

Sanitation Challenges in Retail Delis: An Opportunity

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Listeria monocytogenes and Retail: A Challenge

- Ready-to-eat foods: a common source of listeriosis
 - 83% of listeriosis cases from RTE deli meats from deli meats sliced at retail
 - Post-heat treatment contamination
- *L. monocytogenes* prevalence in delis
 - 14.2% of NFCS
 - 4.5% of FCS

Why *Listeria* in deli meats

- Ubiquitous: “found everywhere”^[12-14]
- Salt tolerant^[15, 16]
- Grows at refrigeration temps ^[15, 16]
- Formation of biofilms ^[16, 7]

Once *L. monocytogenes* enters a deli, it can grow, potentially be transferred to food, and cause illness.

***Listeria monocytogenes* and *Listeria* spp. Contamination Patterns in Retail Delicatessen Establishments in Three U.S. States**

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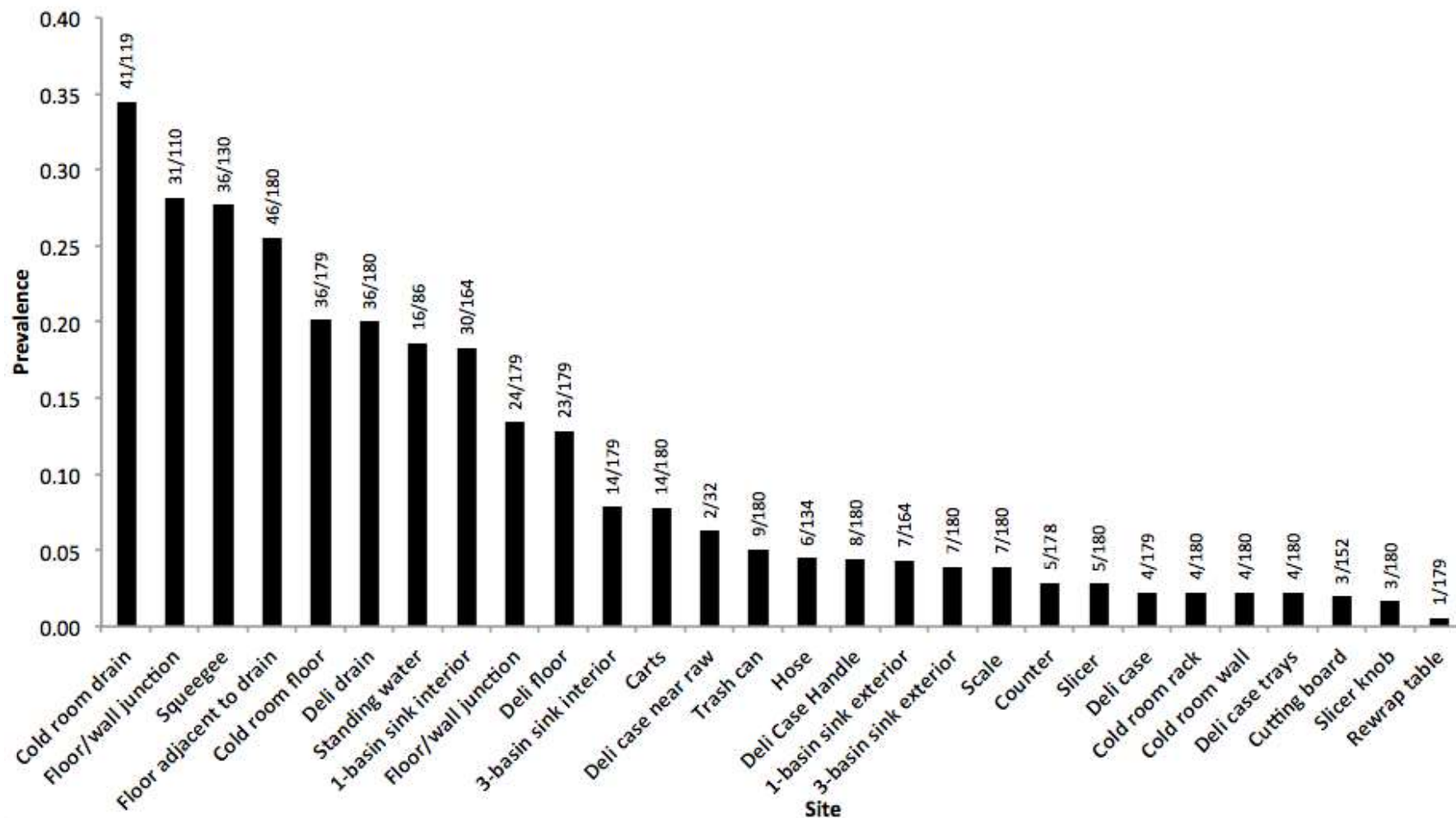
Longitudinal study of deli environments

Which surfaces have highest prevalence of *L. monocytogenes*?

