



Cornell University
College of Agriculture and Life Sciences

Seek and Destroy to control pathogens in food processing environments

Martin Wiedmann

Gellert Family Professor of Food Safety

Department of Food Science

Cornell University, Ithaca, NY

E-mail: mw16@cornell.edu

Phone: 607-254-2838



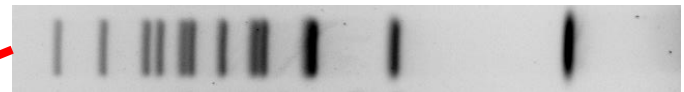


Take home messages

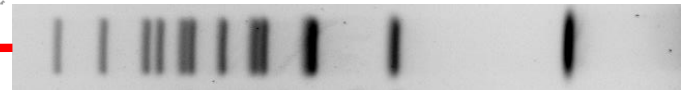
- Processing plant environments are key sources of pathogens and spoilage organisms
- Seek & Destroy and Pathogen Environmental Monitoring (PEM) Programs are a critical component of food safety programs

PulseNet allows (international) outbreak detection and traceback

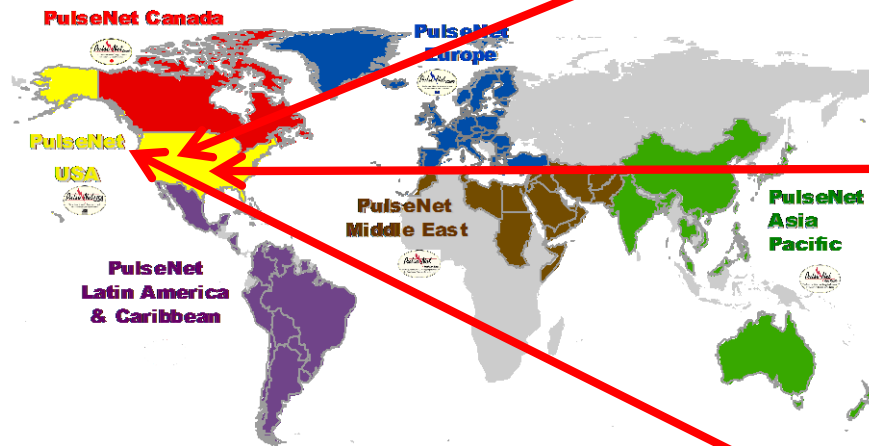
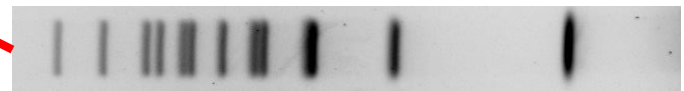
Food isolate, deposited into
PulseNet



Human case



Human case



DNA fingerprinting can identify persistence in plants

	Sample	Ribotype	Sample Source	RiboPrint® Pattern
VISIT 1	015-3	* 1039C	(E) Floor drain, raw materials area	
	20-35-6	* 1039C	(E) Floor drain, hallway to finished area	
	20-22-1	* 1039C	(IP) Troll Red King Salmon, in brine, head area	
	20-23-1	* 1039C	(IP) Troll Red King Salmon, in brine, belly area	
	20-27-1	* 1039C	(IP) Brine, Troll Red King Salmon	
	20-28-1	* 1039C	(IP) Faroe Island Salmon, in brine, head area	
	20-34-1	* 1039C	(F) Smoked Sable	
VISIT 2	20-42-1	* 1039C	(F) Cold-Smoked Norwegian Salmon	
	20-30-1	1044A	(E) Floor drain, brining cold room 1	
	20-10-1	1044A	(R) Raw Troll Red King Salmon, head area	
	20-31-2	1044A	(IP) Brine, Faroe Island Salmon	
	20-11-1	1045	(R) Raw Troll Red King Salmon, belly area	
	20-29-3	1045	(IP) Faroe Island Salmon, in brine, head area	
	20-24-1	1053	(IP) Norwegian Salmon, in brine	
VISIT 3	20-16-1	1062	(E) Floor drain #1, raw materials preparation	
	30-10-3	* 1039C	(E) Floor drain #1, raw materials preparation	
	30-11-13	* 1039C	(E) Floor drain, brining cold room 1	
	30-13-4	* 1039C	(E) Floor drain #2, raw materials preparation	
	30-14-1	* 1039C	(E) Floor drain #2, raw materials receiving	
	30-6-21	* 1039C	(E) Floor drain, finished product area	
	30-8-26	* 1039C	(E) Floor drain, hallway to finished area	
	30-36-2	* 1039C	(IP) Brine, Troll Red King Salmon	
	30-50-1	* 1039C	(F) Smoked Sable	
	30-38-1	1044A	(IP) Sable, in brine	
	30-42-3	1044A	(IP) Brine, Faroe Island Salmon	
	30-37-1	1062	(IP) Brine, Norwegian Salmon	



