Agricultural Outlook Forum 2008

Crystal City, VA

FOOD RISK & SECURITY TRACK

Protecting the Food Supply Through Food Safety and Defense

"Preventing *E. coli* Contamination of Food"

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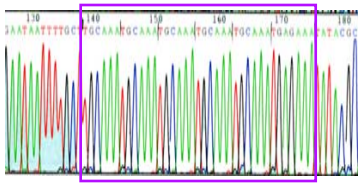
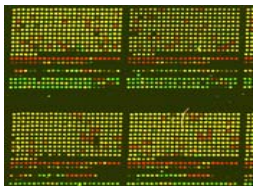
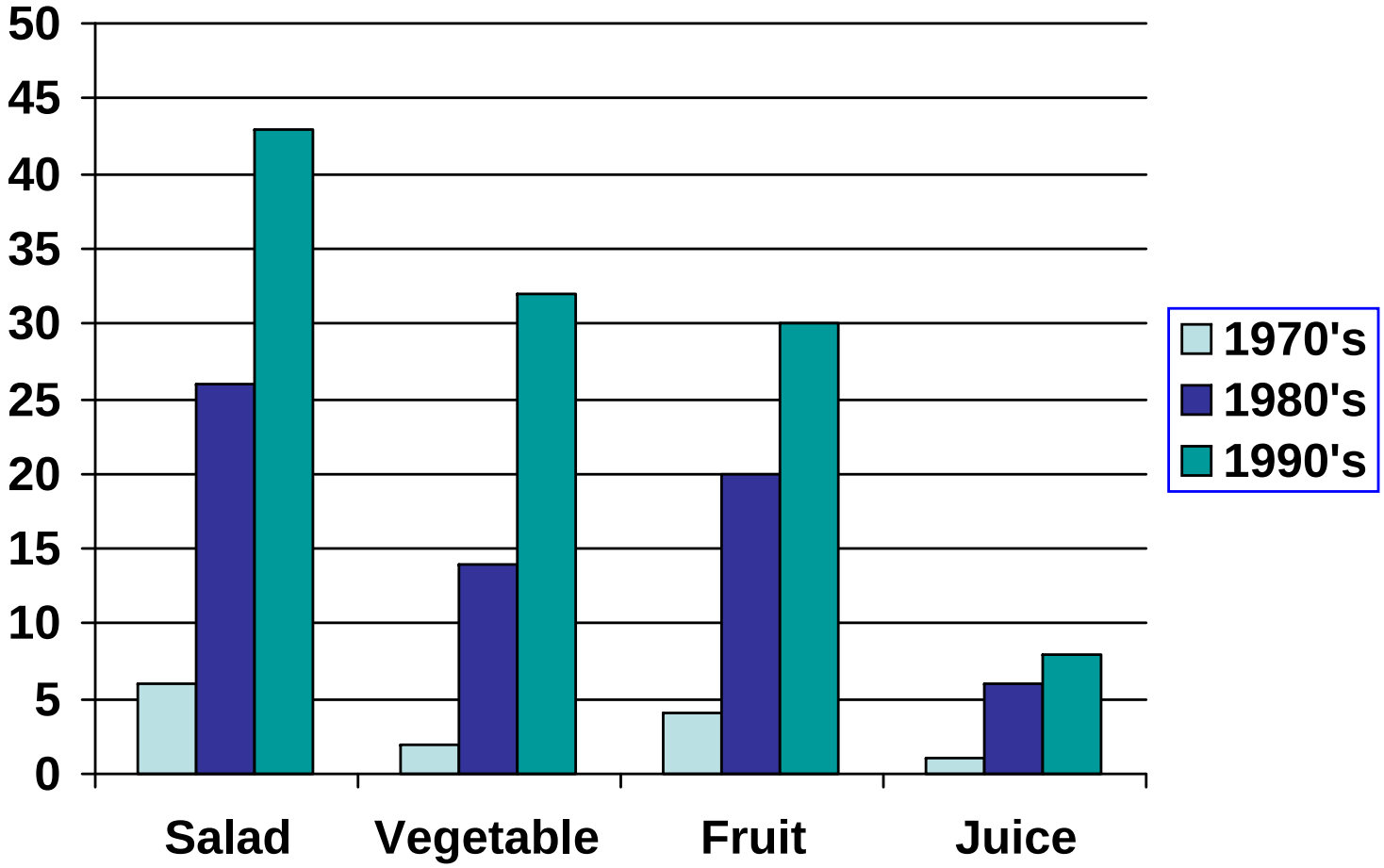




