How did that get there?

Case studies in produce packing and production

MICHELLE DANYLUK

UNIVERSITY OF FLORIDA

SEPTEMBER 16TH, 2023

WASHINGTON ASSOCIATION FOR FOOD PROTECTION

UF IFAS UNIVERSITY of FLORIDA

Florida Avocado

Green Skin Avocado

- Looks very different from the ‘Hass’ avocado grown in California (86% of domestic production)

Florida Avocado

Green Skin Avocado

- Looks very different from the ‘Hass’ avocado grown in California (86% of domestic production)

Florida Avocado

Green Skin Avocado

- Falls into one of three main types
  - West Indian
  - Guatemalan
  - Mexican

http://edis.ifas.ufl.edu/st435
http://edis.ifas.ufl.edu/fe956

Florida Avocado

Second most valuable tree crop in Florida

- 7,000 acres in Florida
- 60% of the tropical fruit industry
- 95% of commercial production is in Miami-Dade
- Orchard size between 0.1 – 500 acres
  - 93% of farms are less than 15 acres

http://edis.ifas.ufl.edu/st435
http://edis.ifas.ufl.edu/fe956

Avocados and Food Safety Recalls

2014-2016 FDA sampling assignment – Whole fresh avocados

- 1,615 avocado samples tested for *Salmonella* and *Listeria monocytogenes*
- 70% imported, 30% domestic
- After 3 months (out of 18 total), sampling approach changed to only test the flesh for *L. monocytogenes*. Not the whole fruit.
- *Salmonella* prevalence at 0.74%
- *L. monocytogenes* prevalence at 17.73 for whole fruit and 0.24 of pulp

https://www.fda.gov/media/119969/download

Avocados and Food Safety Recalls

2014 FDA initiated a sampling project to evaluate presence of foodborne pathogens on avocados in the US

- Included avocados that were grown and packed in Florida
- At least 4 recalls initiated for Florida Packers in 2014
- Two recalls for one firm

Food Safety News

Breaking news for everyone's consumption

Home | Foodborne Illness Outbreaks | Food Recalls | Food Politics | Events | Subscribe | About U

Florida Firm Recalls Avocados for Potential Salmonella Contamination

BY NEWS DESK | AUGUST 12, 2014

Avocados and Food Safety – What do we know?

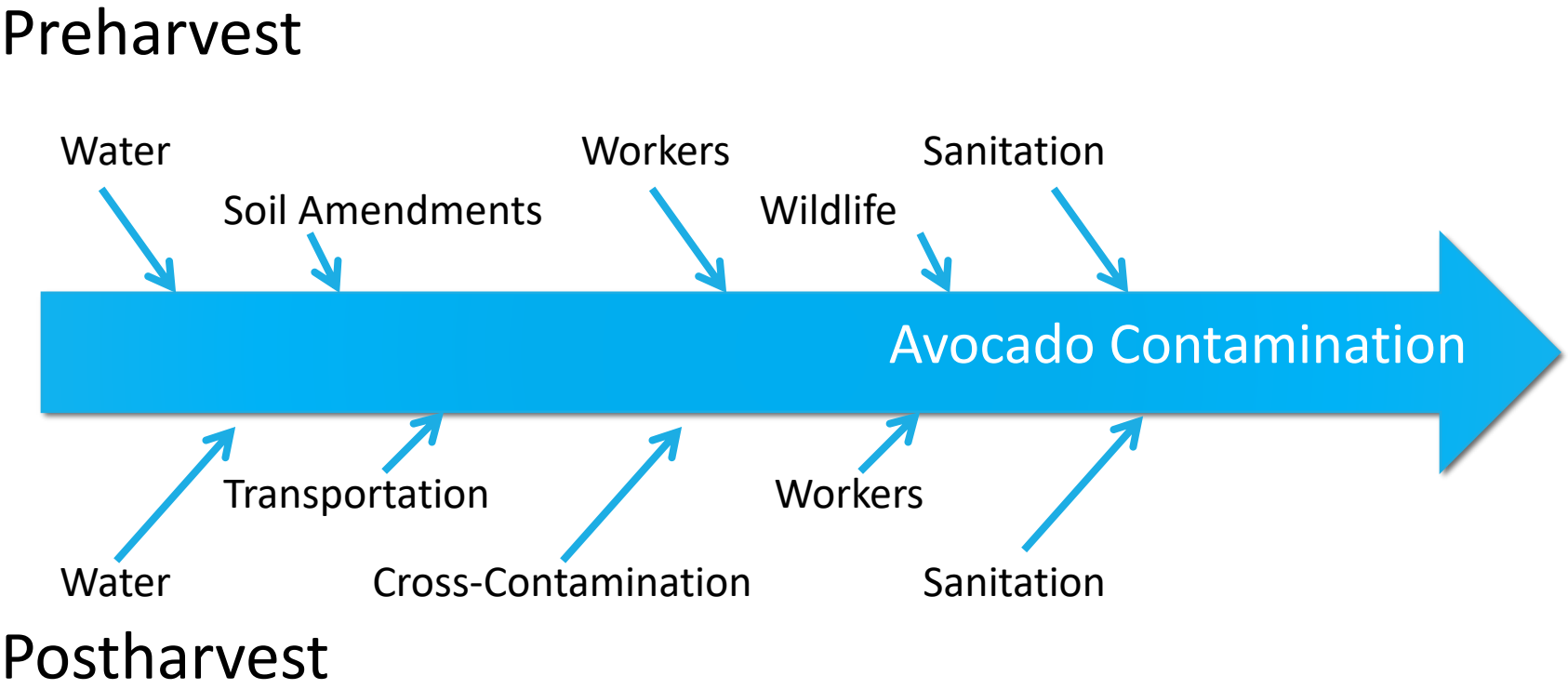
Salmonella, *Escherichia coli* O157:H7, *Staphylococcus aureus*, and *Listeria monocytogenes* can grow in avocado pulp or juice at a range of temperature conditions (Arvizu-Medrano et al. 2001; Yigeremu et al., 2001; Iturriaga et al., 2002; Mutaku et al., 2005).

No work published on survival on whole fruit, potential for pathogen internalization during handling, or mitigation strategies to remove contamination once present.

No work done on green skin varieties grown in Florida.

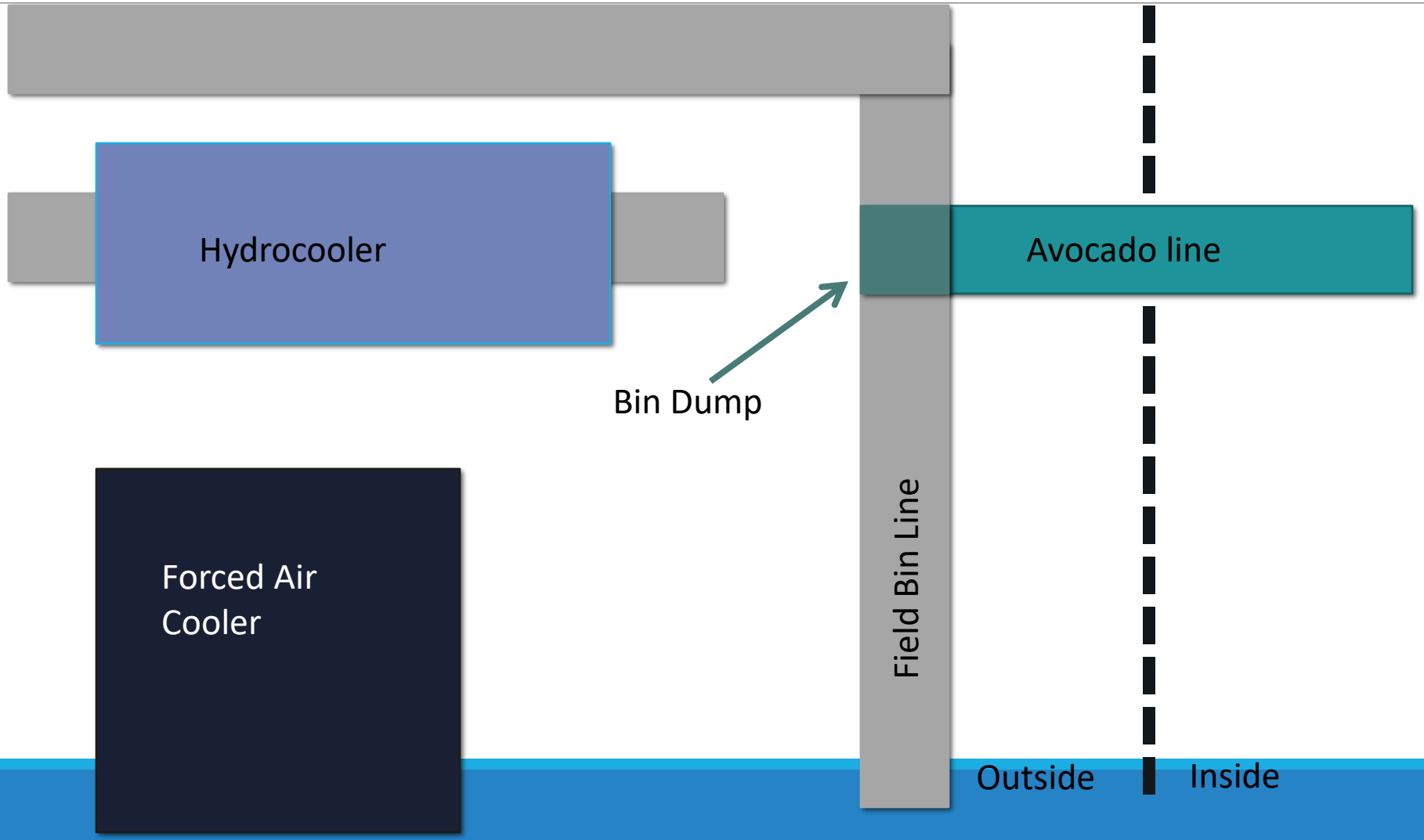
Where was the *Salmonella* coming from?