House bugs & pet *Listeria*

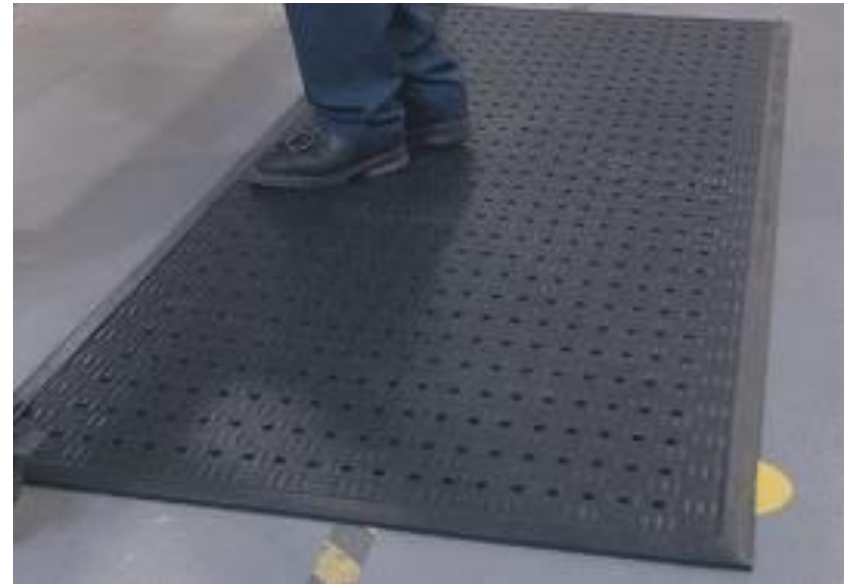
	Plant B	Plant C	Plant D	P-value
Samples	n=129	n=173	n=229	
Ribotype	% Prevalence			
1039C	0.0	0.0	10.0	0.0000
1042B	0.8	1.2	0.4	0.8221
1042C	6.2	0.6	0.4	0.0003
1044A	0.0	2.3	3.1	0.1494
1045	5.4	0.0	0.9	0.0006
1046B	0.0	2.3	0.0	0.0144
1053	0.0	0.6	1.7	0.2686
1062	0.8	0.6	2.6	0.1822

Plant A2	2/28/01	3/26/01	4/24/01	5/22/01	6/19/01	7/17/01	8/14/01	9/18/01	10/9/01	11/6/01	12/12/01	1/29/02	2/25/02
Raw Product Samples	1062D	1060A	-	-	-	-	-	-	-	L.spp	-	L.spp	
	1 of 6	1 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	3 of 6	6 of 6	1 of 6	
Raw/In-Process Areas													
E3: Floor drain, raw salmon room	1053A	-	-	-	-	-	-	-	-	L.spp	L.spp	L.spp	
Salmon receiving floor drain				-	-	L.spp	1053A	-	-	L.spp	-	-	
Raw salmon room, Drain (SB-FD1)													
Raw salmon room, Drain (SB-FD2)													
Raw salmon room, 3 floor mats													
Raw salmon room, mats- post cleaning													
Raw salmon room, plastic pallet													
Raw Salmon room, pallet, post cleaning													
Raw salmon room, pallet jacket handle													
E8: Apron, employee in raw area	1062D	-	-	1053A	-	1053A	1025A	-	1053A	-	1053A	-	
Incoming raw material packaging												-	
Finished Product Areas													
E1: Trench Drain, processing room	L.spp	-	-	116-693	L.spp	L.spp	L.spp	-	L.spp	L.spp	-	L.spp	
E2: Trench Drain, smoke room	-	-	-	-	-	-	-	-	-	-	-	-	
Smoke room trench drain, in use													
E4: Cart wheels, for box transfer	L.spp	-	-	-	-	-	-	L.spp	-	L.spp	-	-	
E5: Floor, under conveyor belt	L.spp	-	-	-	-	L.spp	L.spp	L.spp	L.spp	L.spp	L.spp	-	
Finish Room, floor mats #1													L.spp
Finish room, floor mats #2													L.spp
Finish room, floor mats, reg. Clean													
Finish room, floor mats, reg. Clean													L.spp
Finish room, 1200 ppm Quat, weekend													L.spp
Finish room, 1200 ppm Quat, weekend													-
Booth dip valve cover, processing room	-	-	L.spp										
E6: Platform under Geba #1 slicer	-	-	-	-	-	-	L.spp	L.spp	L.spp	-	-	-	
E9: Sliding door handle, skinning room	L.spp	-	-	-	-	-	-	1053A	L.spp	-	-	-	
Food Contact Surfaces													
E7: Gloved hands, finish product	-	-	-	-	-	-	-	-	-	-	-	-	
E10: Skinning machine	L.spp	-	L.spp	-	-	-	L.spp	L.spp	L.spp	-	L.spp	-	
E11: Geba #5 slicer	L.spp	-	-	-	-	-	-	-	-	-	L.spp	-	
E12: 20/20 vac belt	-	-	-	L.spp	-	-	-	-	-	-	-	-	
	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	
Finished Product Sample	-	-	-	-	-	-	-	-	-	-	-	-	