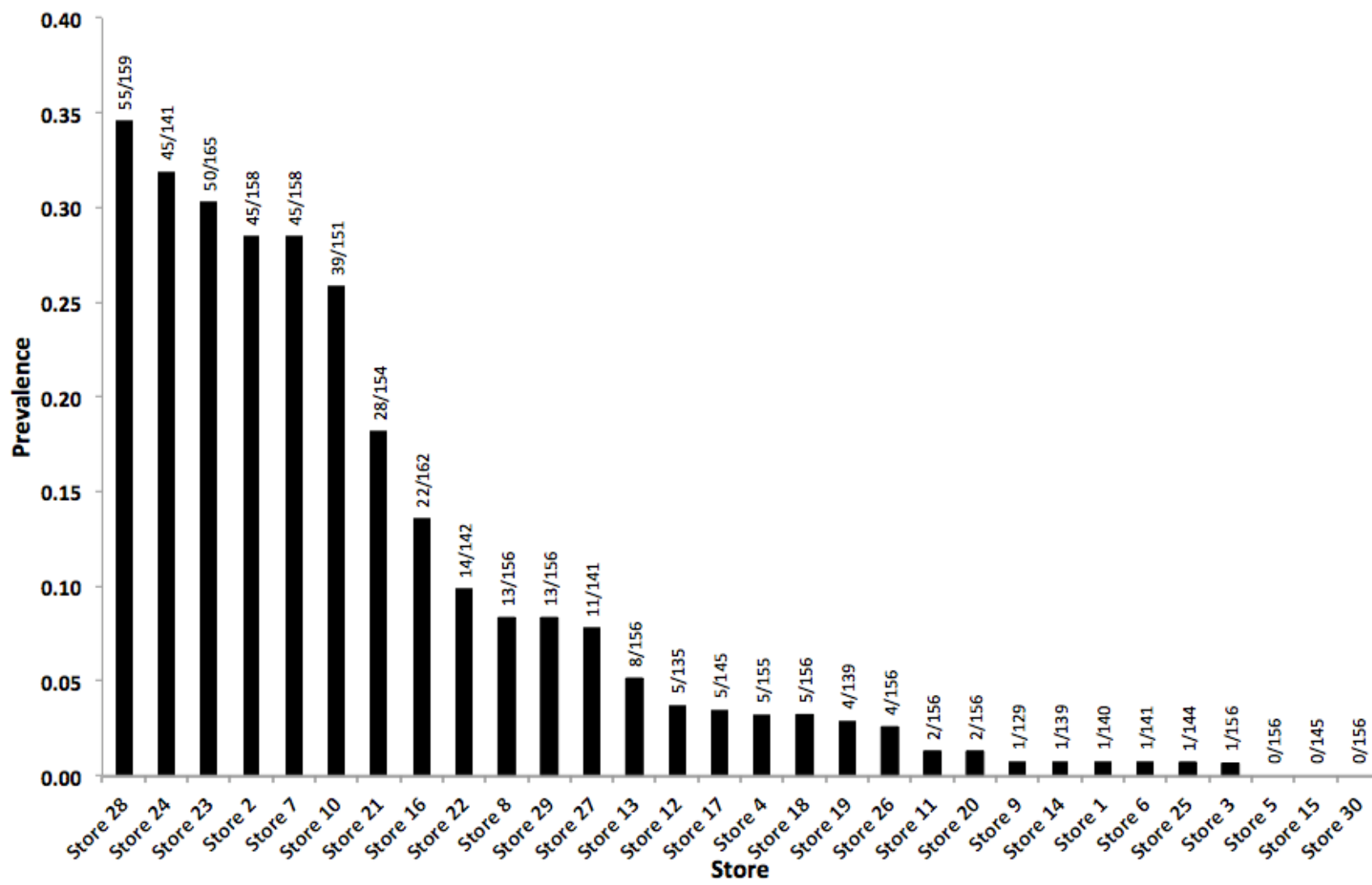
Think – Pair – Share

1. Think: consider your answer
2. Pair: discuss it with a partner
3. Share: share with group if called

Prevalence of LM by Site



Prevalence of LM by Store



Persistent and Transient Strains in Delis

- Strain: unique PFGE pulsotype
- Persistent strain: *L. monocytogenes* with PFGE pattern in the same store for ≥ 3 separate months
- Transient strain: *L. monocytogenes* with PFGE pattern in the same store for < 3 separate months

	April	May	June	July	August	September	October	November	December
Food Contact Sites									
Slicer	-	-	-	-	-	-	-	-	-
Deli case	NT	NT	NT	-	-	-	-	-	-
Deli case near raw meat	NT	NT	NT	-	-	-	-	-	-
Deli case trays	NT	NT	NT	-	-	-	-	-	-
3-basin sink interior	NT	NT	NT	CU-57,267	-	-	-	-	-
1-basin sink interior	NT	NT	NT	CU-258,69	-	-	-	CU-294,321	-
Cold room rack	-	-	-	-	-	-	-	-	-
Cutting board	NT	NT	NT	NT	-	-	NT	NT	-
Rewrap table	NT	NT	NT	-	-	-	-	-	-
Counter	NT	NT	NT	-	-	-	-	-	-
Non-food contact sites									
3-basin sink exterior	NT	NT	NT	-	-	-	-	-	-
Floor/wall junction (3-basin)	CU-258,69	CU-258,69	CU-258,69	CU-258,69	CU-258,69	CU-8,96	LM	CU-258,69	CU-258,69
1-basin sink exterior	NT	NT	NT	CU-258,69	-	-	LM	-	CU-258,69
Floor/wall junction (1-basin)	NT	NT	NT	CU-258,69	-	-	LM	CU-258,69	CU-258,69
Deli drain	NT	NT	NT	CU-258,69	CU-258,333	-	CU-258,69	CU-258,69	CU-258,69
Floor adjacent to drain	-	CU-258,69	CU-258,69	CU-258,69	CU-258,69	-	-	CU-258,69	CU-258,69
Deli floor	NT	NT	NT	CU-258,69	-	-	-	CU-258,69	-
Cold room floor	NT	NT	NT	CU-258,69	CU-295,329	-	CU-258,69	CU-258,69	CU-258,69
Cold room wall	CU-258,69	-	-	-	-	-	-	-	-
Cold room drain	NT	NT	NT	CU-258,69	CU-258,69	-	CU-258,69	CU-258,69	CU-258,69
Standing water	NT	NT	NT	NT	-	-	NT	NT	-
Squeegee	NT	NT	NT	CU-258,69	CU-258,69	-	CU-258,69	CU-258,69	CU-258,69
Cart Wheel	-	-	CU-258,69	CU-258,69	-	-	-	-	-
Hose	NT	NT	NT	-	CU-258,69	-	-	-	-
Trash can	-	-	CU-258,69	-	CU-258,69	-	-	-	-
Transfer Points									
Slicer knob	-	-	-	-	-	-	-	-	-
Case handle	-	-	-	-	-	-	-	-	-
Scale	NT	NT	NT	-	-	-	-	-	-