Following the second recall in the 2014 season from the same facility, we were asked to help identify the source of the *Salmonella*

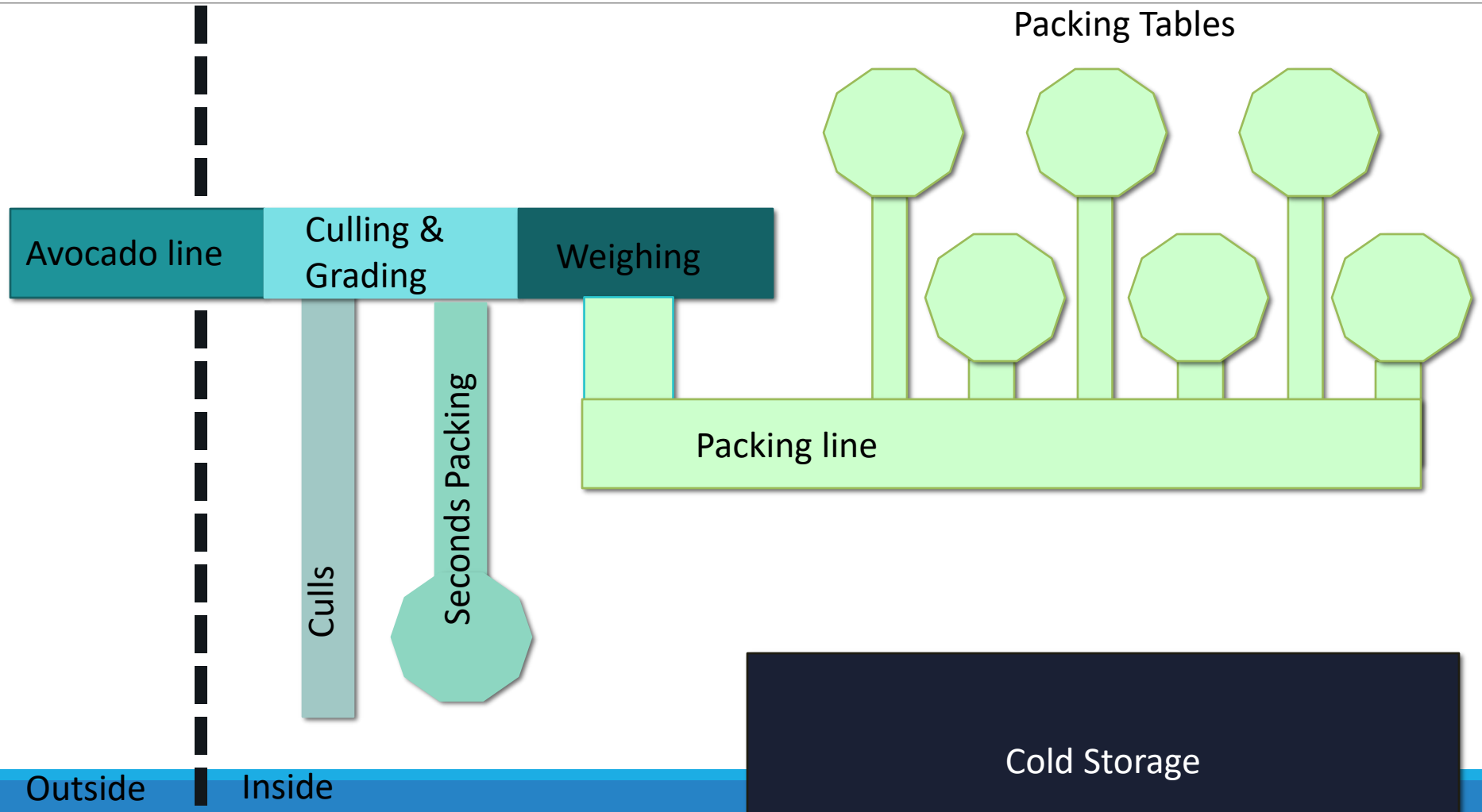


Chapin and Danyluk, unpublished

Postharvest Source



Postharvest Source



Postharvest Source

Visited the facility following a full day of operation to collect swab samples

- 198 samples, from zones 1-4
- Included water samples from hydrocooler

Facility Sanitation

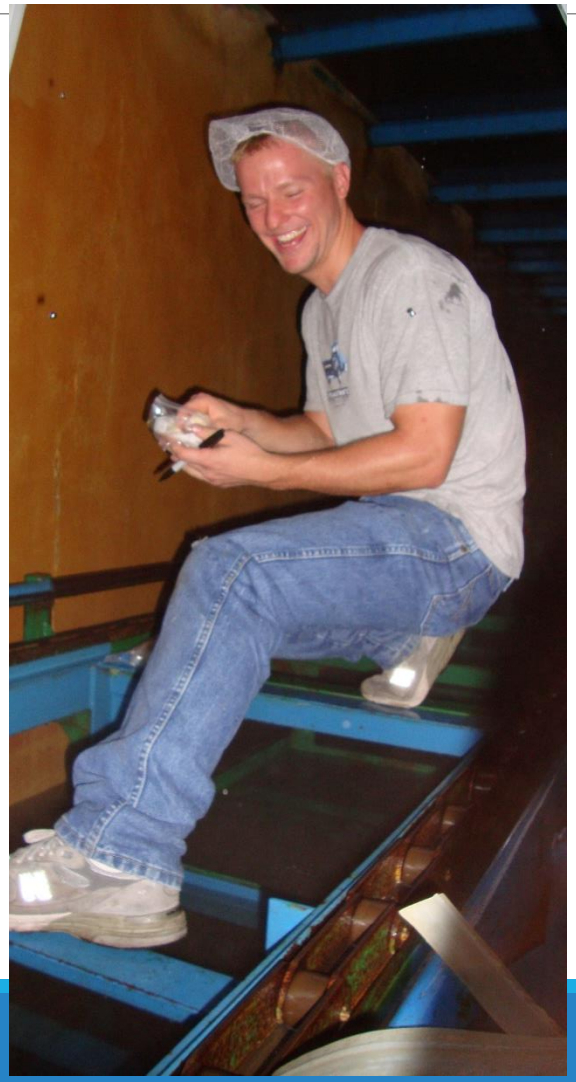
- Food contact surfaces cleaned either daily (packing tables), or weekly (weighing line)
- Hydrocooler water maintained at 14-17 ppm free Chlorine, 6.5-7.5 pH, concentration measured hourly by titration, water changed weekly

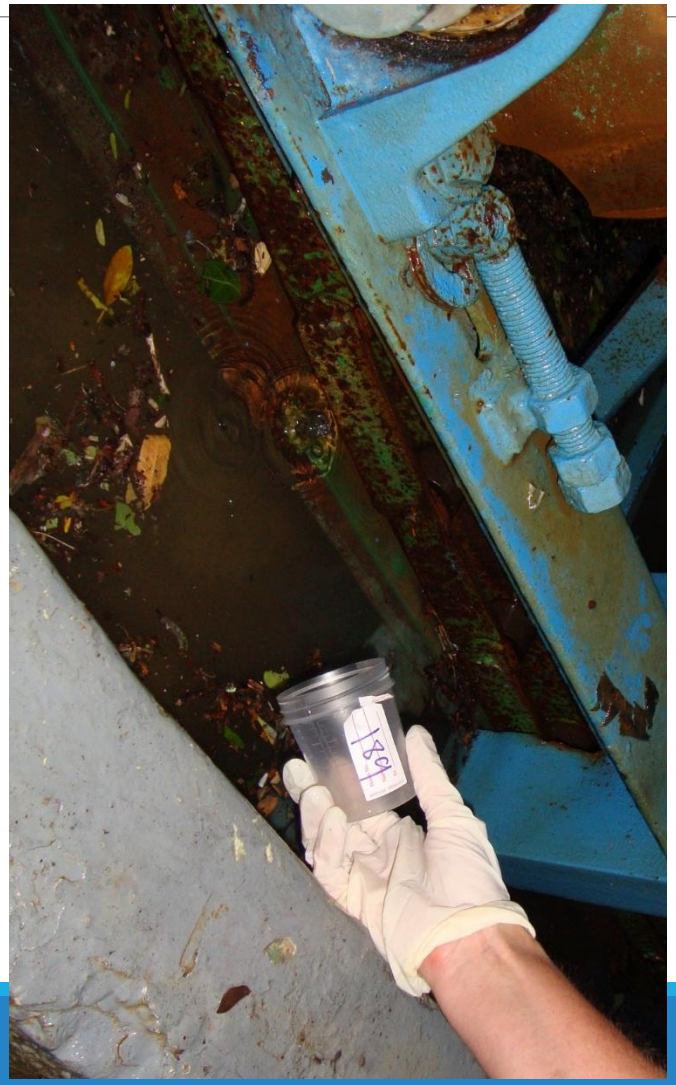
Methodology

All samples enriched following FDA BAM for *Salmonella*

- Preenrichment (Lactose broth)
- Selective enrichment (Rv-R10 and TT broths)
- Selective & differential plating media (XLD, XLT-4, HE, and Chrome)
- Colony isolation and confirmation (TSI and LIA)
- PCR confirmation (*invA*)
- Serotyping
- Genetic Fingerprinting