Plant A2	2/28/01	3/26/01	4/24/01	5/22/01	6/19/01	7/17/01	8/14/01	9/18/01	10/9/01	11/6/01	12/12/01	1/29/02	2/25/02	3/5/02	4/2/02	4/16/02	5/14/02	6/10/02	7/1/02	7/23/02	8/20/02	9/17/02	10/15/02	11/12/02	12/10/02
														1-L spp			2-L spp			1-L spp					1-L spp
Raw Product Samples	1062D	1060A	-	-	-	-	-	-	-	L spp	-	L spp		1025A	-		1053C	-	-	1039C	-	-	-	-	1039C
	1 of 6	1 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	3 of 6	6 of 6	1 of 6		1 of 6	6 of 6		1 of 6	6 of 6	6 of 6	1 of 6	6 of 6	6 of 6	6 of 6	6 of 6	1 of 6
Raw/In-Process Areas																									
E3: Floor drain, raw salmon room	1053A	-	-	-	-	-	-	-	-	L spp	L spp	L spp		1053A	-		-	-	-	-	-	-	-	-	-
Salmon receiving floor drain				-	-	L spp	1053A	-	-	L spp	-	-		L spp	-		-	-	-	L spp	L spp	L spp	-	-	-
Raw salmon room, Drain (SB-FD1)														1053A	1053A		-	-	1053a	1053A	-	1053A	1062A	L spp	1053A
Raw salmon room, Drain (SB-FD2)														1053A	1053A		1053A	-	L spp	1053A	1053A	L spp			-
Raw salmon room, 3 floor mats														1053A	1053A			1053A	1053A	1053A	1053A	1053A	1053A	1053A	1053A
RawSalmon room, mats- post cleaning																1053A	1053A								
Raw salmon room, plastic pallet														1053A	-				-	L spp	-	-	-	-	-
Raw Salmon room, pallet, post cleaning																-	-								
Raw salmon room, pallet jacket handle														-	-		-	-	-	-	-	-	-	-	-
E8: Apron, employee in raw area	1062D	-	-	1053A	-	1053A	1025A	-	1053A	-	1053A	-		-	-		-	-	-	-	-	-	-	-	-
Incoming raw material packaging												-		-	-		-	-	-	-	-	L spp	-	L spp	-
Finished Product Areas																									
E1: Trench Drain, processing room	L spp	-	-	116-693	L spp	L spp	L spp	-	L spp	L spp	-	L spp		1042C	L spp		1042C	L spp	-	-	L spp	L spp	L spp	L spp	L spp
E2: Trench Drain, smoke room	-	-	-	-	-	-	-	-	-	-	-	-		-	-		-	-	L spp	-	-	L spp	-	-	L spp
Smoke room trench drain, in use																1053A	-	-	-	-	-	-	-	-	-
E4: Cart wheels, for box transfer	L spp	-	-	-	-	-	-	L spp	-	L spp	-	-		-	-		-	-	-	-	-	L spp	L spp	-	L spp
E5: Floor, under conveyor belt	L spp	-	-	-	-	L spp	L spp	L spp	L spp	L spp	L spp	-		-	-		-	-	-	-	-	-	1053	1053	-
Finish Room, floor mats #1													L spp												
Finish room, floor mats #2													L spp												
Finish room, floor mats, reg. Clean													L spp	L spp	L spp	L spp	L spp	L spp	L spp	L spp	L spp	1042B	L spp	L spp	L spp
Finish room, floor mats, reg. Clean													L spp												
Finish room, 1200 ppm Quat, weekend													L spp												
Finish room, 1200 ppm Quat, weekend													-												
Boordip valve cover, processing room	-	-	L spp																						
E6: Platform under Geba #1 slicer	-	-	-	-	-	-	L spp	L spp	L spp	-	-	-		-	-		-	-	-	-	-	-	-	-	-
E9: Sliding door handle, skinner	L spp	-	-	-	-	-	-	1053A	L spp	-	-	-		-	-		-	-	-	L spp	-	-	-	-	-
Food Contact Surfaces																									
E7: Gloved hands, finish product line	-	-	-	-	-	-	-	-	-	-	-	-		-	-		-	-	-	-	-	-	1053	-	L spp
E10: Skinning machine	L spp	-	L spp	-	-	-	L spp	L spp	L spp	-	L spp	-		L spp	-		-	-	-	-	-	L spp	-	L spp	-
E11: Geba #5 slicer	L spp	-	-	-	-	-	-	-	-	-	L spp	-		-			-	-	-	-	-	-	1053	-	-
E12: 20/20 vac belt	-	-	-	L spp	-	-	-	-	-	-	-	-		-	-		-	-	-	-	-	-	-	-	-
	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6		6 of 6	6 of 6		6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	1 of 6	6 of 6
Finished Product Sample	-	-	-	-	-	-	-	-	-	-	-	-		-	-		-	-	-	-	-	-	-	1039A	-



***L. monocytogenes* persisted in rubber floor mats despite sanitation**



Listeria can be protected from sanitizer in “micro-cracks”, but can be squeezed out by pressure if people stand on mats



