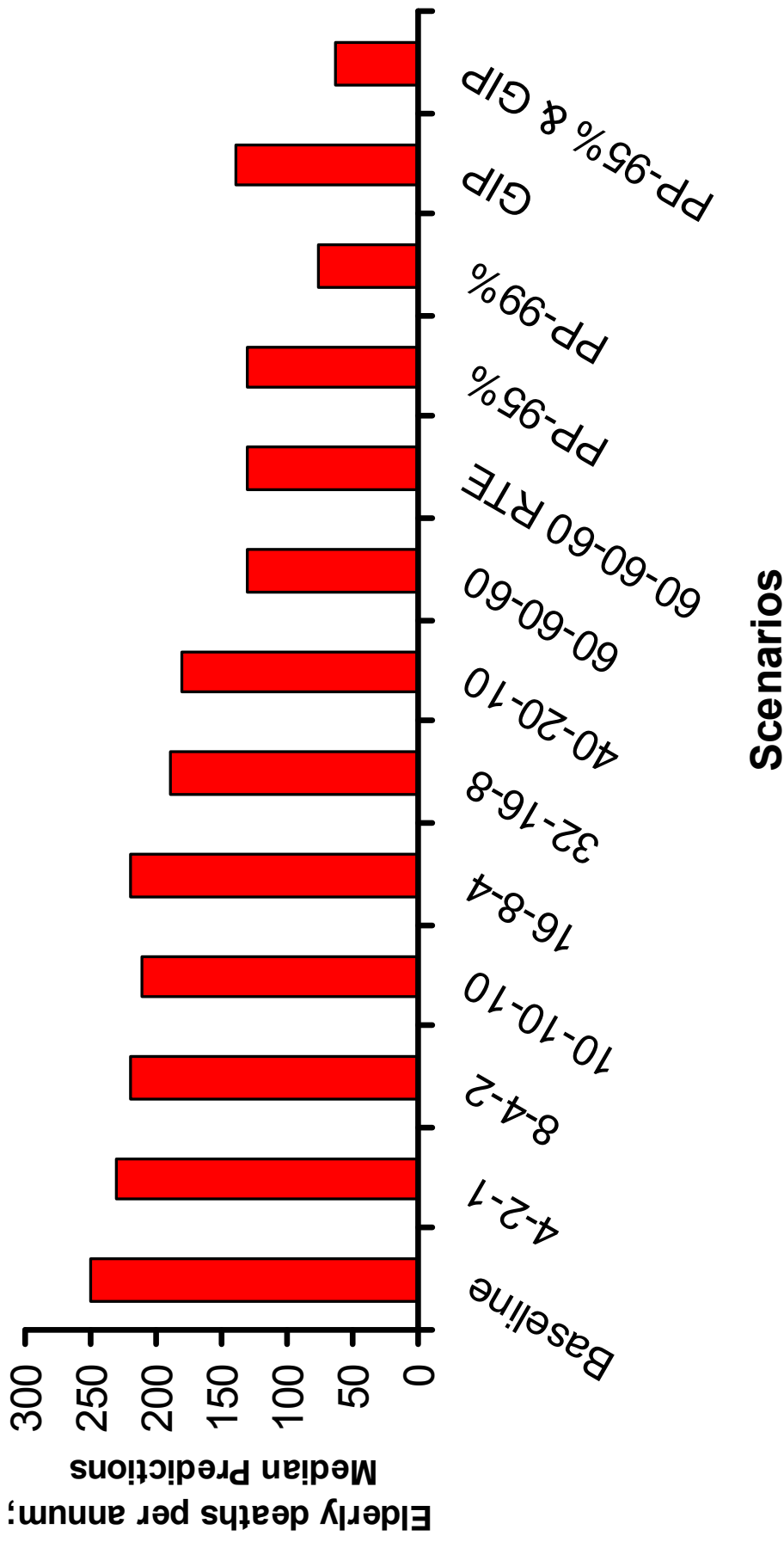
Parameter	Low Ratio	Baseline	High Ratio
Mean Lm/Lspp ratio	0.052	0.52	0.95
Std dev Lm/Lspp ratio	0.026	0.26	0.026
Mean Lspp/cm <sup>2</sup> added during contamination event (log scale)	-5	-6	-6.4
Std dev Lspp/cm <sup>2</sup> added	3.5	3.5	3.5
overall lot prevalence (%)	2.2	2.2	2.0
overall FCS prevalence (%)	18.7	13.8	12.0
contingent lot prevalence when FCS is positive (%)	11.7	15.7	17.0
Improvement	5.3	7.1	8.5