Types of packing surfaces



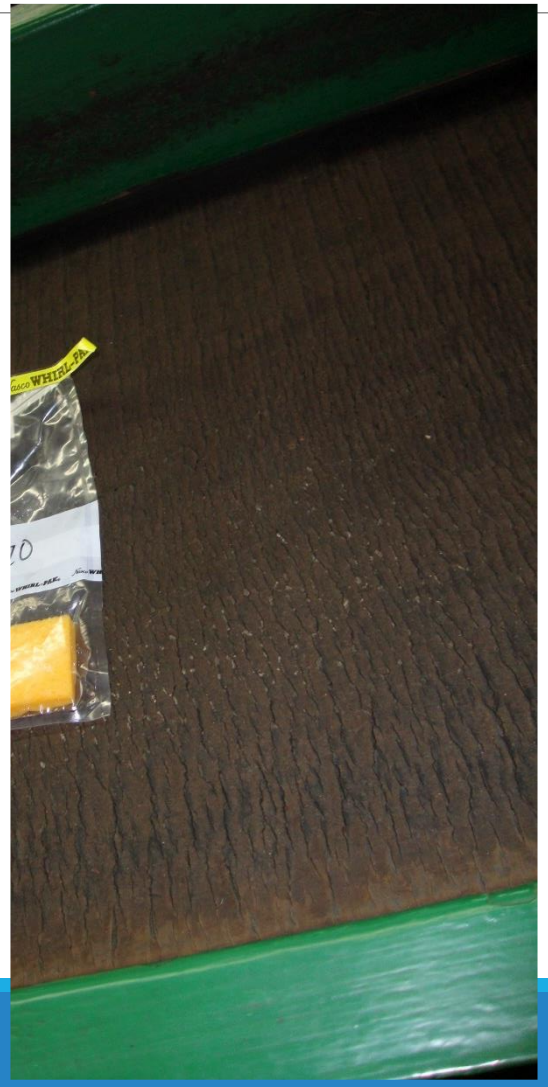


Chapin and Danyluk, unpublished

Types of packing surfaces

Chapin and Danyluk, unpublished

Types of packing surfaces

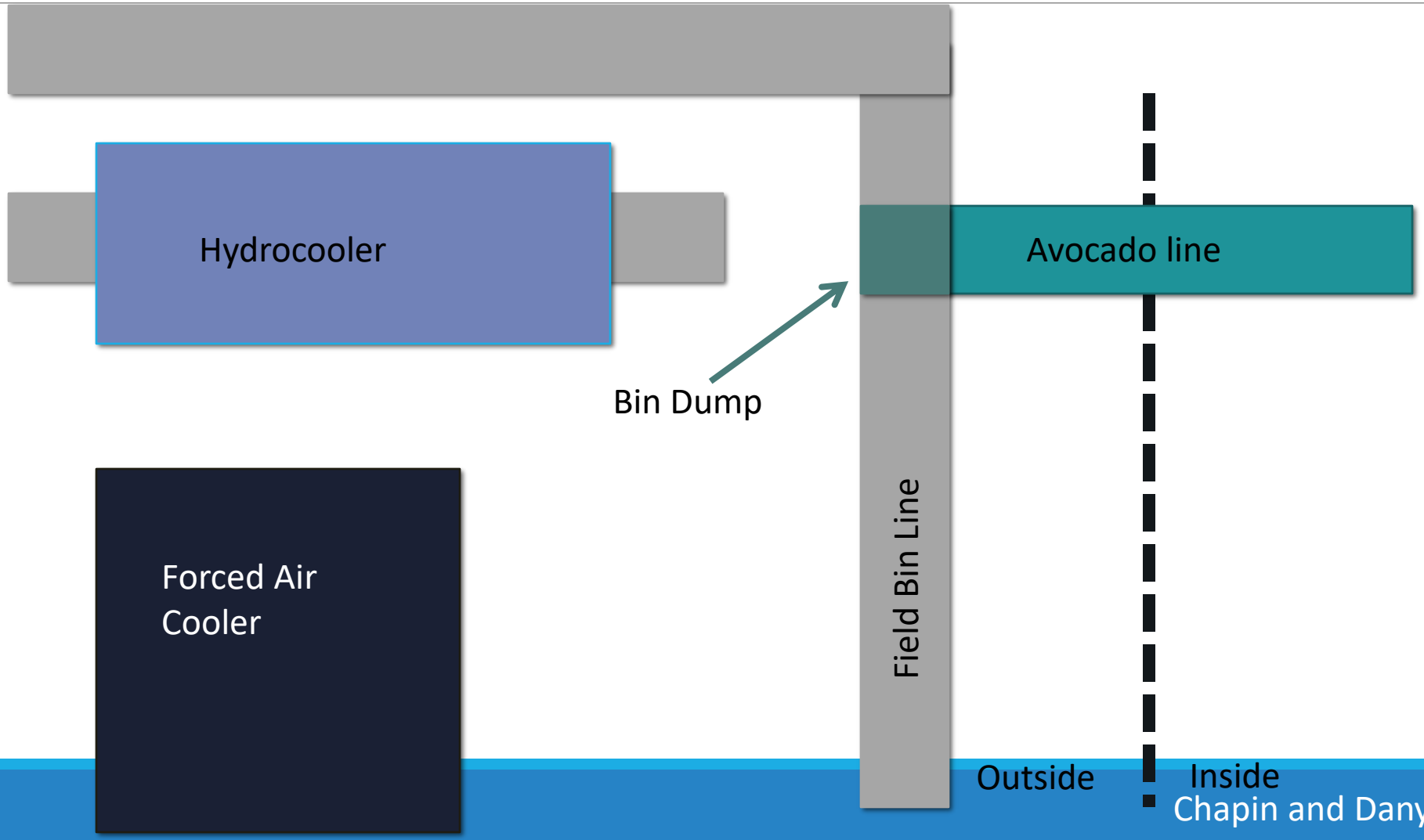


Chapin and Danyluk, unpublished

Types of packing surfaces

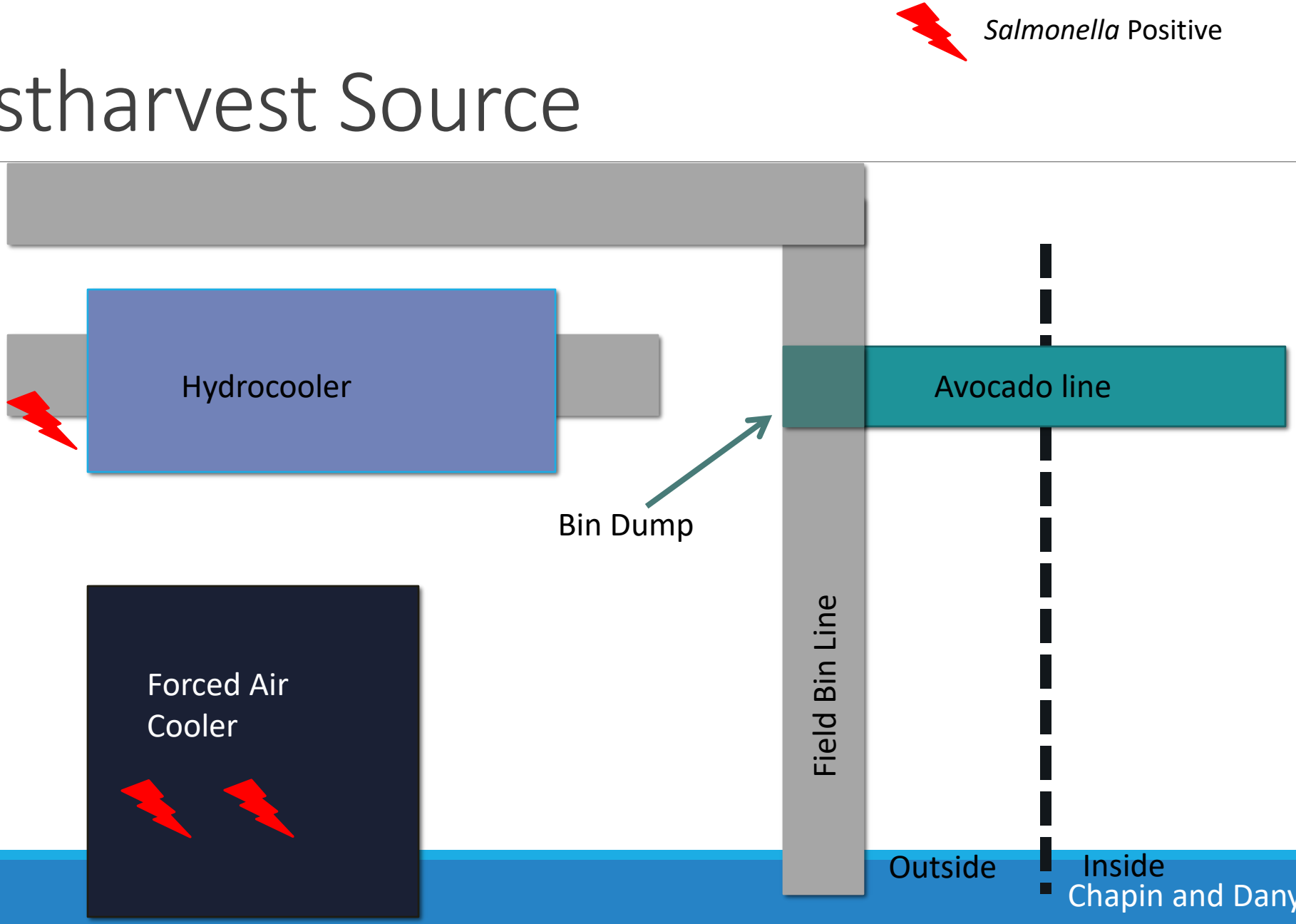
Chapin and Danyluk, unpublished

Postharvest Source



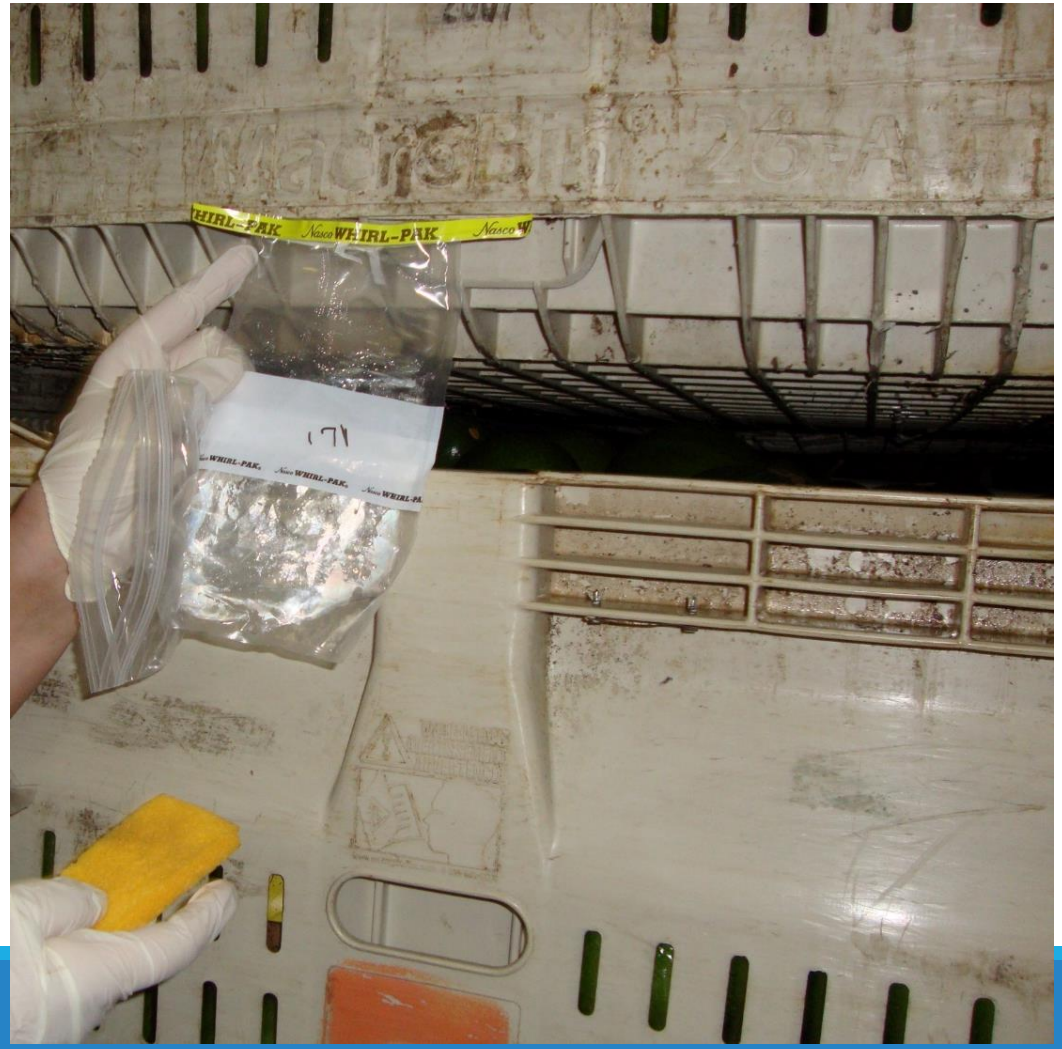
Chapin and Danyluk, unpublished

Postharvest Source



Chapin and Danyluk, unpublished

Postharvest Contamination



Chapin and Danyluk, unpublished

Preharvest Contamination