Growth niches

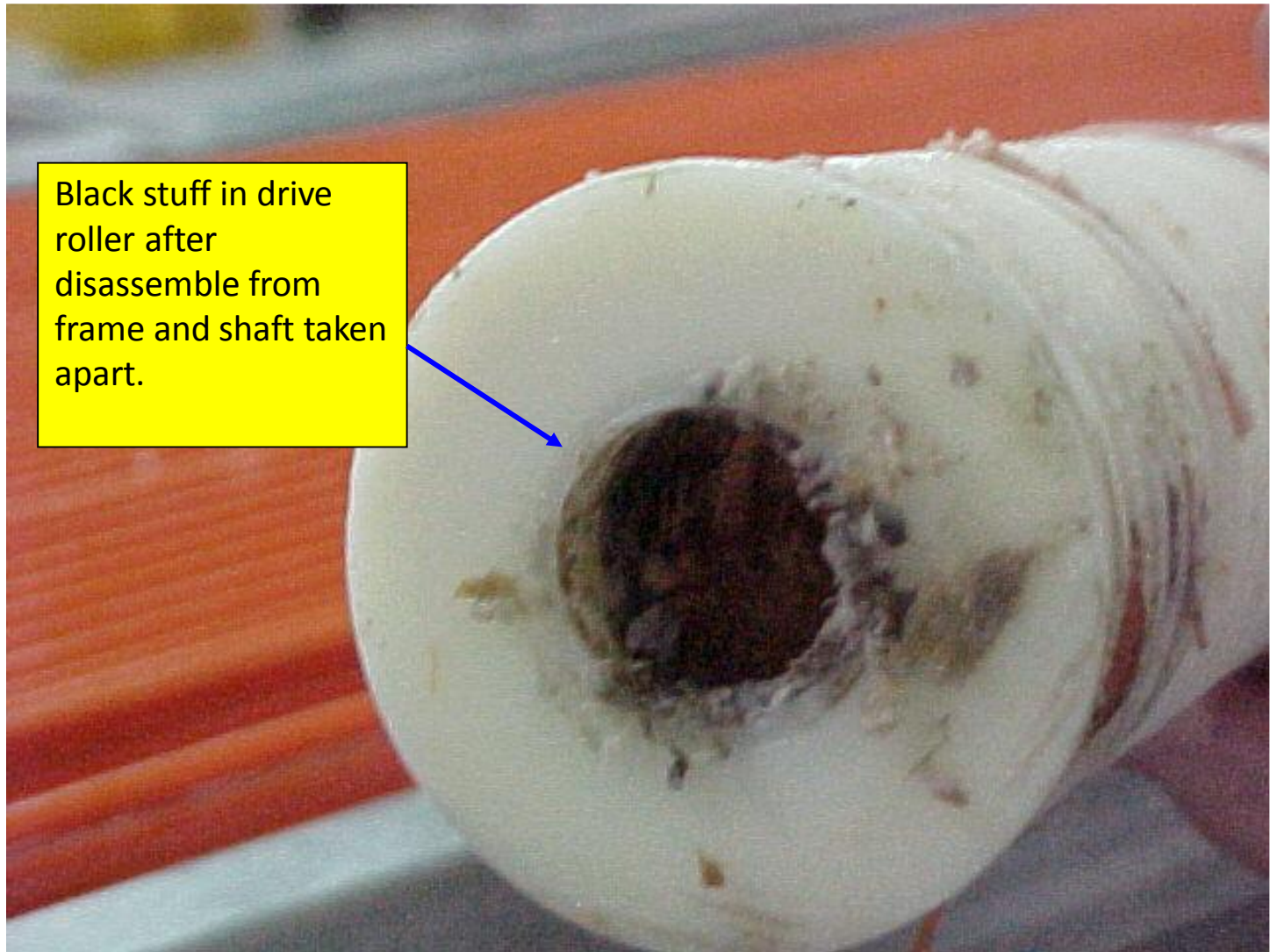
Locations harboring the organism after the routine sanitation process for that area has been completed.

Examples

- Hollow roller on conveyor transporting food product
Hollow rollers not disassembled cleaned and sanitized or heat treated in a manner to eliminate any contaminating organisms can become growth niches.



Black stuff in drive
roller after
disassemble from
frame and shaft taken
apart.





An Outbreak of *Listeria Monocytogenes* Serotype 3a Infections from Butter in Finland








The Journal of Infectious Diseases 2000;181:1838–41

The outbreak strain was first isolated in samples of butter from the implicated dairy in 1997, which led to processing-line cleaning and increased monitoring of the products and environment. Despite intensified sampling, the dairy did not detect *Listeria* before February 1999. However, the process seems to have been contaminated for a longer period, because *L. monocytogenes* was detected in samples from several batches manufactured between September 1998 and February 1999. Long-

25 cases, 6 deaths

eration. The outbreak strain was isolated from the butter-producing equipment and the dairy environment. We could not confirm any error in operation. The source of *L. monocytogenes* may have been the screw conveyor in the butter wagon, which