# Sensitivity Analysis Findings

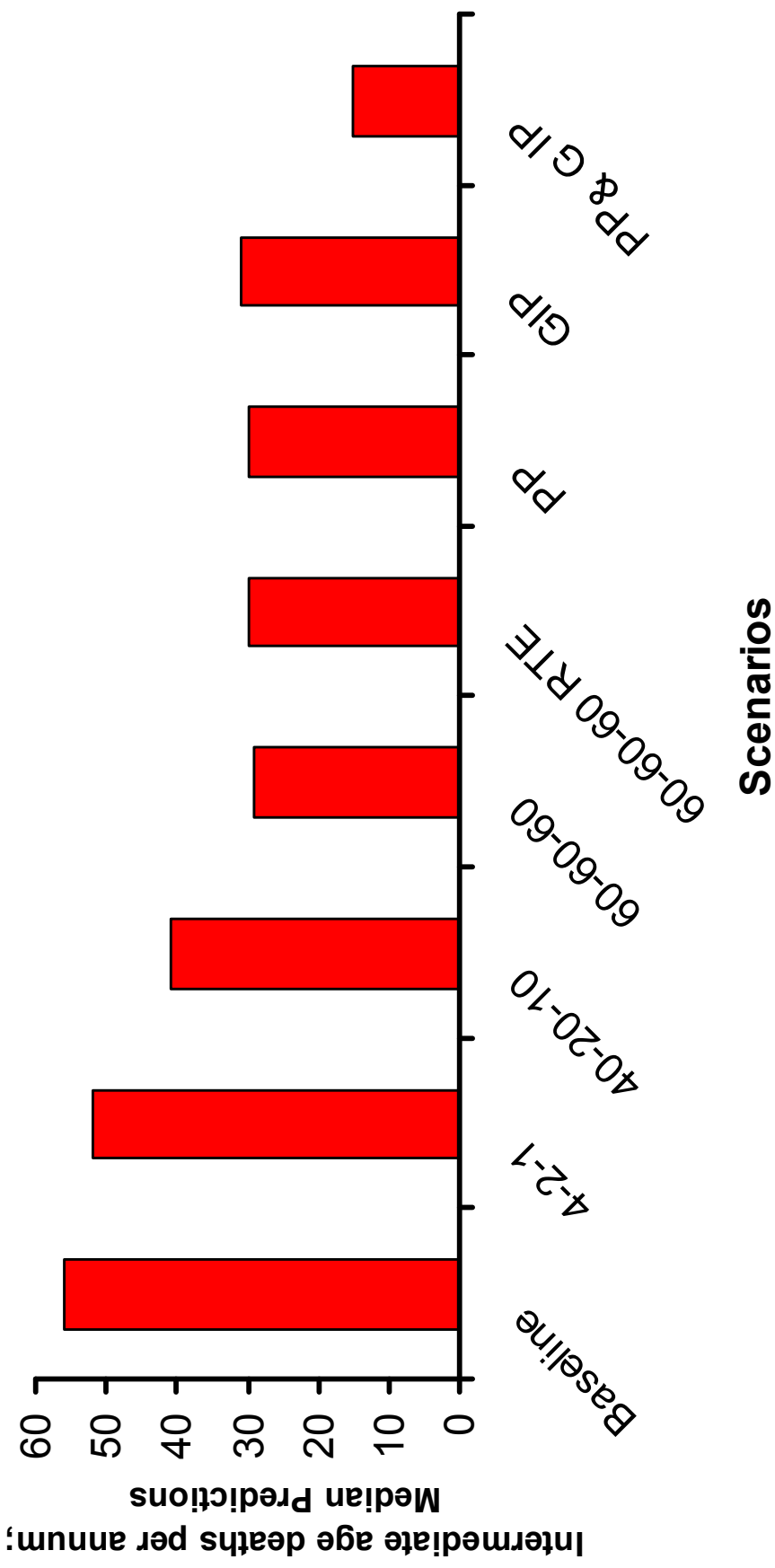
- ↑ RTE sampled mass, ↓ retail  $L_m$ 
  - Mass should be limited only by lab considerations.
- ↑ FCS area sampled, ≈ retail  $L_m$ 
  - Caution: assumes  $L_m$  evenly distributed
- FCS testing is effective for a wide range of  $L_m/L_{spp}$  ratios. The effectiveness is higher at higher ratios.
- ↑ Post processing & industry participation, ↓ ↓ retail  $L_m$