Visited three groves, two associated with the recalls, one currently storing soil amendments

- 57 samples, including soil, water, drag swabs, standing water, bird feces, snails, biosolids, fence bordering horse pasture

Visited field bin storage

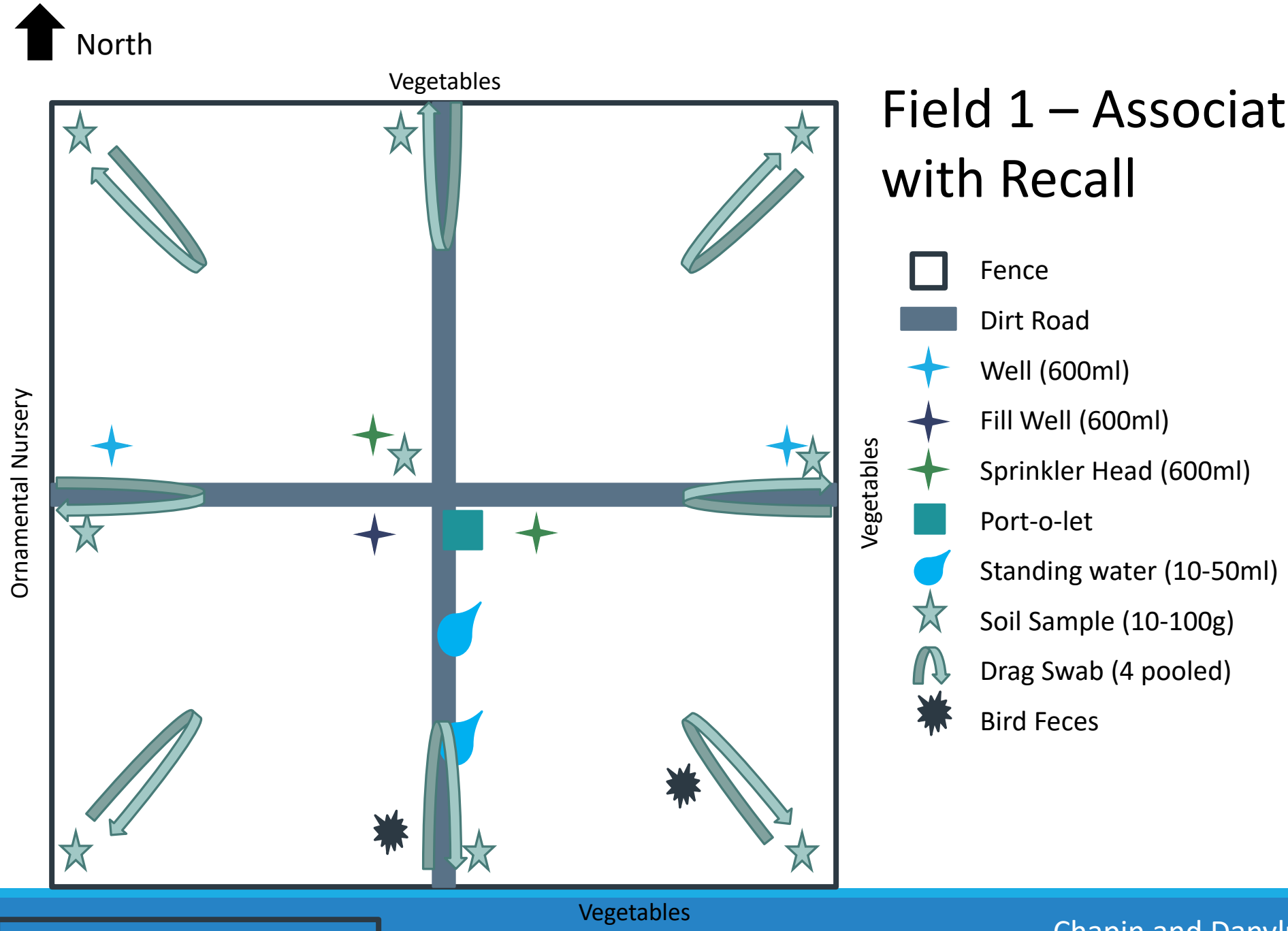
- 15 additional swabs

Methodology

All samples enriched following FDA BAM for *Salmonella*

When water (14), soil (13) or biosolids (9) samples were big enough, samples were split, and ½ went through pre-enrichment in lactose, the other ½ went through pre-enrichment in buffered peptone water.