Phenotypic Characteristics of LM

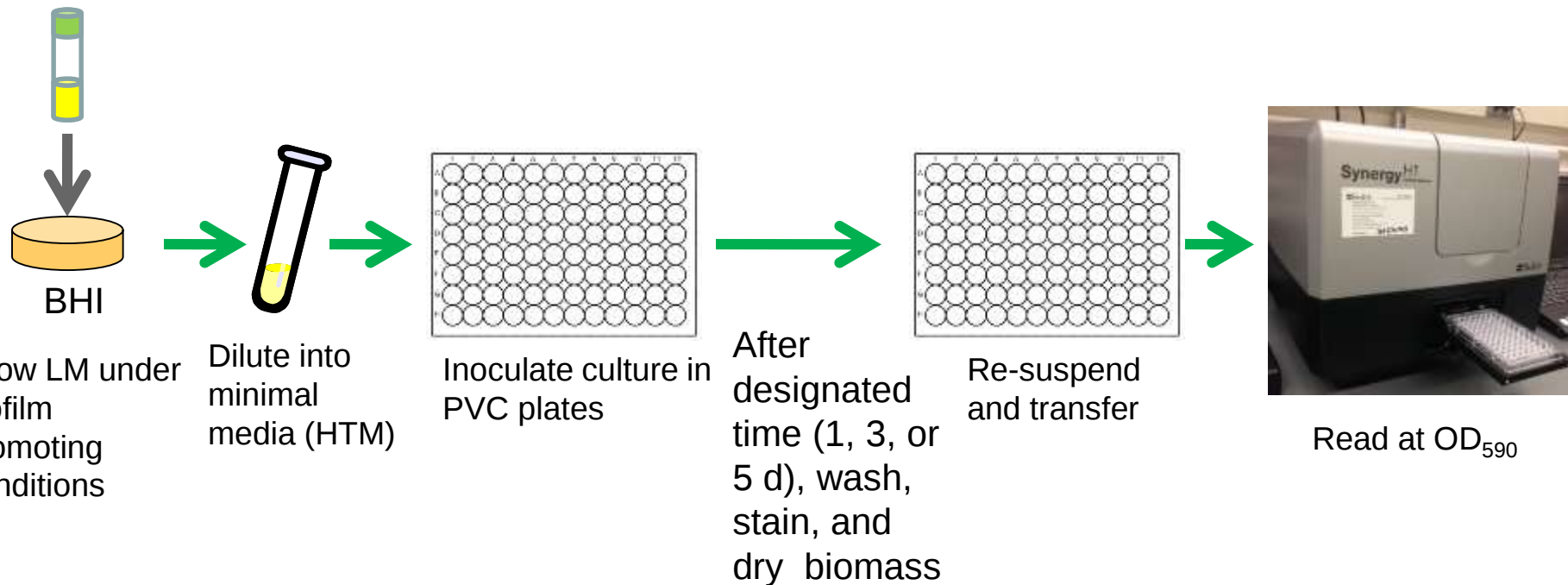
- Biofilms
 - Protect LM against environmental stress⁴
 - Form on various food contact surfaces⁵
 - Potential cause of contamination⁶
 - Influenced by: strains, properties of surfaces, temperatures, growth media, and the presence of other microorganisms^{7,8}

Phenotypic Characteristics of *L. monocytogenes* Retail Isolates

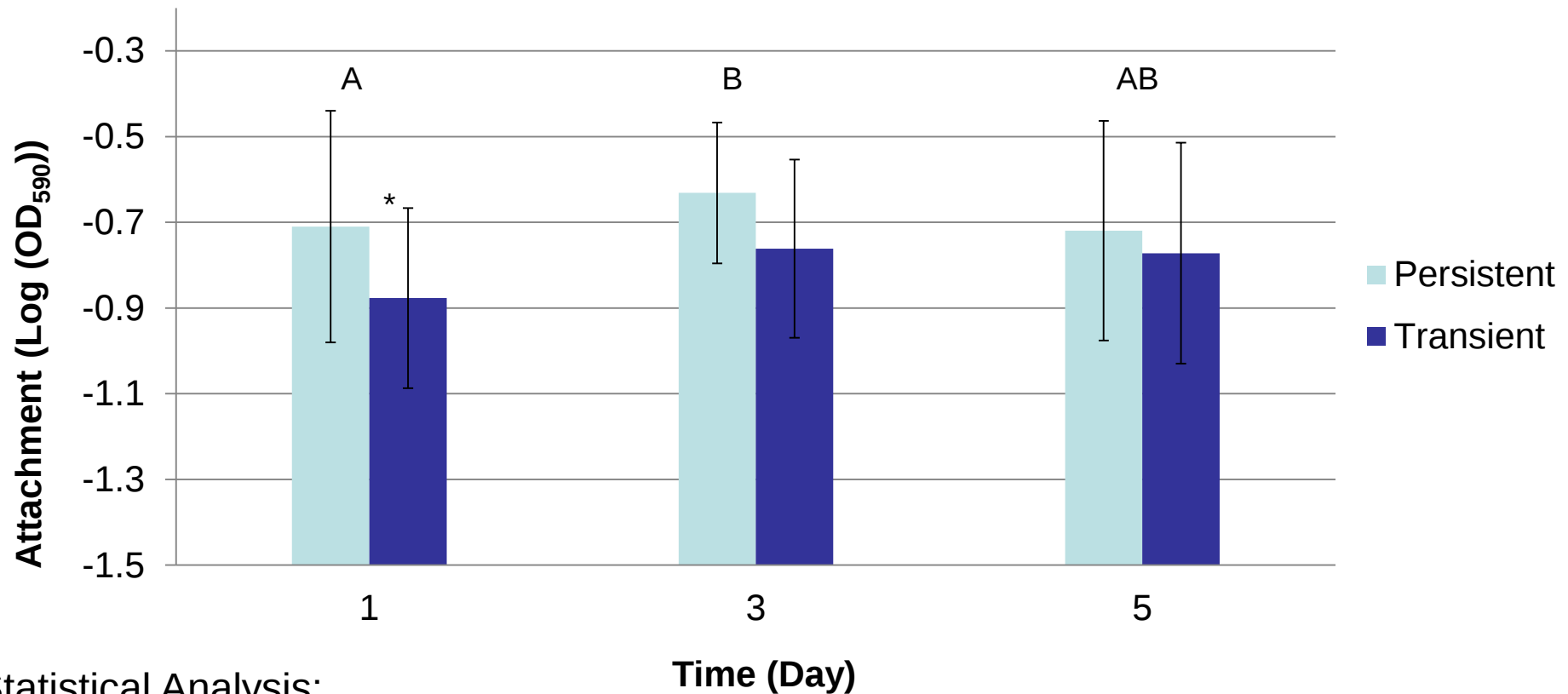
- Hypothesis:
 - *L. monocytogenes* persistent strains are better at forming biofilms
 - There is relationship between biofilm formation and sanitizer tolerance
- Goals of this Work:
 - To assess the ability of 23 persistent strains and 73 transient strains
 - Attachment to abiotic surfaces (indicator of biofilm formation)
 - Sanitizer tolerance
 - Relationship between attachment ability and sanitizer tolerance