# Public Health Impacts

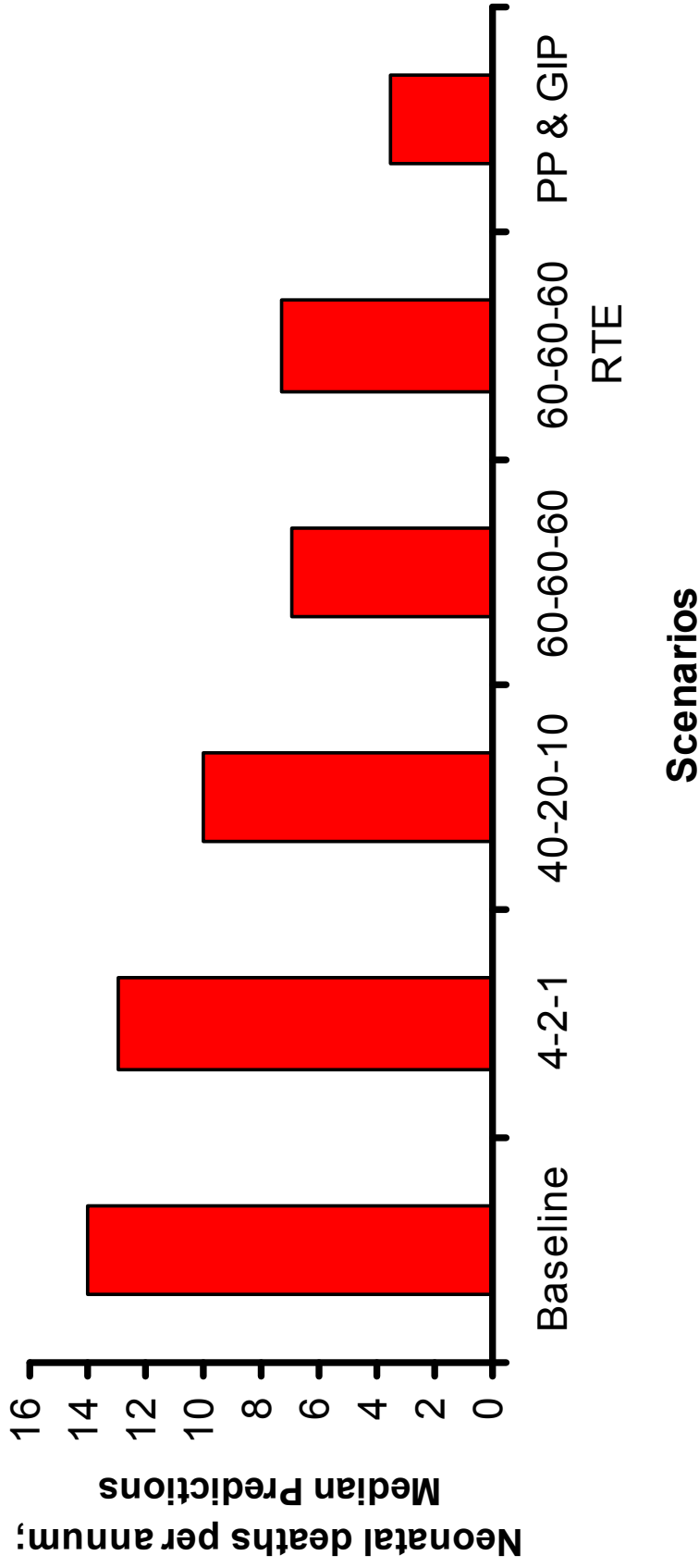
# Predicted elderly deaths from deli meats