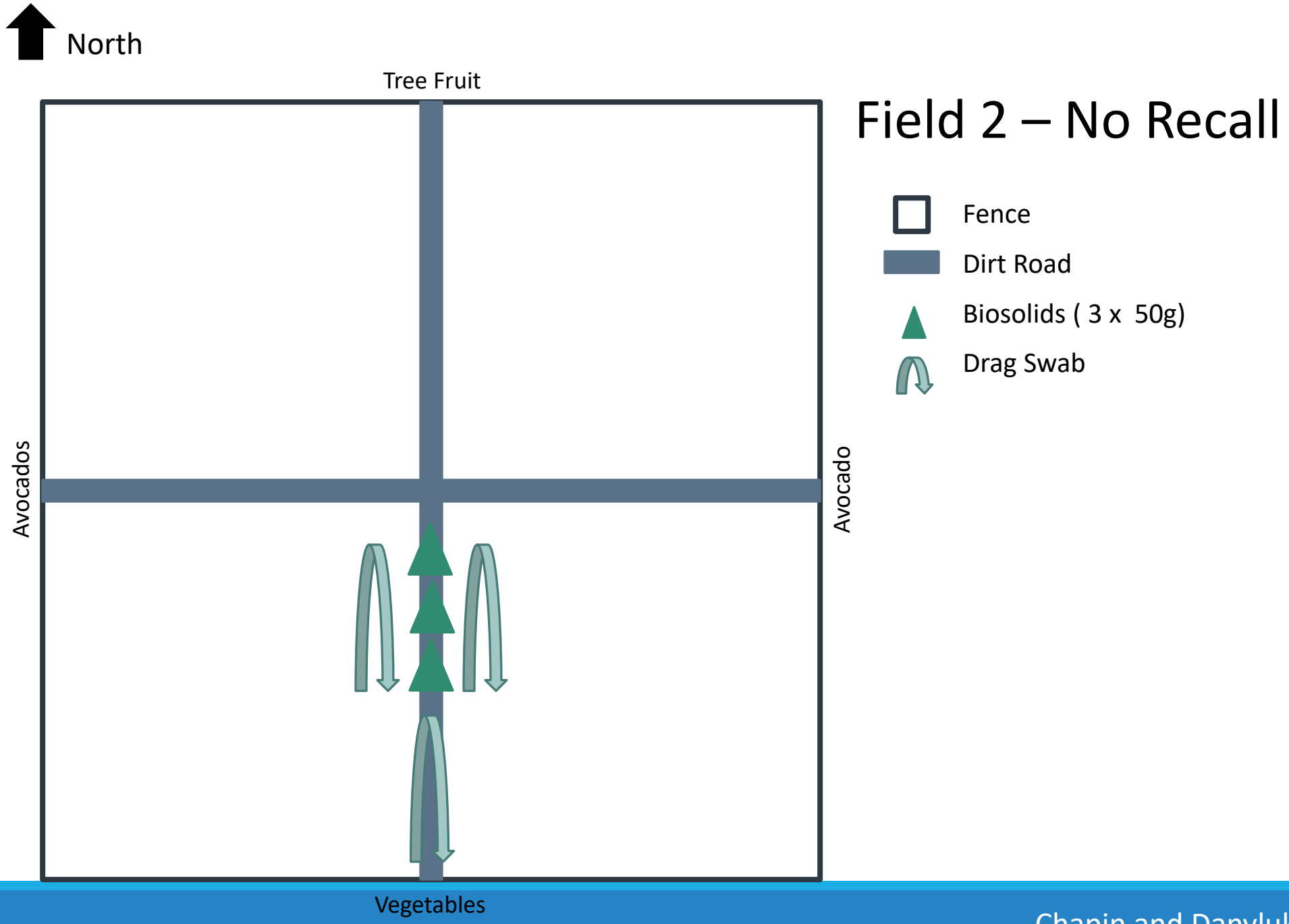
- Why?
- We keep seeing FDA reports using buffered peptone instead of lactose for pre-enrichment of environmental samples



Field 1 – Associated with Recall

- Fence
- Dirt Road
- Well (600ml)
- Fill Well (600ml)
- Sprinkler Head (600ml)
- Port-o-let
- Standing water (10-50ml)
- Soil Sample (10-100g)
- Drag Swab (4 pooled)
- Bird Feces

Chapin and Danyluk, unpublished



Field 2 – No Recall

Fence

Dirt Road

Biosolids (3 x 50g)

Drag Swab

Chapin and Danyluk, unpublished

Chapin and Danyluk, unpublished

Biosolid Use

How were biosolids used in the orchard?

- Trees are side dressed with in throughout the year
- Can be close to harvest and can generate dust

Chapin and Danyluk, unpublished

North

Field 3 – Associated with Recall

Fence
Dirt Road
Well (600ml)
Fill Well (600ml)
Sprinkler Head (600ml)
Standing water (10-50ml)
Soil Sample (10-100g)
Drag Swab (4 pooled)