DuPont ID/ DuPont ID Label	RiboPrint(R) Pattern
DUP-1052 <i>Listeria monocytogenes</i>	
DUP-1052 <i>Listeria monocytogenes</i>	
DUP-1052 <i>Listeria monocytogenes</i>	
DUP-1052 <i>Listeria monocytogenes</i>	
DUP-1052 <i>Listeria monocytogenes</i>	
DUP-1052 <i>Listeria monocytogenes</i>	
DUP-1052 <i>Listeria monocytogenes</i>	



From the Centers for Disease Control and Prevention

Leads From the Morbidity and Mortality Weekly Report
Atlanta, Ga

Multistate Outbreak of *Salmonella* Serotype Agona Infections Linked to Toasted Oats Cereal— United States, April-May, 1998

209 cases

Information as of May 13, 2008 (FINAL Update)

[Click Here for Advice to Consumers](#)

28 cases

CDC is collaborating with public health officials in multiple states across the United States and with the U.S. Food and Drug Administration (FDA) to investigate a multi-state outbreak of *Salmonella* Agona infections. An investigation that includes interviews of persons with *Salmonella* Agona infections and comparison of the DNA fingerprints suggests that cereal from Malt-O-Meal unsweetened Puffed Rice Cereals and unsweetened Puffed Wheat Cereals is likely related to these illnesses.



Cornell University
College of Agriculture and Life Sciences

Persistence of spoilage organisms



Journal of Food Protection, Vol. 61, No. 10, 1998, Pages 1336–1340
Copyright ©, International Association of Milk, Food and Environmental Sanitarians

Bacterial Tracking in a Dairy Production System Using Phenotypic and Ribotyping Methods

ROBERT D. RALYEA, MARTIN WIEDMANN, AND KATHRYN J. BOOR*

Food Safety Laboratory, Department of Food Science, Cornell University, Ithaca, New York 14853, USA

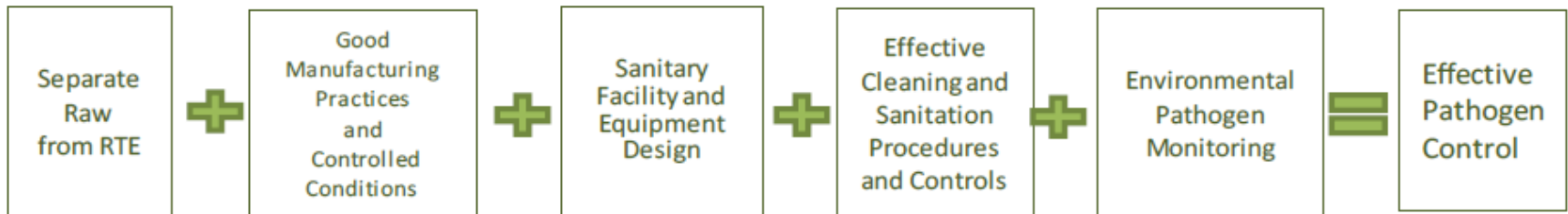
MS 98-2: Received 15 January 1998/Accepted 4 May 1998

ABSTRACT



Listeria Equation ***(Environmental pathogen and spoilage equation)***

Controlled
Traffic
Patterns + **GMP's** + Sanitary
Design
Equip &
Building + Clean Dry
Uncracked
Floors + Effective
Sanitation
Procedures



= Listeria Control
(Environmental pathogen and spoilage control)



Pathogen environmental monitoring programs

- **A key tool to verify and monitor adherence with the components of the Listeria equation**
 - Need to set up a system that encourages collection of samples that yield positive results
- **Specific goals:**
 - Identify problem areas harboring pathogen sources (“niches”) and locate contamination sources (“Seek & Destroy”)
 - Verify that food safety systems works (“verification”) and identify early indicators of problems (“indicator sites”)
 - Confirm effectiveness of problem-solving procedures
 - Characterize transmission pathways



Seek and Destroy

- Systematic approach to finding sites of persistent growth ("niches") in food processing plants
 - Environmental sampling with follow up on every positive sample
- Goal is to either eradicate or mitigate effects of niches
- Seek and Destroy can be applied to specific equipment (e.g., new equipment qualification) or the facility as a whole

Journal of Food Protection, Vol. 78, No. 2, 2015, Pages 436–445

doi:10.4315/0362-028X.JFP-13-507

Copyright ©, International Association for Food Protection

General Interest

Seek and Destroy Process: *Listeria monocytogenes* Process Controls in the Ready-to-Eat Meat and Poultry Industry

THOMAS J. V. MALLEY,¹ JOHN BUTTS,² AND MARTIN WIEDMANN^{1*}

¹Department of Food Science, Cornell University, Ithaca, New York 14853; and ²Land O'Frost, Inc., Lansing, Illinois 60438, USA



Cornell University
College of Agriculture and Life Sciences

Challenges with environmental sampling





Where to sample if you hear

“Our company goal for 2016 is zero Listeria environmental positives”

“Our Key Performance Indicator (KPI) is <1% Listeria environmental positives”