# Predicted intermediate age deaths from deli meats



# Predicted neonatal deaths from deli meats

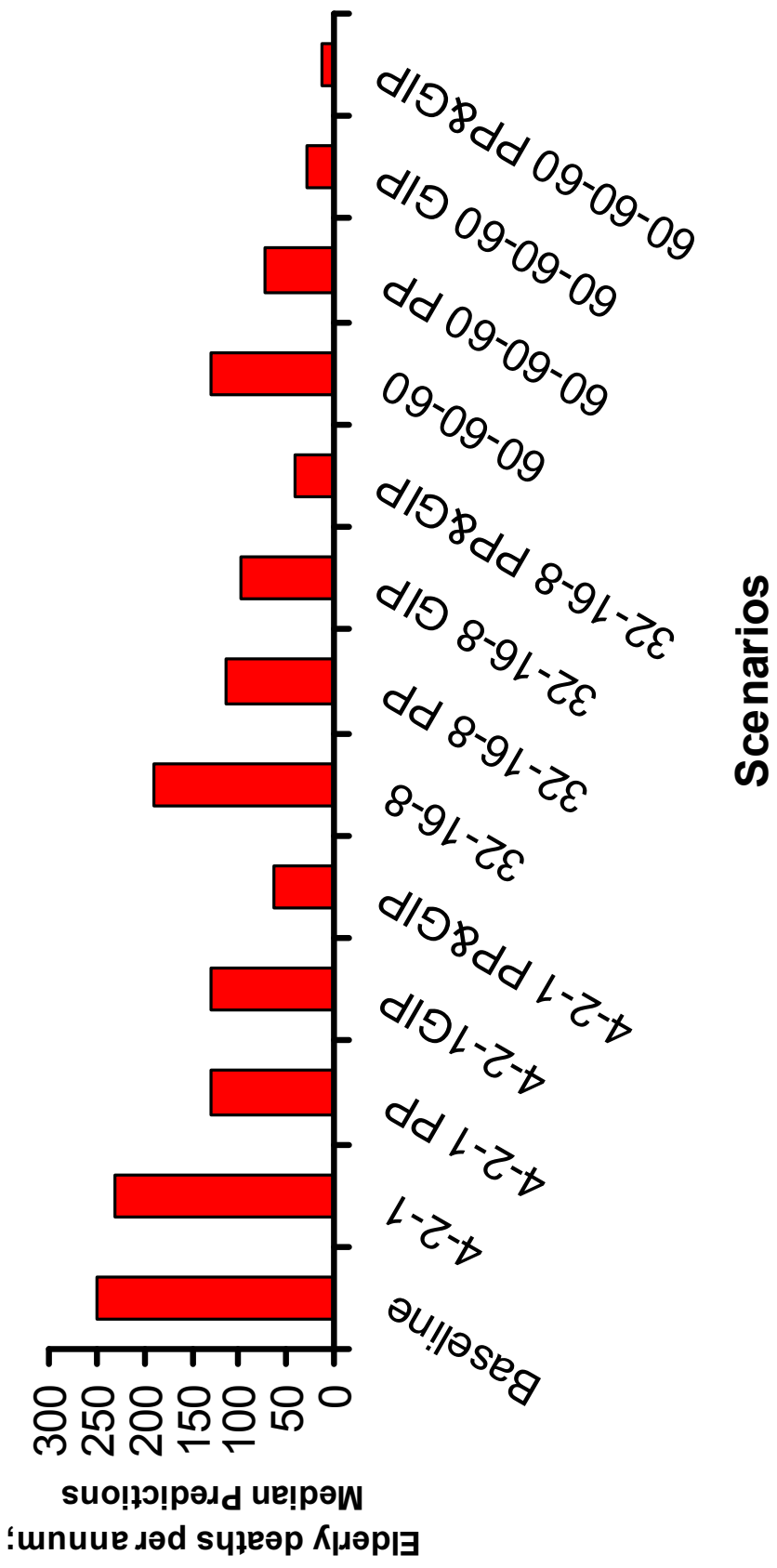


# Predicted lives saved relative to baseline

Scenario	Elderly	Intermediate	Neonates	Total
4-2-1	20	4	1	25
8-4-2	30	?	?	30
10-10-10	40	?	?	40
16-8-4	30	?	?	30
32-16-8	60	?	?	60
40-20-10	70	15	4	89
60-60-60	120	27	7	154
60-60-60 RTE	120	26	7	153
PP-95%	120	26	?	146
PP-99%	173	39	10	221
GIP	110	25	?	135
PP-95% & GIP	186	41	11	238



# Test and control combinations



Note: Testing is non-additive with post-processing treatment.