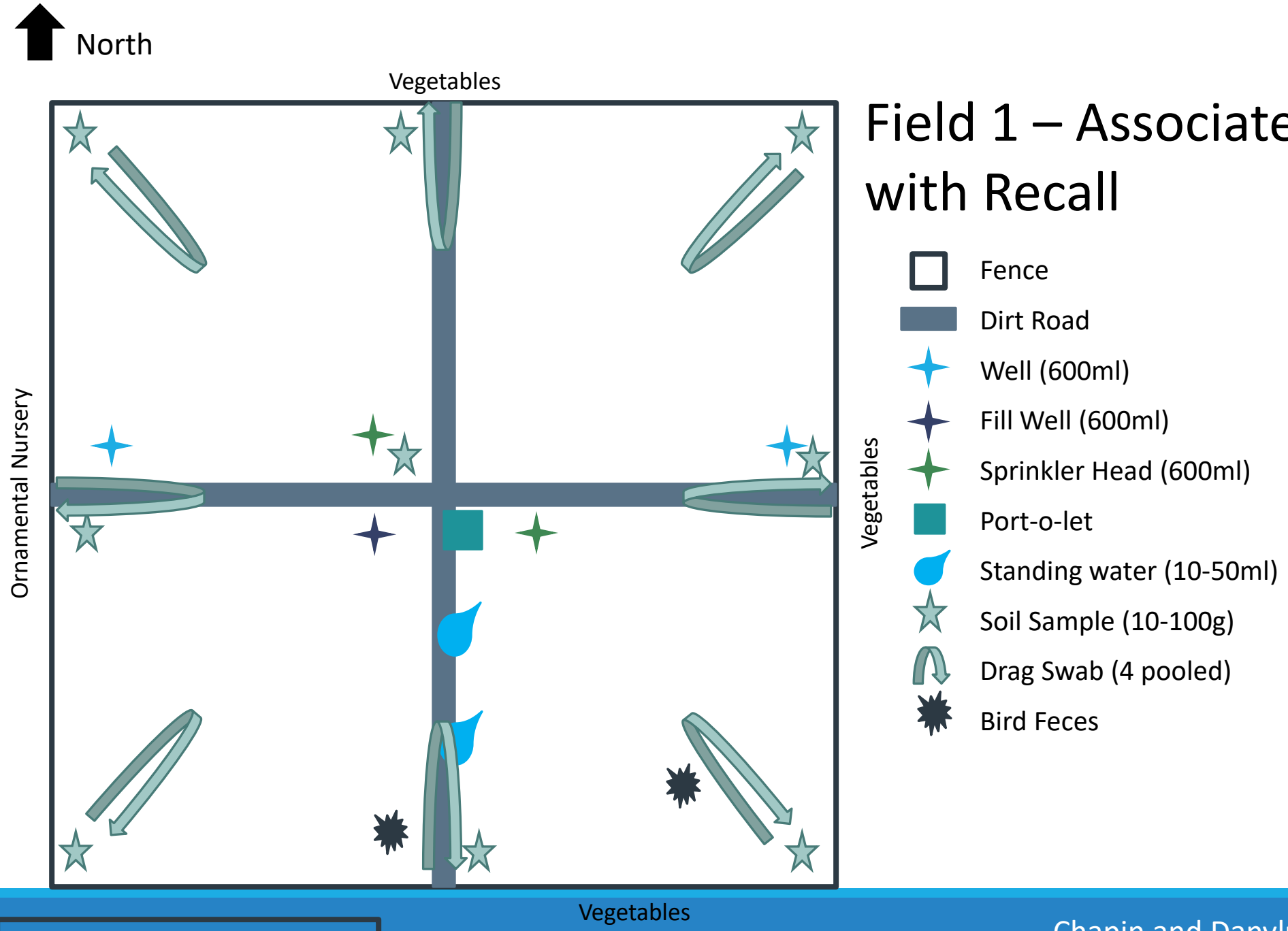
Chapin and Danyluk, unpublished

Field 3 – Grove was approximately 70 years old

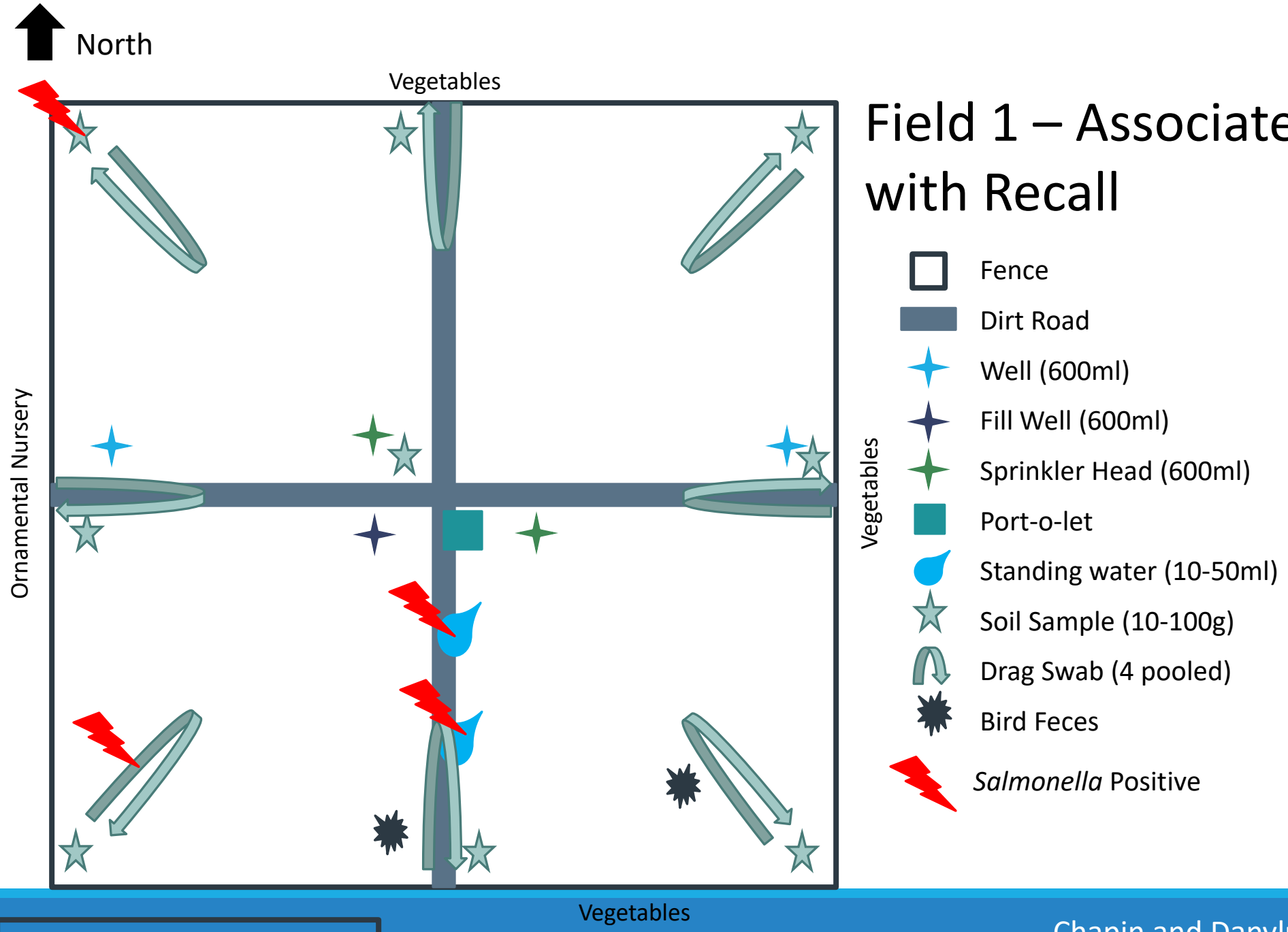
Chapin and Danyluk, unpublished

Field 3 – And home to a Burmese Python

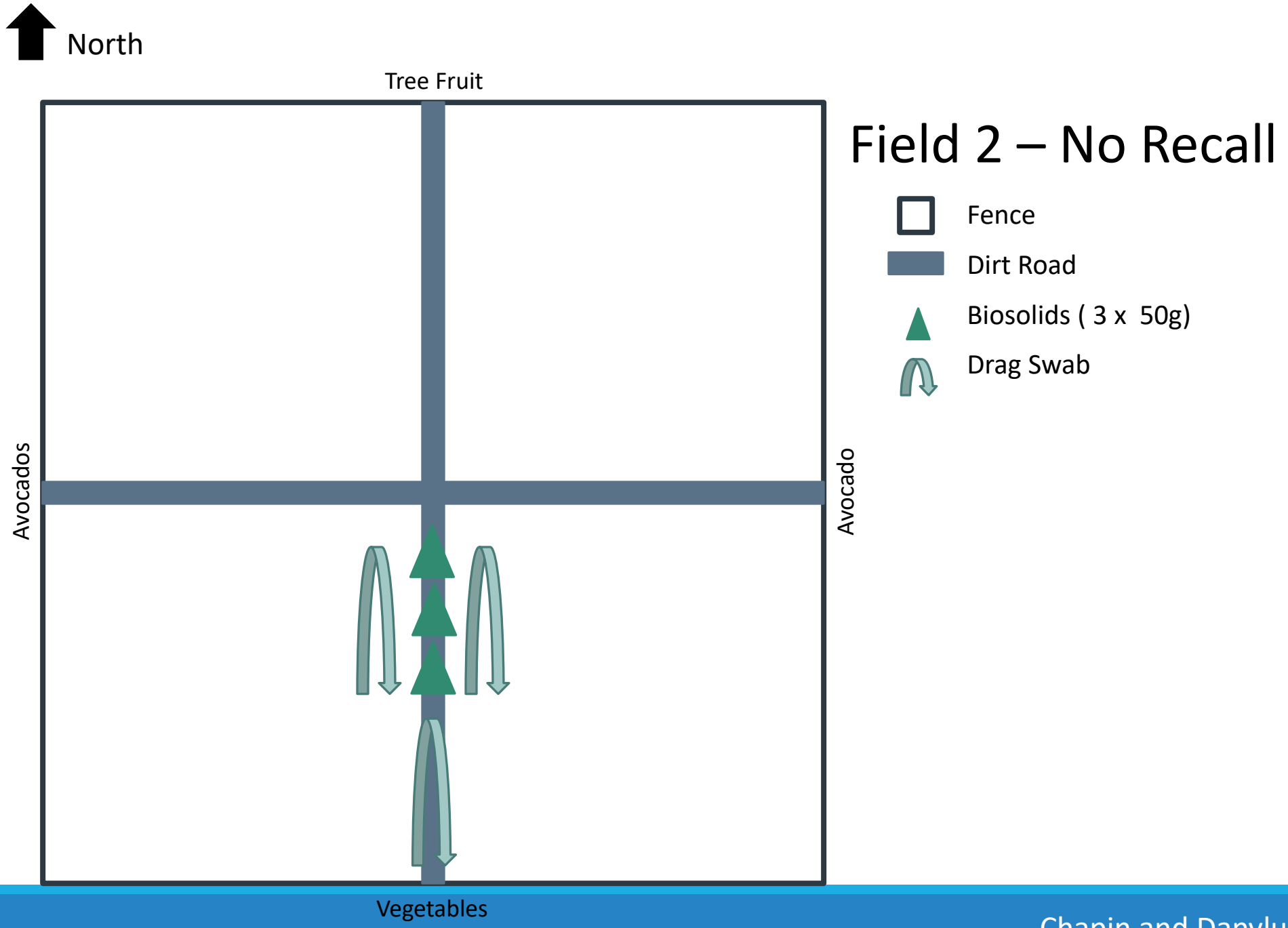
(that we found out about after we had sampled and wondered what was hissing at us)



Chapin and Danyluk, unpublished



Chapin and Danyluk, unpublished



Field 2 – No Recall

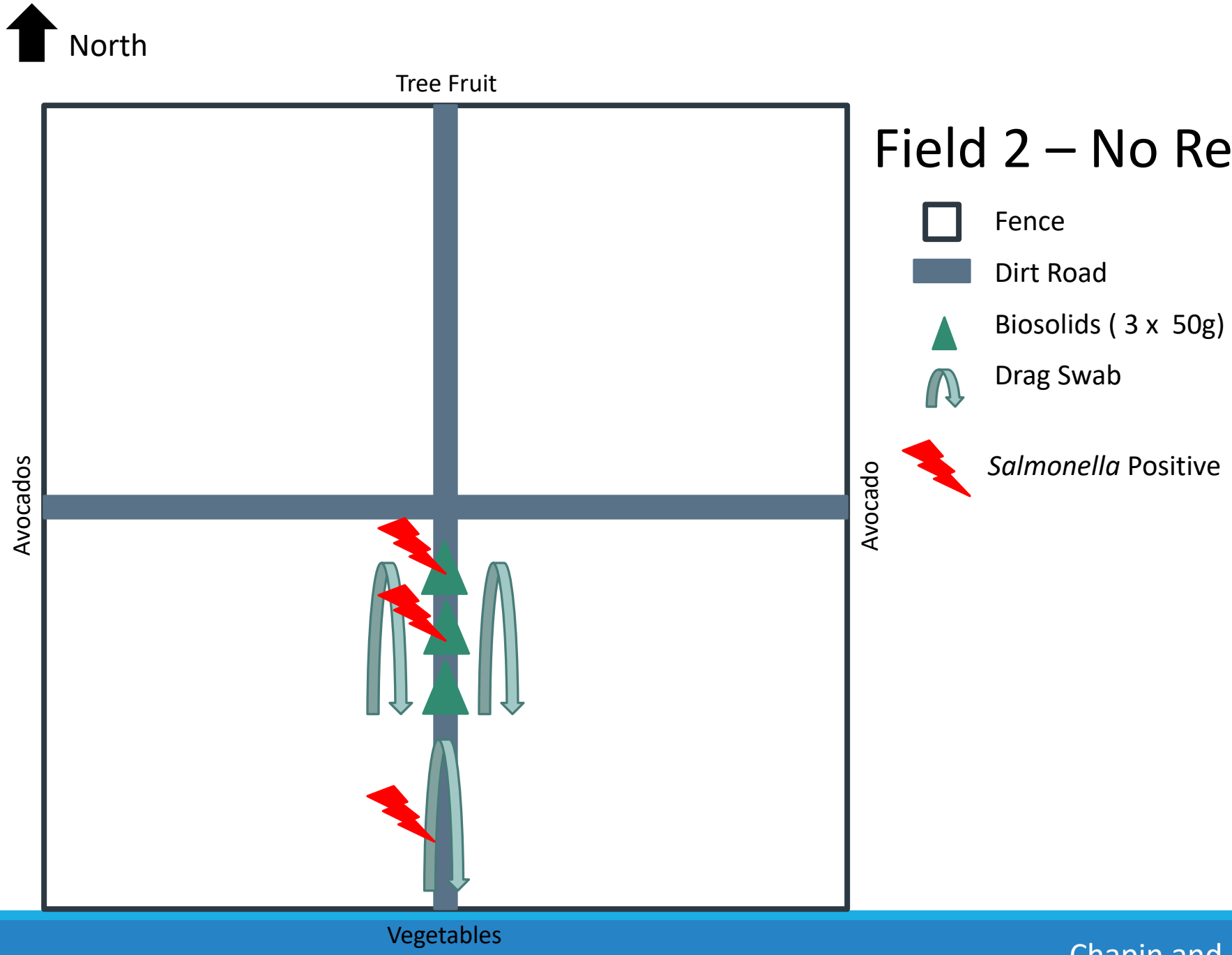
Fence

Dirt Road

Biosolids (3 x 50g)

Drag Swab

Chapin and Danyluk, unpublished



Field 2 – No Recall

Fence

Dirt Road

Biosolids (3 x 50g)