Attachment Assay

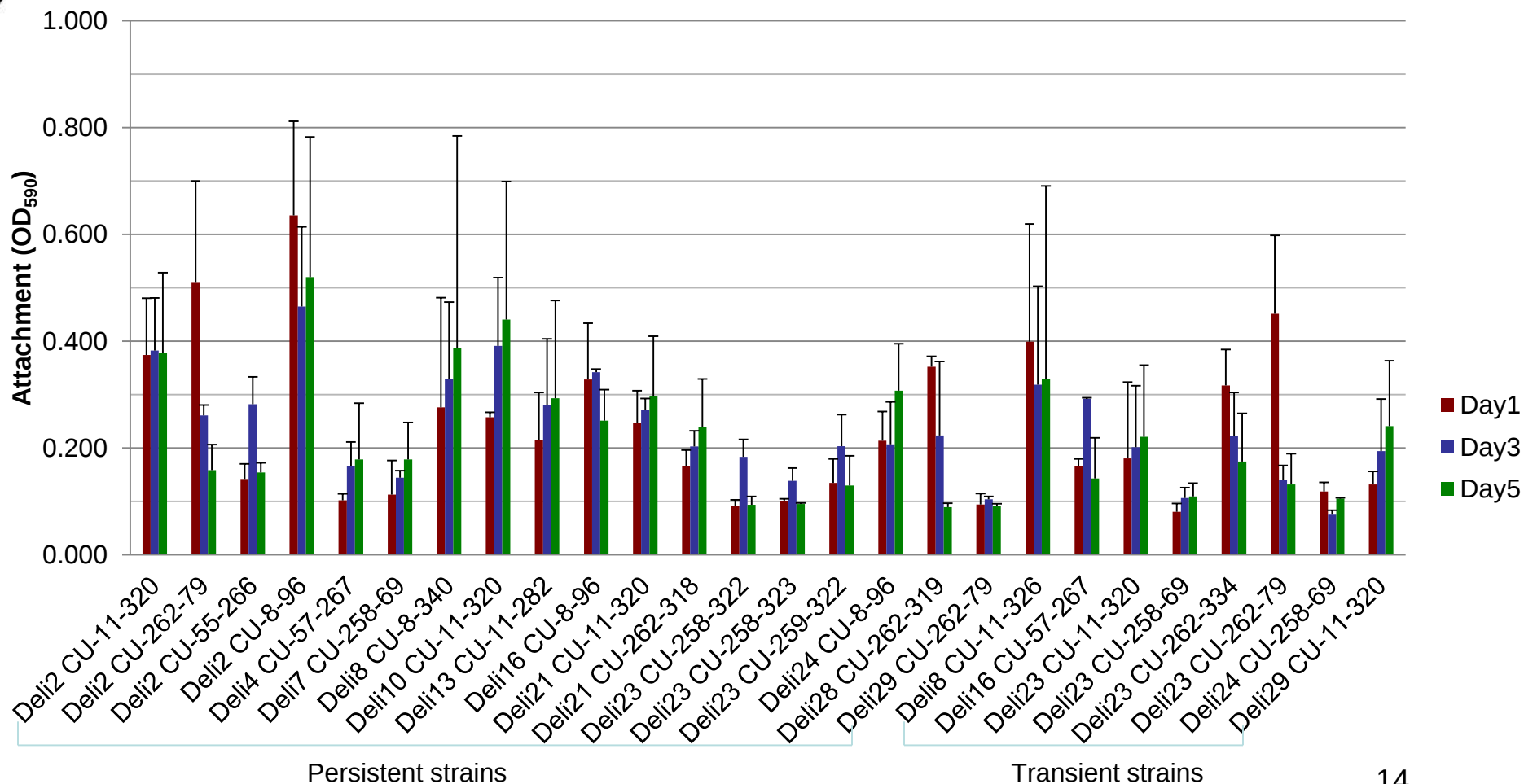
Adapted from Lemon et al., 2007, Chen et al., 2013



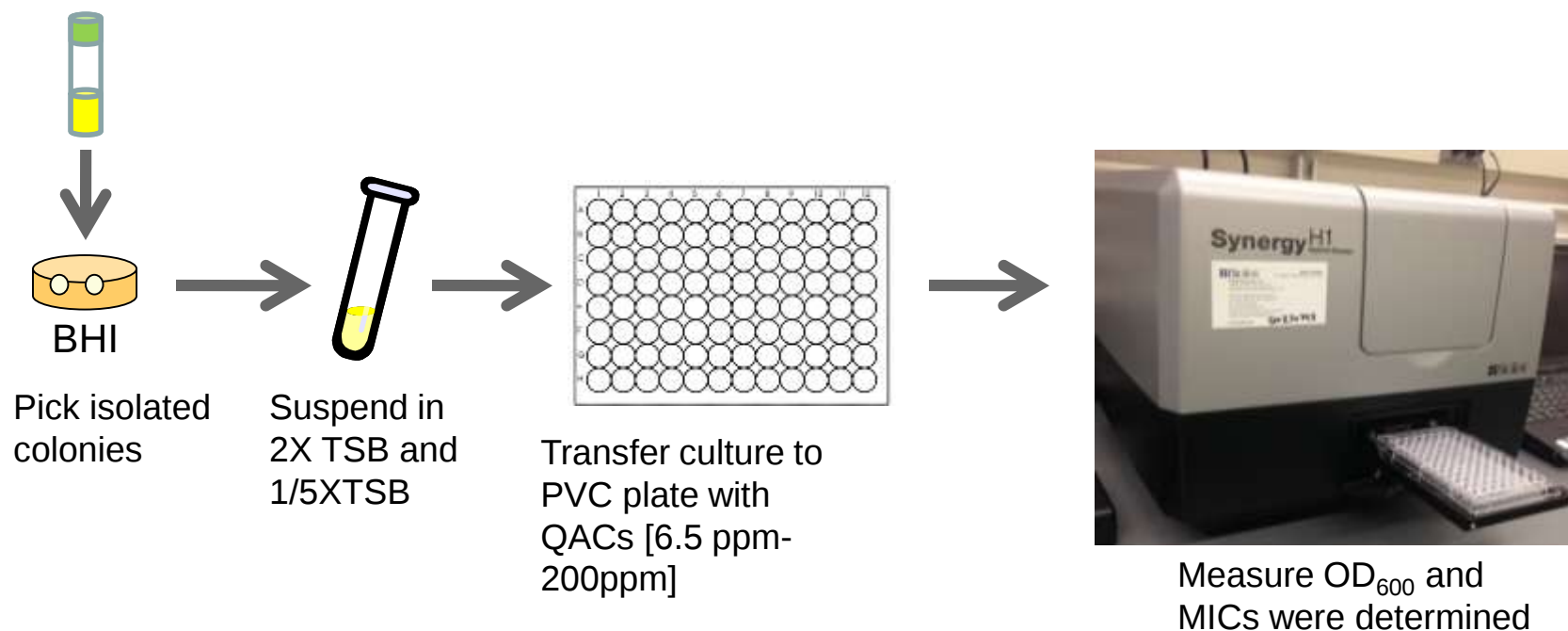
Persistent Strains Attach to Abiotic Surfaces Better than Transient Strains