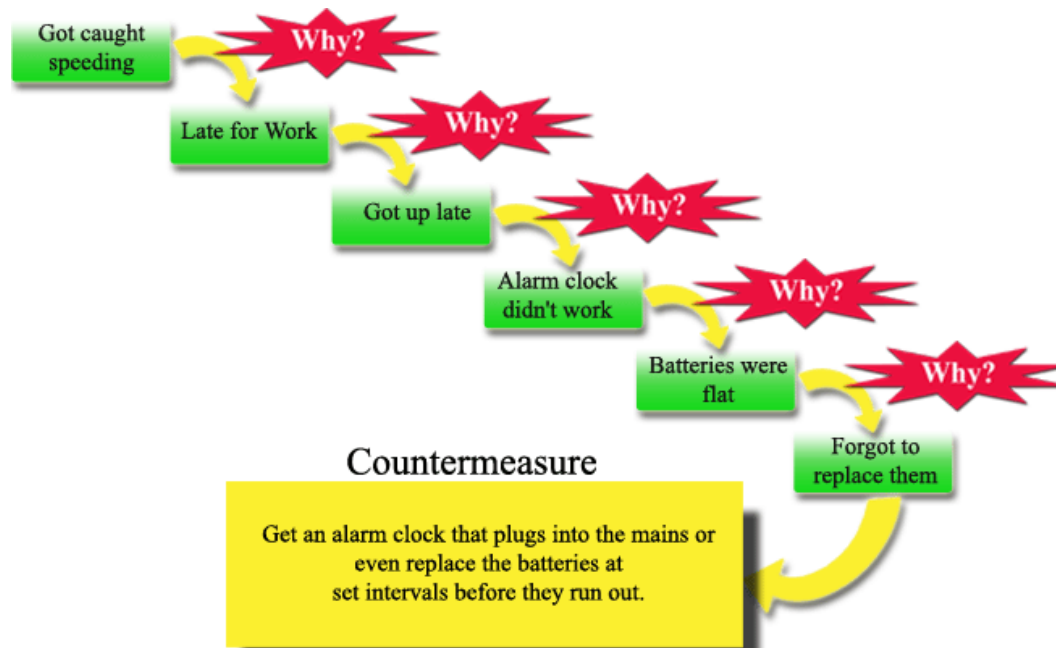


Guidelines for follow-up and corrections

- Corrections need to be plant specific and may differ by zone
 - Trend towards increased frequency of pathogen detection also needs to be investigated to determine reason and action to be taken to reduce frequency
- Additional samples should be taken from environmental area that showed positive results (“vector swabbing”)
- Positive samples should be followed up with additional investigations and **root cause analyses** as well as intensified cleaning and sanitation (“deep cleaning” alone is not enough)
- Corrective actions may furthermore include:
 - Updates and changes to cleaning and sanitation procedures, SSOPs, master sanitation schedule
 - Maintenance and revision of preventive maintenance programs
 - Equipment may have to be modified and replaced
 - Retraining of staff
 - Problem areas may have to be shut down temporarily
 - Test and hold program may be needed