Topics covered

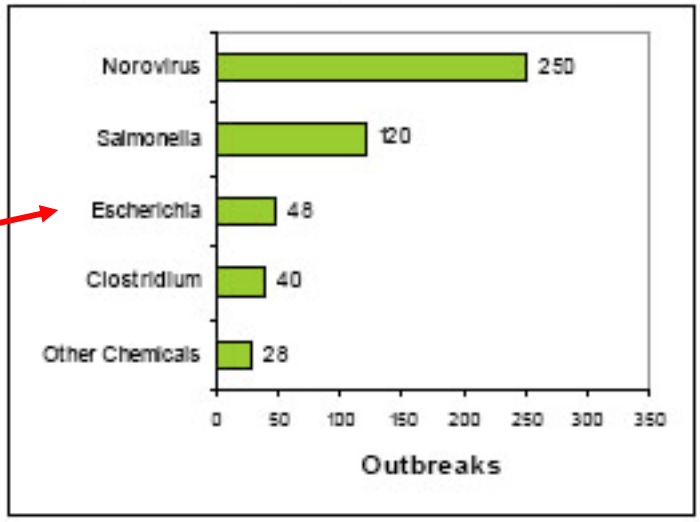
- *E. coli* O157:H7 outbreaks associated with leafy vegetables.
- Central California Coast
  - Environment
  - Incidence in watersheds
  - Spinach outbreak, Sep-Oct, 2006.
- Potential risk factors and solutions.

Foodborne outbreaks related to fresh produce, 1973-1997



Ref.: R. Tauxe. 2005. CDC.

Most common single-fo
linked to outbreaks,



~20 recalls in 2006

NY Times, Dec 6, 2006

Ref.: Outbreak alert! 2006. CSPI.

From 1995 to 2006,

There have been ~22 outbreaks ***E. coli* O157:H7** in the US associated with lettuce and other leafy vegetables

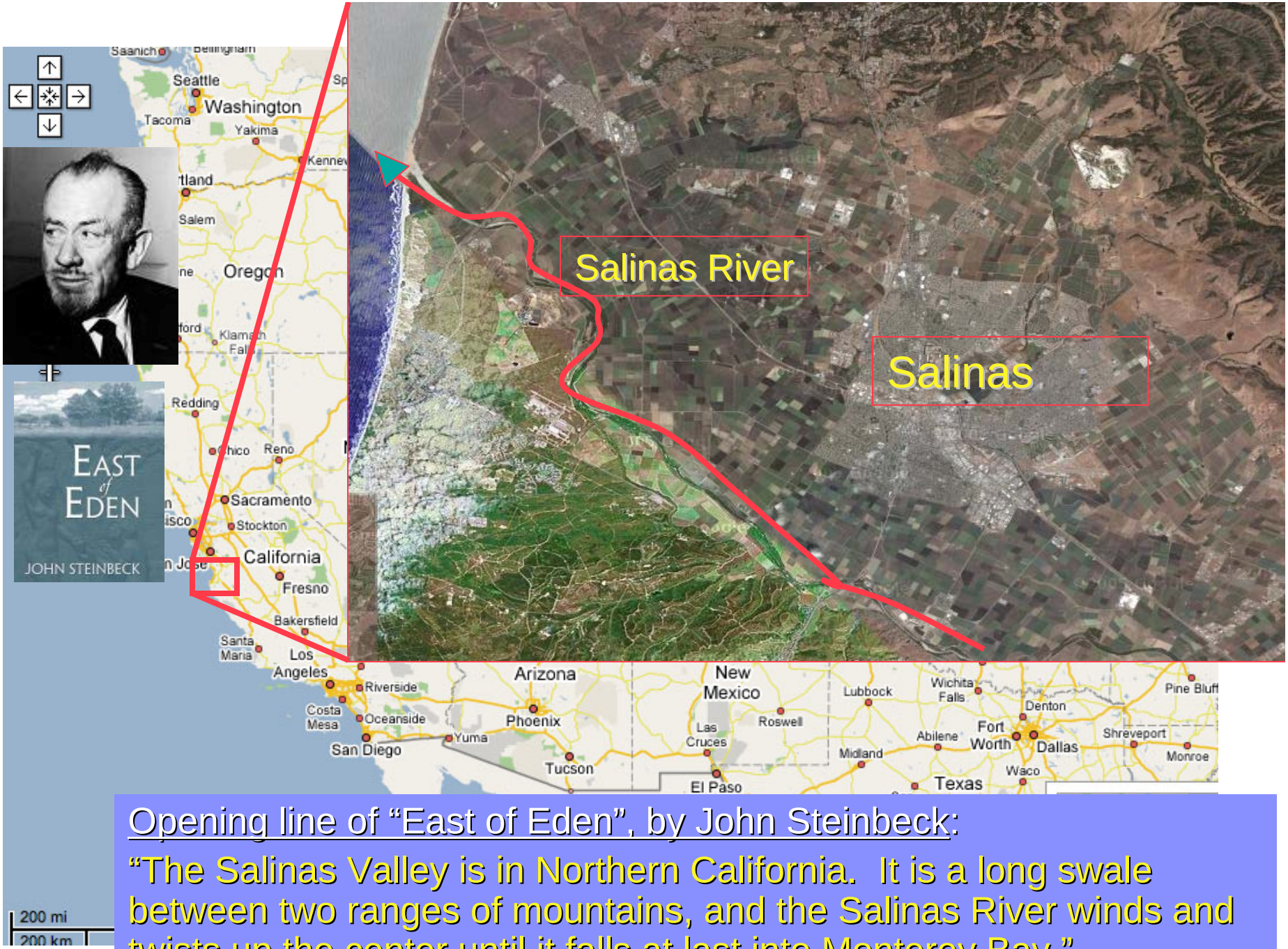
E. coli O157:H7 outbreaks associated with leafy vegetables, 1995-2006