Drag Swab

Salmonella Positive

Chapin and Danyluk, unpublished

Methodology

With the remaining biosolids samples, we performed a 3 tube MPN for *Salmonella*

- Report results in MPN/4 g, based on the proposed standards from the initial proposed Produce Safety Rule for treated compost

L. monocytogenes	***0 CFU / 5 g***	**OR**	**-----**
Salmonella	***< 3 MPN / 4 g***		***< 3 MPN / 4 g***
***E. coli* O157**	***<0.3 MPN / 1 g***		**-------**
Fecal coliforms	**-----**		**<1000 MPN / 1 g**

Chapin and Danyluk, unpublished

Amount of *Salmonella* in the three biosolids piles

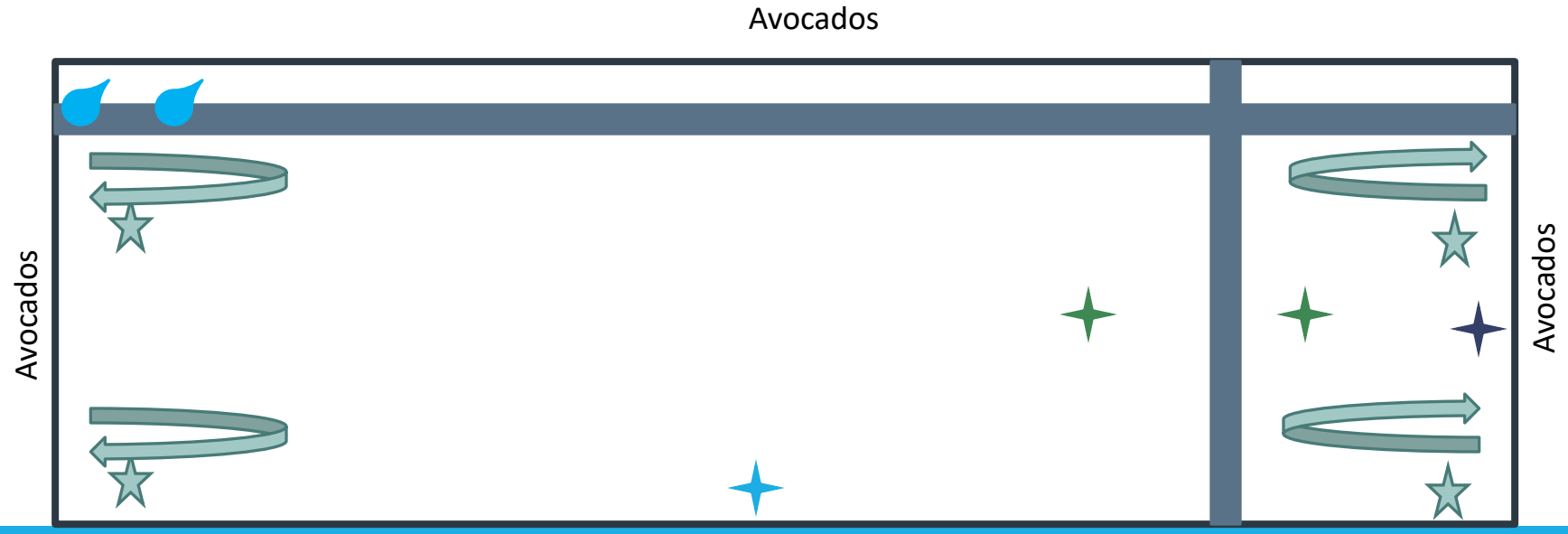
Biosolid Pile	*Salmonella* MPN/4 g Dry Weight
1	0.64
2	2.96
3	3.38

Chapin and Danyluk, unpublished

North

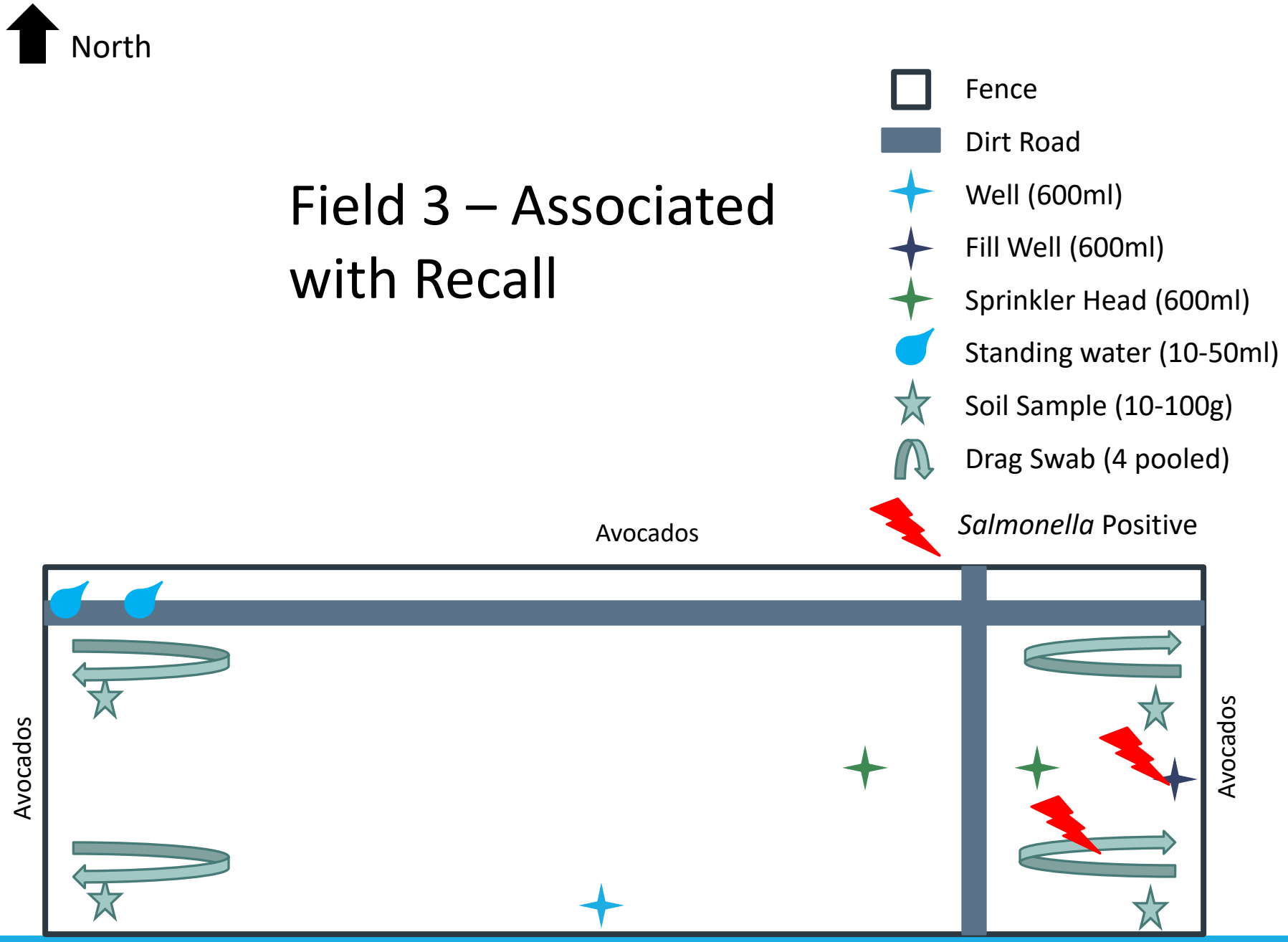
Field 3 – Associated with Recall

Fence
Dirt Road
Well (600ml)
Fill Well (600ml)
Sprinkler Head (600ml)
Standing water (10-50ml)
Soil Sample (10-100g)
Drag Swab (4 pooled)



Chapin and Danyluk, unpublished

Field 3 – Associated with Recall

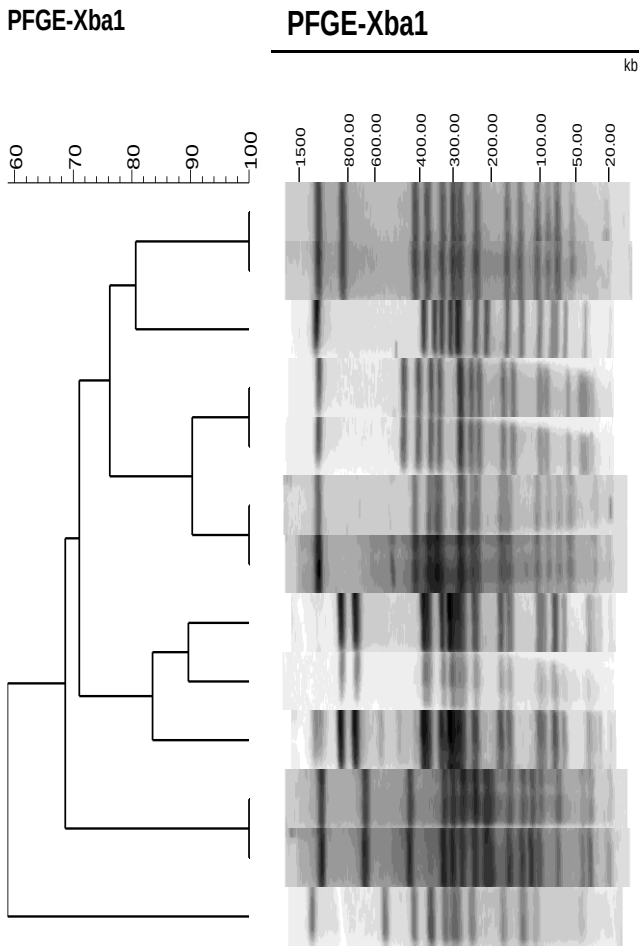


What Types of *Salmonella*?