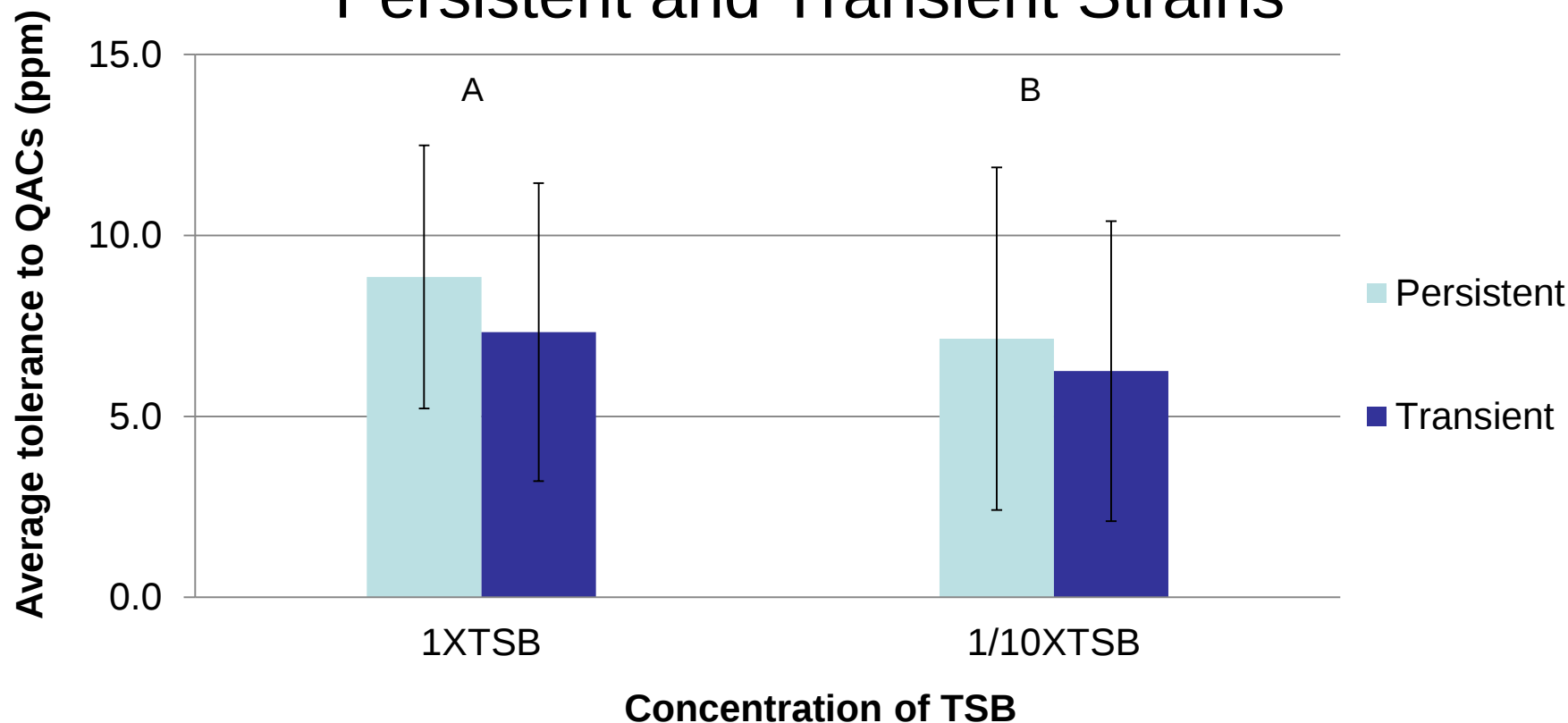
Isolates Within a Strain Display Significant Variation in Attachment Ability



