Rapid Response: Flood

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Industry Need/Rapid Response Timeline

- The National Weather Service issued flood watches and warnings for Monterey County due to Atmospheric River Evacuation Warning for Pajaro Community starting **1/4/2023** at 8:00 am.
- CPS call **01/13/23** to discuss possible Rapid Response Project
- 02/01/23 Project initiation (20+ Industry Contributors \$\$)
- **02/03/23** Industry in-person meeting Salinas, CA to recruit farms (extensive support from Grower Shipper Association)
- 02/09/23 First sampling campaign
- 04/24/23 Last sampling campaign

What does it take to conduct Rapid Response research?

- Teams able to deploy quickly
- Expertise in laboratory **AND** field sample collection methods
- Supplies and consumables already on hand
- University support to shift priorities
- Industry TRUST



Meet the research team!

Dr. Channah Rock*, UA – Water Quality and Food Safety Dr. Charles Gerba, UA – *Microbiology, Env. Microbiology, Risk Assessment* Dr. Kerry Cooper, UA – *Genomics, Epidemiology, Pathogenesis* Dr. Debankur Sanyal, UA – *Soil biogeochemist, Soil health management*









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Characterizing Flood Waters/Ranches

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Recognized Hazards for Flood Waters and Storm-Related Wastewater Discharge

Chemicals

- Hydrocarbons
- Urban and industrial or non-farmed ag runoff

Heavy metals

 Environmental, Commercial sites, and Urban

Pesticides

 Storage areas, wash out basins, or land applied

Pathogens

- o Environmental
- AFO
- Composting Facilities
- 1° or 2° Wastewater Treatment
- Septic system discharge
- \circ Carcasses

Flood Characterization

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Four Unique Ranches

- Gilroy/Holloway
- Salinas
- Spence
- King City

Flooding Type

- Overflow from adjacent creek, grazing operations adjacent land (F)
- Overflow from adjacent creek, tributary grazing (H)
- Salinas River, adjacent neighbor ranch (S)
- Salinas River, grazing operations adjacent land (T)

LGMA Metrics

BEFORE PLANTING AFTER A FLOODING EVENT

Wait a minimum of 60 days; soil must be sufficiently dried out.



Soil testing can shorten the interval to 30 days:

- Collect a representative soil sample of the entire flooded area
- Soil test results:
 - Fecal coliforms are < 100 MPN / gram of total solids
 - Salmonella: Negative || STEC: Negative
- Soil Screening Guidance: Technical Background Document (US EPA 1996) provides guidance
- Third party environmental consultants and/or accredited labs can provide sampling services

This document provides an overview of a section of the LGMA Metrics (food safety practices). It is not a substitute for the full Metrics document, which can be found on the LGMA Tech Resources Page.

WWW.LGMA.CA.GOV

Sample Types



Water (Ultrafilter)







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Sampling Strategy

- Pathogens (Enrichment 25 grams Soil)
 - Salmonella
 - STEC
- Indicators (MPN/gram Soil)
 - Total Coliform bacteria
 - Fecal Coliform bacteria
 - Generic E. coli bacteria
- Heavy Metals, Salinity, Soil Moisture

Sample Approach Map



Soil Methods TC/EC/FC

1 to 25 grams Soil +100ml PBS (w/dilutions)

IDEXX Quanti-tray

37C = Total Coliform and *E.coli* 44.5C = Fecal Coliform





Bacterial Die-off Over Time (Ranch H - Trib)



Bacterial Die-off Over Time (Ranch F - Trib) 10000 2nd Flood Event 1000 **Ground fully** 100 saturated.... 10 1/15/23 2/9/23 2/16/23 2/23/23 3/9/23 4/11/23 4/19/23 Fecal Coliform (MPN/grm) E. coli (MPN/grm) Total Coliform (MPN/grm)





Log Reductions

- Log reductions across all fields assayed ranged from -0.28 to 0.34 over the course of the 13-week study for Total Coliform bacteria
- Log reductions across all fields assayed ranged from 0.04 to 0.80 over the course of the 13-week study for Fecal Coliform bacteria
- Log reductions across all fields assayed ranged from 0.00 to 0.95 over the course of the 13-week study for *E. coli* bacteria

Fecal Coliform Heat Map

100 ft	200 ft	400 ft	800 ft	1600 ft
43.3	91.4	37.2	64.0	277.8
39.8	108.1	53.5	9.6	39.8
1986.3	387.7	25.4	396.8	107.7
20.3	13.8	866.4	18.1	14.7
11.3	16.7	26.0	791.5	27.8

2/16/23

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E.coli Heat Map

100 ft	200 ft	400 ft	800 ft	1600 ft
2.0	3.0	1.0	0.0	2.0
1.0	5.2	3.1	3.0	0.0
1.0	1.0	9.7	1.0	0.0
2.0	1.0	2.0	0.0	0.0
2.0	2.0	2.0	1.0	1.0

2/16/23

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Presumptive Positive STEC Molecular vs. Culture in Soils

	Tributary		
% ddPCR (stx & eae)		% PP Culture	
	32%	42%	0

Salinas River			
% ddPCR (stx & eae) % PP Culture			
9.5%	17%		



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- Not all floods are the same
- Fields adjacent to tributaries/ creeks with overland flow had increased likelihood of detecting pathogens than those adjacent to Salinas River
- We were able to confirm STEC SerO groups more often in samples collected from fields adjacent to flooded tributaries/creeks
- No O157:H7; No REP Strains!!