# Model Variables

- Only considers food contact surface as source of Lspp/Lm in product
- Only a “generic” food contact surface
- Assumes Lspp evenly distributed across food contact surface, and Lm evenly distributed within product
- Operates on a product lot basis

# Summary Findings

- Food contact surfaces found to be positive for *Listeria* species greatly increased the likelihood of finding RTE product lots positive for Lm (x7 if test and hold, x2 if not) .
- Frequency of contamination of FCS with *Listeria* species appears to encompass a broad timeframe, and the duration of contamination lasts about a week.
- The proposed minimal frequency of FCS testing/sanitation, as presented in the proposed rule (66 FR 12589, Feb. 27, 2001) results in a small reduction in the levels of Lm in deli meats at retail.
- Increased frequency of testing/sanitation leads to proportionally lower risk of listeriosis.
- Combinations of interventions appear to be much more effective than any single intervention in mitigating the potential contamination of RTE product with Lm and reducing the subsequent risk of illness or death.



Questions?

# Lm Distributions at Retail for Scenarios Tested

Retail Concentrations of Lm (cfu/g)										
Testing	Q80	Q85	Q90	Q95	Q99	Q99.5	Q99.9	Q99.99		
<b>FDA</b>	7.40E-06	3.70E-05	2.70E-04	5.50E-03	1.50E+00	1.10E+01	7.90E+02	1.40E+05		
<b>Baseline</b>	2.95E-06	2.66E-05	3.06E-04	8.86E-03	2.60E+00	1.78E+01	8.04E+02	2.06E+05		
<b>4-2-1</b>	1.50E-06	1.57E-05	2.07E-04	6.47E-03	2.47E+00	2.20E+01	1.70E+03	3.53E+05		
<b>8-4-2</b>	1.15E-06	1.25E-05	1.70E-04	5.34E-03	1.98E+00	1.70E+01	1.24E+03	3.31E+05		
<b>10-10-10</b>	1.18E-06	1.25E-05	1.65E-04	4.78E-03	1.45E+00	1.33E+01	1.23E+03	2.53E+05		
<b>16-8-4</b>	1.39E-06	1.41E-05	1.81E-04	5.05E-03	1.40E+00	1.27E+01	1.01E+03	1.80E+05		
<b>32-16-8</b>	8.38E-07	8.98E-06	1.18E-04	3.19E-03	5.26E-01	4.50E+00	4.52E+02	7.76E+04		
<b>40-20-10</b>	8.68E-07	9.02E-06	1.09E-04	2.71E-03	3.42E-01	2.61E+00	3.02E+02	5.62E+04		
<b>60-60-60</b>	6.29E-07	6.13E-06	6.88E-05	1.35E-03	6.10E-02	1.47E-01	5.04E-01	1.25E+00		
<b>60-60-60 Lot</b>	7.67E-07	7.52E-06	8.34E-05	1.53E-03	6.51E-02	1.54E-01	5.08E-01	1.31E+00		
<b>PP</b>	1.12E-07	1.18E-06	1.59E-05	5.22E-04	2.03E-01	1.70E+00	1.39E+02	2.47E+04		
<b>GIP</b>	1.22E-07	1.25E-06	1.69E-05	5.60E-04	2.24E-01	1.90E+00	1.47E+02	2.09E+04		
<b>PP &amp; GIP</b>	8.67E-09	9.06E-08	1.23E-06	3.93E-05	1.56E-02	1.32E-01	1.08E+01	1.67E+03		

# Health Impacts for Scenarios Tested

Deaths Among the Elderly			
Testing	5%	50%	95% Average
Baseline	79	250	290
4-2-1	73	230	270
8-4-2	70	220	260
10-10-10	67	210	250
16-8-4	69	220	260
32-16-8	61	190	230
40-20-10	58	180	210
60-60-60	42	130	150
60-60-60 Lot	43	130	160
PP	43	130	160
GIP	43	140	160
PP & GIP	21	64	76
			59