Sanitizer Tolerance Assay



No Significant Difference between Persistent and Transient Strains



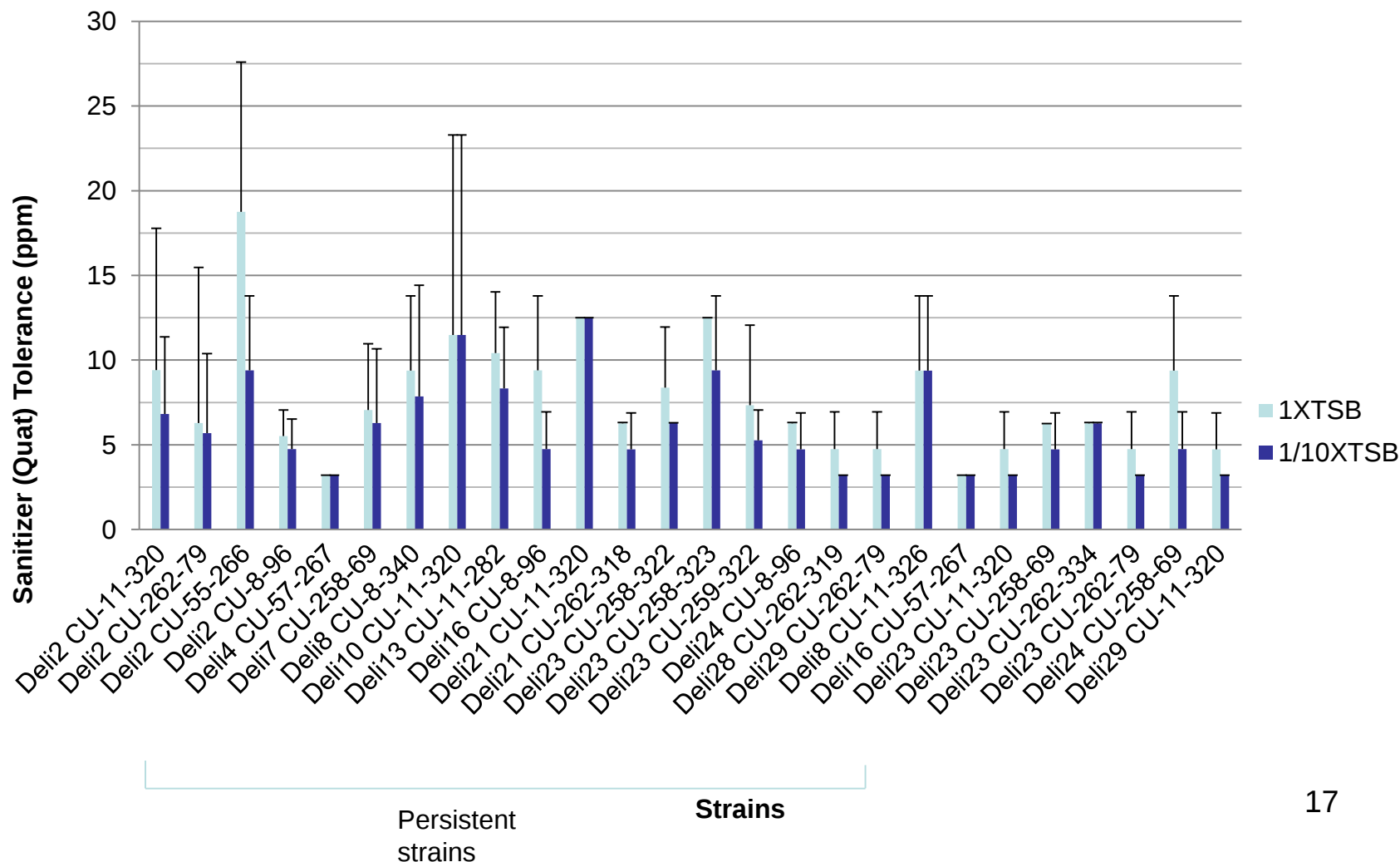
Statistical Analysis:

GLIMMIX: tolerance = "nutrient", "type", and "nutrient*type"

LS Means to determine p-value for "nutrient*type"

* Denotes significance at $P < 0.05$

Isolates Within a Strain Display Significant Variation in Sanitizer Tolerance



Conclusion

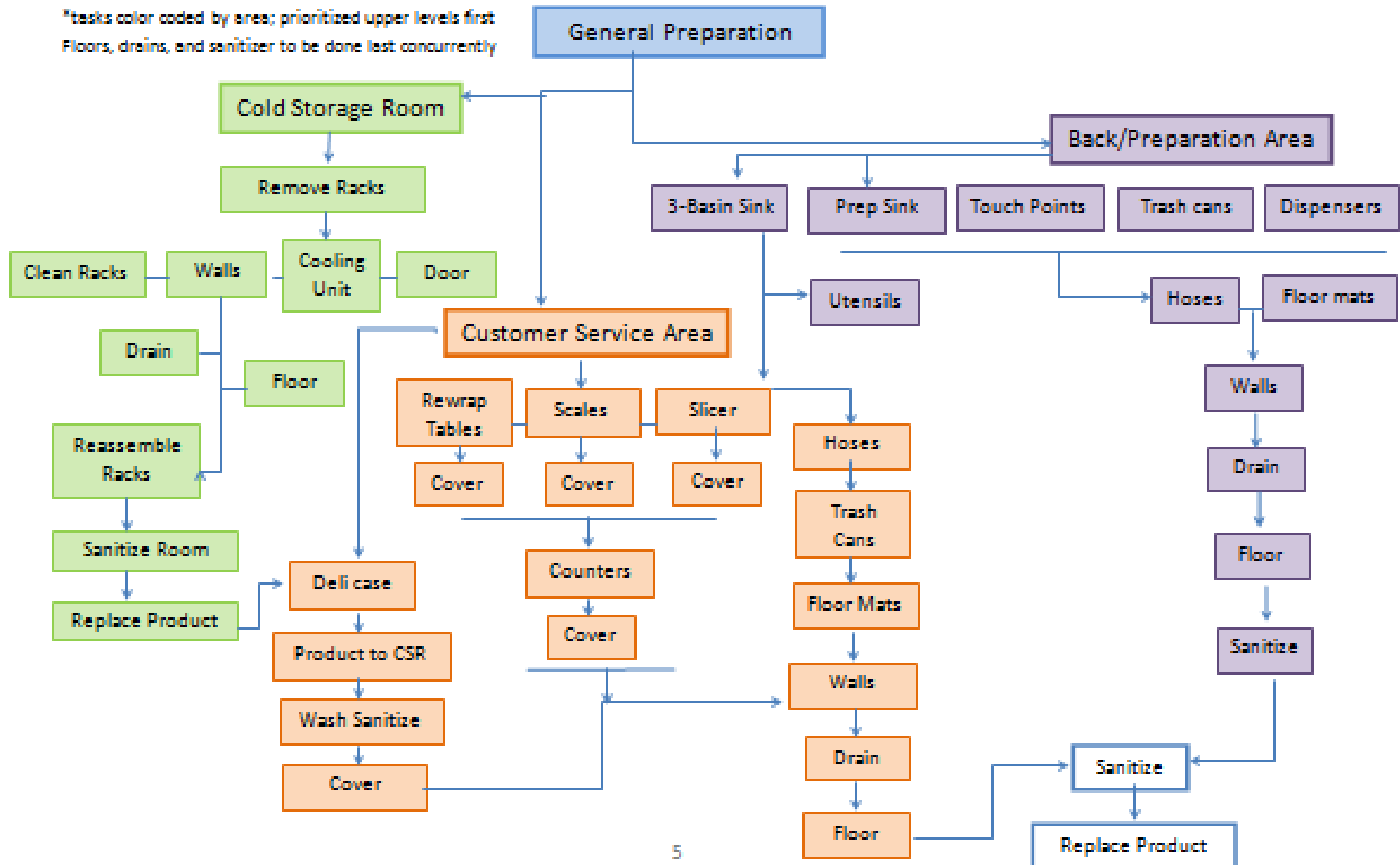
- Persistent LM strains were better at attaching to abiotic surfaces (PVC) than transient strains
- Persistent strains and transient strains displayed similar levels of sanitizer tolerance
 - LM was more tolerant to QACs under nutrient rich conditions than in nutrient limiting conditions
- Both attachment ability and sanitizer tolerance varied widely among isolates of the same strain

Environmental *L. monocytogenes* occurs.