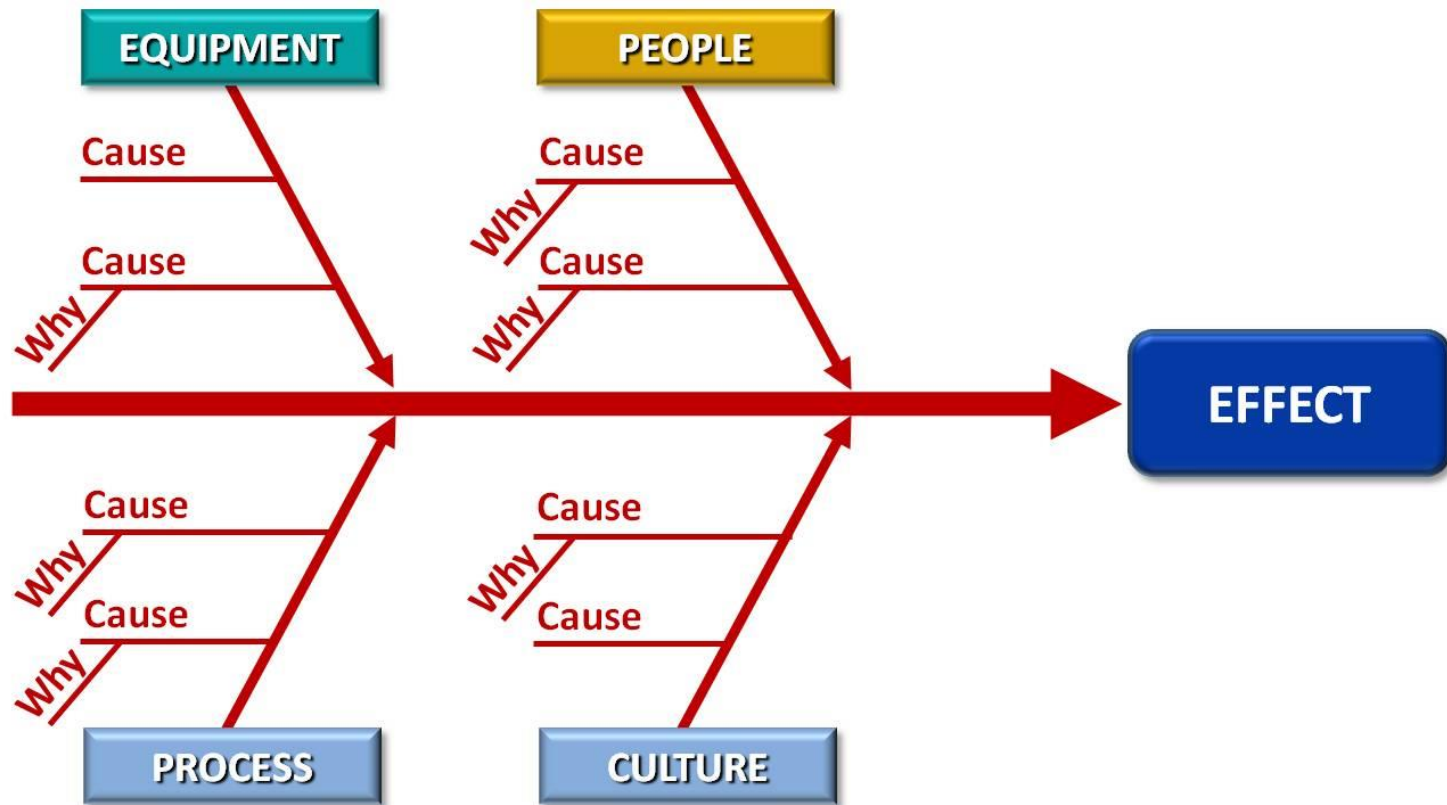


Root cause analysis – how to make sure the same problem does not happen again





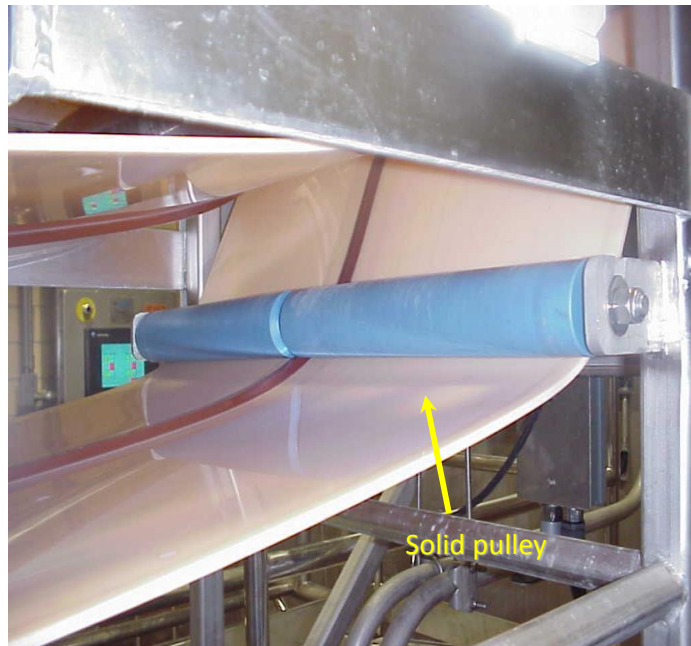
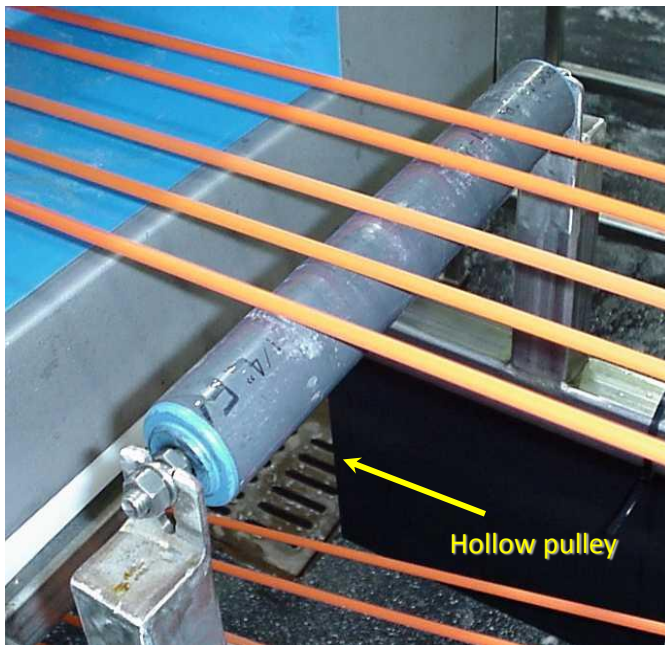
Fishbone diagram





No Food Product or Liquid Collection

Applying the 10 Principles of Sanitary Design



From This To This
Previous Design Sanitary Redesign

A horizontal arrow pointing from left to right, divided into three colored segments: red, yellow, and grey.

Thank you to John Butts for pictures and discussions!