Field	Location	Serotype
Packinghouse	Field Bin in cold storage	Tennessee
	Field Bin in cold storage	Tennessee
	Ground by hydrocooler	Tennessee
Field 1	Standing water 1	Madjorio
	Standing water2	Infantis
	NW Soil	Tennessee
	SW Drag	Muenchen
Field 2	Biosolids Pile 2	Cerro
	Biosolids Pile 3	Branderup
	South Biosolids Drag	Cerro
Field 3	Fill Well	Kedougou
	SE Soil	Tennessee

Chapin and Danyluk, unpublished

What Types of *Salmonella*?



Key	Sample Nu	Sample Location	Serotype
MDD 437/#1	237	Pile #2 Biosolids	Cerro
MDD 437/#2	237	Pile #2 Biosolids	Cerro
MDD 441	223	Standing Water with Birds (Entrance)	Infantis
MDD 443	245	Grove Fill Well	Kedougou
MDD 443/#1	245	Grove Fill Well	Kedougou
MDD 435	175	Packinghouse Floor	Tennessee
MDD 435/#1	175	Packinghouse Floor	Tennessee
MDD 440/#1	211	Grove SW drag swab	Muenchen
MDD 440/#2	211	Grove SW drag swab	Muenchen
MDD 440	211	Grove SW drag swab	Muenchen
MDD 436	240	Pile #3 Biosolids	Braenderup
MDD 436/#1	240	Pile #3 Biosolids	Braenderup
MDD 438	205	Grove Standing Water	Madjorio

Chapin and Danyluk, unpublished

Salmonella Pre-Enrichment Lactose broth vs BPW

No difference seen between two preenrichment media

We used the full spread of enrichment broths and plating media, following each preenrichment

- Not all samples positive, or typical colonies on all media types

When working with environmental samples, use all enrichment media, if possible

Sample Type	Number Tested	Total Positive	Positive Lactose Broth	Positive from BPW
Water	14	4	4	4
Soil	13	2	2	2
Biosolids	9	2	2	2

Chapin and Danyluk, unpublished

Summary of Sampling Results & Recommendations

Biosolids contained *Salmonella*, and could be introducing it into the grove

- Subsequent testing of biosolids, as they arrived at the fields confirmed they were *Salmonella* positive

If field bins contacted the ground, or if dust was generated while field bins were in the grove, field bins could be contaminated.

Stacking of field bins could lead to contaminated product

An SSOP for field bin cleaning should be established

Changes Implemented

Discontinued use of Biosolids

- Shared results with other growers who were also using these biosolids

Implemented an SSOP for field bin cleaning, each bin following each use.

Chapin and Danyluk, unpublished

Populations (log_{10} CFU/avocado; mean ± std dev) of *Salmonella* on avocado surfaces following treatment on a spray roller system with polyvinyl chloride rollers (n=15).

Time (s)	NaOCl (100 mg/L)	ClO_2 (5 mg/L)	PAA (80 mg/L)	Water
0	6.16 ± 0.39 Aa[a]	6.35 ± 0.25 Aa	5.94 ± 0.42 Aa	6.37 ± 0.18 Aa
5	< 2.13 ± 0.24 BCa	4.31 ± 0.55 Bb	< 2.39 ± 0.61 BCDa	4.55 ± 0.66 Bb
15	< 2.14 ± 0.31 BCa	3.69 ± 0.47 Cb	< 2.05 ± 0.14 BCDa	3.42 ± 0.63 Cb
30	< 2.11 ± 0.23 BCa	2.86 ± 0.45 Db	< 2.00 ± 0.00 CDa	< 2.66 ± 0.68 Db
60	< 2.00 ± 0.00 Cab	2.47 ± 0.34 Dbc	< 1.87 ± 0.52 Da	2.57 ± 0.45 Dc

[a] Populations with different uppercase letters within a column or lowercase letters within a row are statistically different ($P \leq 0.05$).

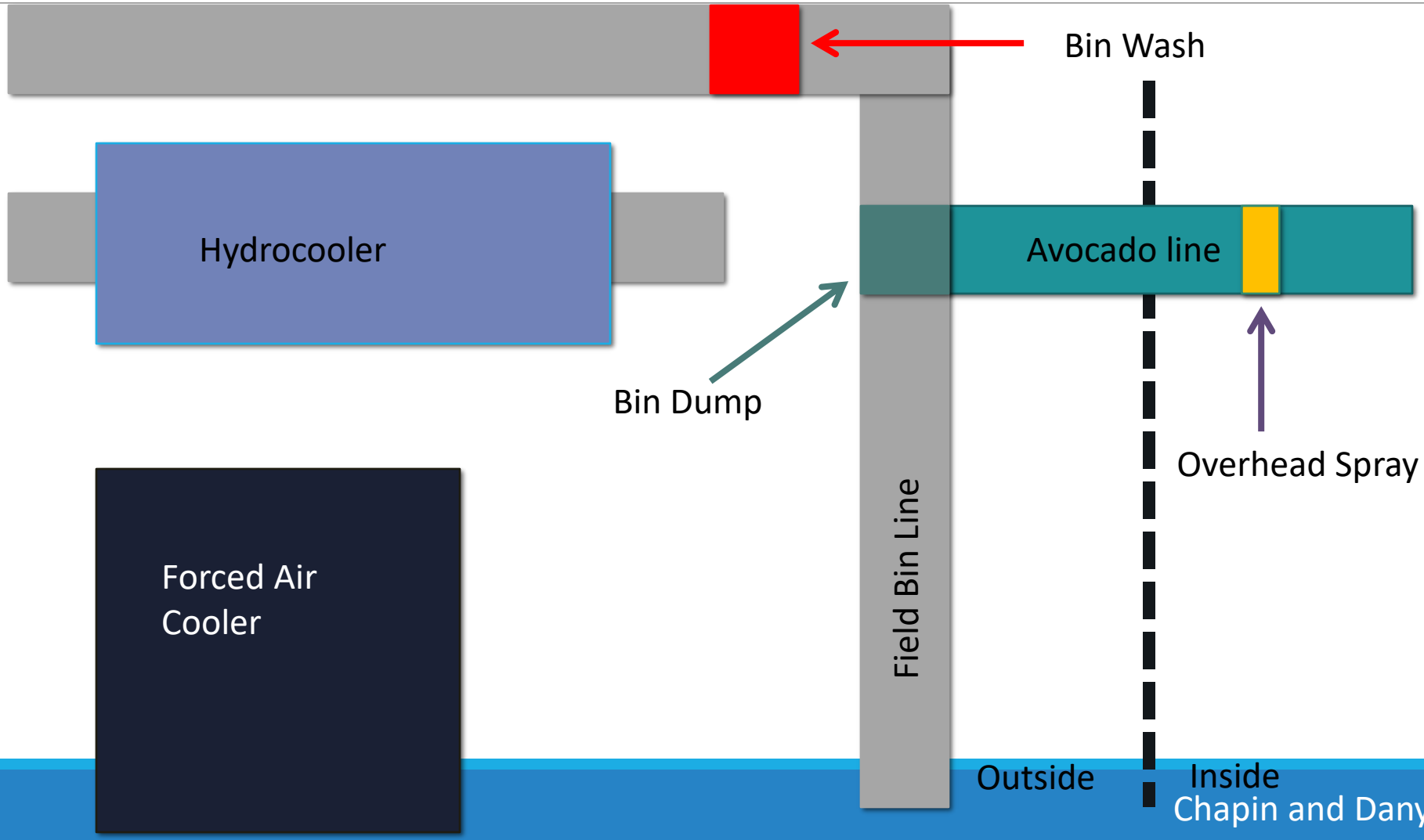
Valdés Garrido and Danyluk, unpublished

Changes Implemented

Added an overhead spray bar with sanitizer and single pass water to wash avocados

Upon retesting, all locations previously positive, no *Salmonella* was detected

Changes Implemented



Chapin and Danyluk, unpublished

Final thoughts…

Produce outbreaks continue to happen

- Fruits and vegetables contribute to the burden of foodborne disease
- We can learn a lot from outbreaks and recalls

Produce Safety is critical during production

- Growing produce outside means there are many risks
- Good management can help mitigate, manage, and minimize risks
- Each situation is different, tailored solutions are key

Acknowledgements – Funding Sources

USDA NIFA SCRI 2008-51180-04846

USDA NIFA SCRI 2011-51181-30767

USDA NIFA FSOP 2016-70020-25803

USDA NIFA AFRI 2018-67016-27578

USDA NIFA SCRI 2020-51181-32157

USDA NIFA FSOP 2020-70020-33024

State of Florida - Citrus Research Initiative

Florida Strawberry Research and Education Foundation

Industry Support (growers, buyers, industry suppliers)

Acknowledgements – Collaborators

University of Florida

- Lidia Valdes Garrido
- Rachel McEgan
- Angela Valadez
- Zeynal Topalcengiz
- Blessing Chukwuaja
- LaTaunya Tillman
- Katie Vazquez
- **Travis Chapin**
- **Lorrie Friedrich**
- **Gwen Lundy**
- **Luis Martinez**
- **Katelynn Stull**
- **Joyjit Saha**
- Keith Schneider
- Renee Goodrich
- Arie Havelaar
- Alicia Whidden
- German Sandoya Miranda
- Haimanote Bayabil
- Sandra Guzman
- Rafael Munoz-Carpena
- Mark Ritenour
- Matt Krug

Rutgers University

- Don Schaffner
- Gabriel Mootian

University of Maryland

- Bob Buchanan

Questions?

MICHELLE DANYLUK

MDDANYLUK@UFL.EDU

UF | IFAS
UNIVERSITY of FLORIDA