WHAT DO WE DO ABOUT IT?

Overnight Deep Clean Protocol

*tasks color coded by area; prioritized upper levels first
Floors, drains, and sanitizer to be done last concurrently



Well...3rd party sort of worked..

- No new niches in low prevalence stores (n=5)
- Some reductions in high prevalence stores.
 - 2/4 stores reduced immediate LM prevalence
- Facilities & equipment design and condition may challenge effective sanitation
 - Damaged floors, service case design





Take 2: Employee Deep Cleans

- Immediately reduced LM prevalence in 6 of 7 stores.

Immediate Efficacy		
	% LM Before	% LM After
Store35	10 (2/20)	20.0 (4/20)
Store37	20 (4/20)	5.0 (1/20)
Store39	35 (7/20)	5.0 (1/20)
Store64	10 (2/20)	0.0 (0/20)
Store40	10.5 (2/19)	0.0 (0/20)
Store44	15 (3/20)	10.0 (2/20)
Store53	10 (2/20)	0.0 (0/20)

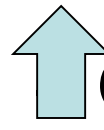
Longitudinal Efficacy

- Reduced average monthly LM prevalence a mean 9.7 percentage points (CI_{95} : 2.50, 16.90%; $p=0.017$) per store.

Longitudinal Efficacy		
	Ave. Monthly %LM Before	Ave. Monthly %LM After
Store35	12.5 (2/20)	3.3 (1.1/20.5)
Store37	21.7 (4.5/21)	24.8 (4.6/20.8)
Store39	31.9 (5.8/20.7)	9.8 (1.9/20.3)
Store64	18.1 (3.3/21)	7.1 (1.3/21)
Store40	16.7 (2.5/18)	1.9 (0.29/18.2)
Store44	8.8 (2/20)	1.7 (0.57/20)
Store53	35.0 (5/20)	28.3 (4.9/20)

For the same deep clean protocol:

- Employee-executed + training > 3rd party

 Organizations' engagement & facilities

Recommendations to Retailers

- Maintain good daily SSOPs in all delis
- Identify store with greatest food safety challenges and focus resources
- Target NFCS for additional cleaning
 - Use cleanable squeegees; store in sanitizer solution
 - Eliminate standing water
 - Improve floor cleaning procedures/frequency
- Education, training & facilities maintenance complement benefits of sanitation changes
- Review Food Code and ensure compliance

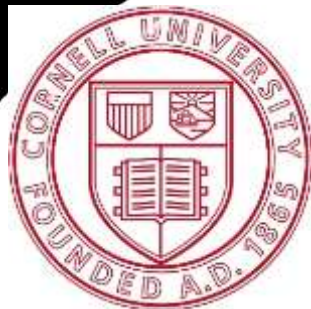
What else should I do?

FSIS

**Best Practices Guidance for Controlling
Listeria monocytogenes (*Lm*) in Retail
Delicatessens
June 2015**

Next Steps

- WGS & RNA-Seq → Genetic elements that increase biofilm/attachment capacity
- Prevalence and persistence of *L. monocytogenes* and *Salmonella* in retail produce environments



NEOGEN®

ECOLAB

Sealed Air
Diversey Care



United States Department of Agriculture
Food Safety and Inspection Service



United States Department of Agriculture
National Institute of Food and Agriculture

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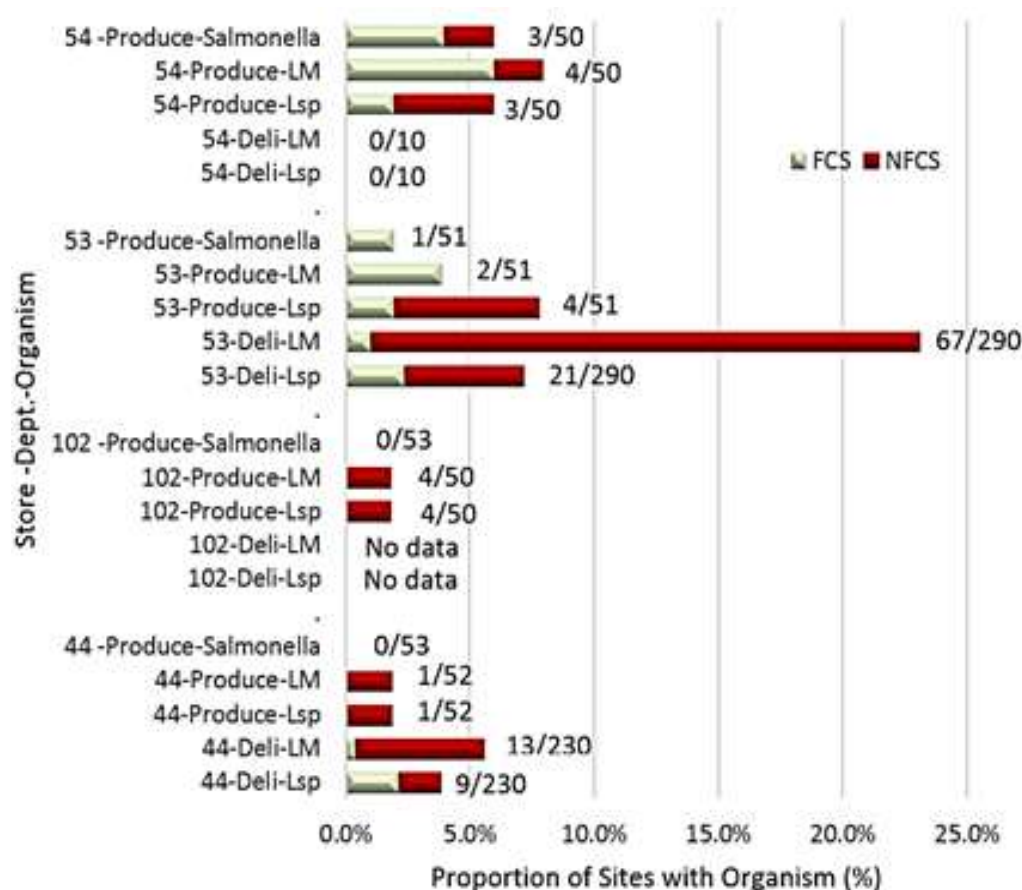
Hypotheses