Pathogens

Flood Description	STEC SerO group		
Adjacent Ranch/Salinas River	not detected		
Adjacent Ranch/Salinas River	not detected		
Adjacent Ranch/Salinas River	026,0103		
Salinas River	026, 0103, 045, 0121		
Salinas River	0111, 026, 0103, 045, 0121		
Tributary	not detected		
Tributary	0103, 045		
Tributary	0103, 045		
Tributary	0145, 0103, 045, 0121		
Salinas River	0103, 045, 0121		
Salinas River	O45		
Tributary	0145, 0103, 045, 0121		
Tributary	O45		
Tributary	0103, 045		
Tributary	0103, 045, 0121		
Tributary	045, 0121		

Soil Parameters and Indicators/Pathogens

- Gravimetric water content (%) is the mass of water per mass of dry soil; it is measured by weighing a soil sample, drying the sample to remove the water, then weighing the dried soil
- Pearson correlation coefficient (*r*) = 0.54 for *E.coli* and Gravimetric Water Content %
- As soil moisture increased, *E. coli* MPN also increased (positive correlation)
- Soil pH and moisture content are primary drivers of *E. coli* O157 survival (*Williams, 2015*)
- Possible additional monitoring parameter to inform field re-entry post flood

Soil Salinity

Soil Properties	S	F	н	т
рН	7.93 – 8.38	7.47 – 7.95	7.44 – 8.19	7.79
Soluble salts (dS/m)	0.22 – 0.85	0.20 - 0.87	0.21 - 0.83	0.26
Sodium, Na (ppm)	91.8 - 111	266 – 274	119 – 165	183
Exchangeable Na percentage (ESP) %	1.44 – 3.76	1.7 – 2.86	1.4 – 2.6	2.55
Sodium adsorption ratio (SAR)	0.7 – 0.8	1.7 – 1.9	1.4	1.3

- Little to no sodicity-salinity problem was detected (0-12" profile)
- High levels of sodium (Na) were detected, but no 'sodicity' problem was detected; higher levels of Calcium and Magnesium possibly helped in 'neutralizing' the sodium problem
- pH at two ranches was very high, more prone to a Na-problem in future
- Flooding helped with salinity; water pushed the salts (Na) down

Key Findings

- Of the total samples collected, roughly **5%** of soil samples were positive for **Salmonella** after the first flood, with **3% positive** after the second flood.
- After first flood, very few STEC positive samples; after second flood, up to 42% of samples from individual ranches had soil samples presumptive positive for STEC.
 - Sustained flushing, force, vs. nutrient loading
- Variable levels of Fecal Coliform bacteria were detected in soil samples across space and time, ranging from <1 to 1986.3 MPN/gram.
- We do not see significant differences in grab sample versus composite sample strategies.

Difficulties/Challenges

- Laboratory calibration
 - Not all testing is equal (1 gram vs 25 grams)
 - Wet weight vs dry weight
 - Incubation temperatures
 - Presumptive vs confirmation results
- Field access
 - Wet ground
 - Safety!!
- Shipping



Video shows widespread flooding in Salinas Valley, CA

March 14, 2023 - General News, Press Release

🕒 Print 🖂 Email 📑





March 13, 2023 — Markon BB #:123315 Live from the Fields' video shows significant widespread flooding currently taking place in California's Salinas Valley.

Difficulties/Challenges

- How could there possibly be <u>more</u> rain?!
- Research teams and sampling plans dramatically shifted
- Must be nimble

Opportunities

- Once in a life-time opportunity to generate data that will inform industry metrics and support grower practices
- Re-flood offered opportunity to get into fields immediately as water is receding
- Confirm first flood TC/FC/EC values
- Potential improvements in LGMA metrics



Industry Guidance



- Fecal Coliform bacteria may not be the best indictor of pathogen risk
 - Highly variable across space and time
 - Not correlated to STEC or Salmonella
- Generic *E. coli* much more consistent
- Not all flood waters are equal risk!
- Flood waters from adjacent creeks/tributaries greater likelihood of detecting pathogens (STEC)
 - Water and Soil
- Bacterial numbers declined or "recovered" before 30-day interval in all ranches (LGMA is highly conservative)





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Acknowledgements



Dalton Zingali, Chaz Stackpole, Taylor Janiec, Zoe Scott, Hannah Crean, Natalie Brassill, Braden Smith, Andrew Rabe, Tori Obergh, UofA

Dr. Trevor Suslow

Chris Valadez, President, Grower-Shipper Association of Central California

> Drs. Kerry Cooper and Debankur Sanyal, UofA

Grower/Food Safety Professionals and Staff



SmartWashSolutions Pinpoint Process Control."



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