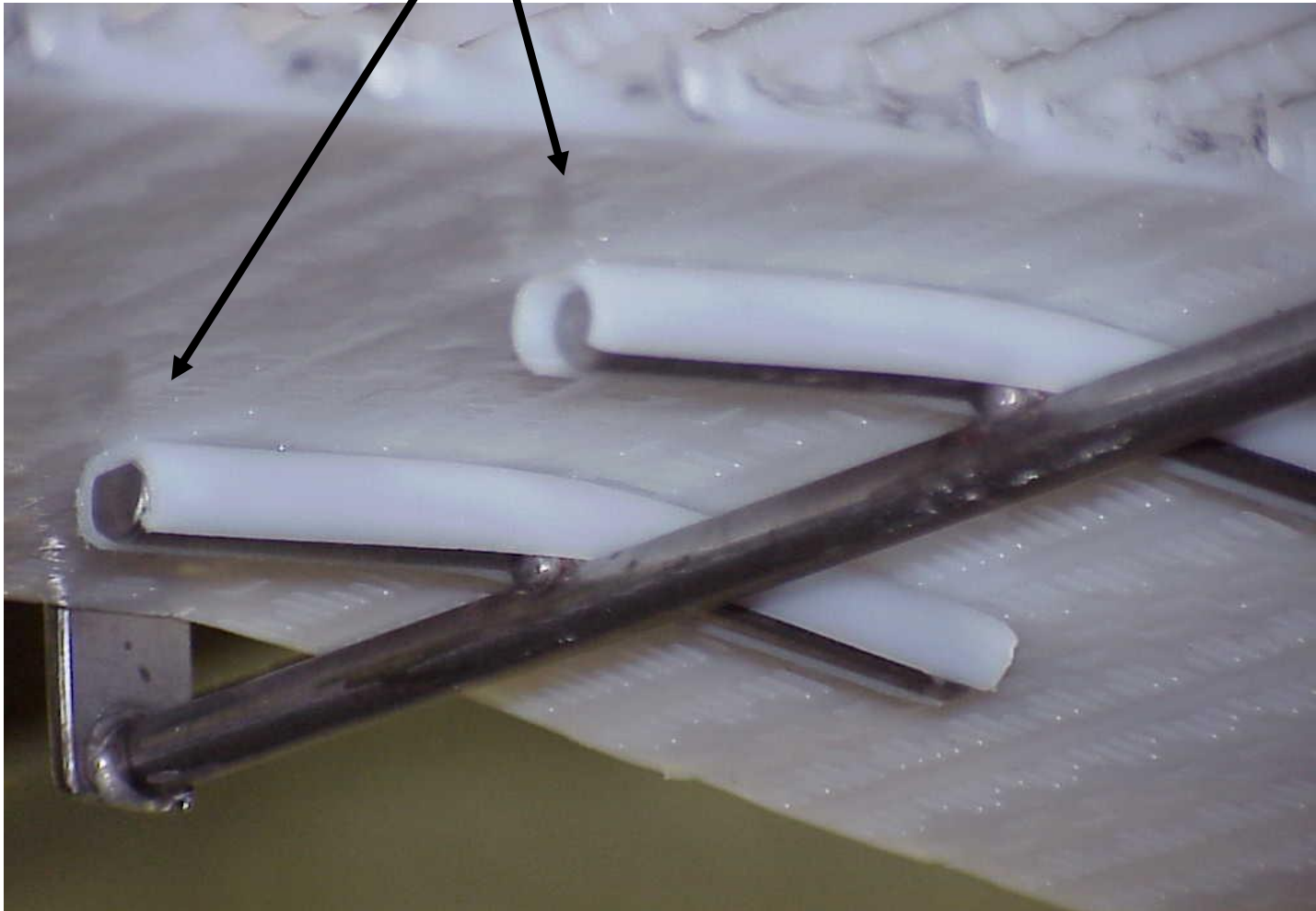


Free of Growth niches





Uncleanable plastic-metal interface





Take home messages

- Processing plant environments are key sources of pathogens and spoilage organisms
- Seek & Destroy and Pathogen Environmental Monitoring (PEM) Programs are a critical component of food safety programs
 - Virtually all processing plants where RTE products are exposed to the environment would need a PEM program
 - Results need to be used for immediate corrective actions as well as long term improvements (equipment design etc.)
 - It's easy to inadvertently send messages that discourage people from finding pathogens



Some Possible Action items

- Industry:
 - Make sure business risks due to food safety (and specifically *L. monocytogenes*) issues are known and communicated in your company
 - Make sure your company's leadership shows commitment to food safety and does not unintentionally send the wrong messages
 - Assure that your company has a robust pathogen and microbial environmental monitoring programs that drive both short term corrective actions and long term improvements
- Academia
 - Review your curriculum to assure that students are trained on the development and implementation of environmental monitoring programs
- Government food safety agencies
 - Review or develop programs and regulations that assure robust environmental pathogen monitoring programs
 - Assure that food safety program and practices do not discourage industry from finding pathogens if they are there