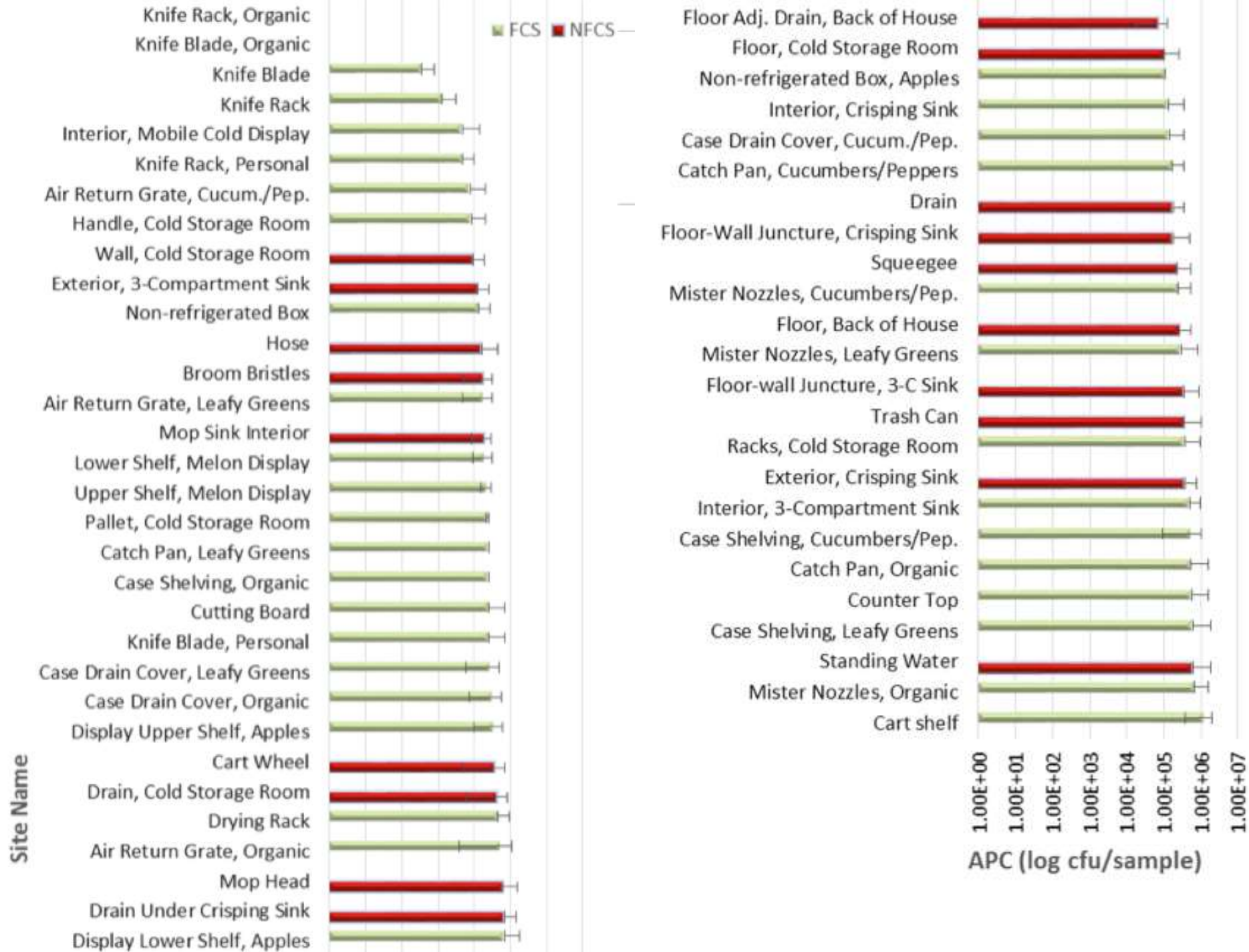
- (i) The retail produce storage, processing, and sales environments (i.e. food and non-food contact surfaces) are potential niches for *Salmonella*, *L. monocytogenes* and *L. spp.*
- (i) Transmission of these to produce at retail significantly contribute to public health risk, which could be reduced by targeted control strategies

Objectives

- **Obj I.** Elucidate *Salmonella*, *L. monocytogenes*, and other *L. spp.* contamination patterns and persistence in retail grocery produce storage and sales environments.
- **Obj II.** Identify practices and store characteristics that distinguish produce storage and sales environments with low *Salmonella*, *L. monocytogenes*, and other *L. spp.* prevalence from stores with high prevalence and evidence of persistence.
- **Obj III.** Develop, implement, and test practical and feasible control strategies in select establishments to (i) reduce *Salmonella* and *L. monocytogenes* in retail produce environments and (ii) reduce cross-contamination.

Preliminary Data on LM and Salmonella in Retail Produce Systems





Study Design

Jan-Feb 2016

Recruitment & Preparation

- Recruit retailers and select stores (Obj. 1 & 2)
- Purchase supplies (Obj. 1)
- Develop produce practices survey (Obj. 2)

Mar-Aug 2016

Assess Prevalence, Persistence & Practices

- Detect pathogens on up to 30 sites in 30 stores once per month for six months (Obj. 1)
- Collect responses to produce practices survey from 30 stores (Obj. 2)
- Select up to 10 stores to participate in evaluation of interventions (Obj. 3)

Sep-Nov 2016

Implement Interventions

- Conduct food safety training with associates (Obj. 3)
- Implement daily SSOP changes and sanitation deep cleans in up to 10 stores (Obj. 3)
- Evaluate immediate efficacy of interventions via sampling (30 sites before & after) (Obj. 3)

Dec 2016-Aug 2017

Evaluate Longitudinal Intervention Efficacy

- Repeat pre-intervention sampling procedures to detect pathogens (30 sites monthly, 9 months)
- Revise daily intervention procedures as needed to target remaining bacterial niches (Obj. 3)
- Compare Pulse-field Gel Electrophoresis (PFGE) fingerprints (Obj. 1, 3)

Sep-Dec 2017

Data Analysis, Communication of Results, & Publication

- Conduct statistical analysis of prevalence and persistence pre- and post-intervention (Obj. 1, 2, 3)
- Identify retail produce practices associated with increased pathogen prevalence (Obj. 2)
- Complete final report and prepare results for publication (Obj. 1, 2, 3)