Outbr.#	Month	Year	Location	No. Ill	Known/Suspected Vehicle	Region of Source
1	Jul	1995	MT	74	Romaine lettuce	MT, WA
2	Sep	1995	ID	20	Romaine lettuce	Unknown
3	Oct	1995	OH	11	Lettuce	Unknown
4	**May**	**1996**	**IL, CT**	**61**	**Mesclun mix lettuce**	**Salinas Valley, CA**
5	Jun	1996	NY	7	Mesclun lettuce	Unknown
6	May	1998	CA	2	Salad	Unknown
7	Sep	1998	MD	4	Lettuce	Unknown
8	**Sep**	**1999**	**CA**	**8**	**Romaine lettuce**	**Salinas Valley, CA**
9	**Sep**	**1999**	**WA**	**6**	**Romaine lettuce**	**Salinas Valley, CA**
10	Oct	1999	OH, IN	47	Lettuce	Unknown
11	**Oct**	**1999**	**OR**	**3**	**Romaine hearts**	**Salinas Valley, CA**
12	**Oct**	**1999**	**PA**	**41**	**Romaine lettuce**	**Salinas Valley, CA**
13	**Jul**	**2002**	**WA (Spokane)**	**29**	**Romaine lettuce**	**Salinas Valley, CA**
14	Nov	2002	IL, WI, MN, SD, UT	24	Lettuce	San Joaquin Valley, CA
15	**Sep**	**2003**	**CA (Pat &Oscars)**	**57**	**Romaine/iceberg lettuce**	**Salinas Valley, CA**
16	Sep	2003	ND	5	Lettuce mix w. romaine	Unknown
17	**Oct**	**2003**	**CA (Sequoias)**	**16**	**Spinach**	**Salinas Valley, CA**
18	**Nov**	**2004**	**NJ**	**6**	**Lettuce**	**Salinas Valley, CA**
19	**Sep**	**2005**	**MN**	**11**	**Romaine mix w. veg.**	**Salinas Valley, CA**
20	**Aug-Sep**	**2006**	**26 states**	**>200**	**Baby spinach, bagged**	**San Juan Valley, CA**
21	Nov	2006	NJ, NY, PA, DE	71	Iceberg lettuce (TB)	Central Valley, CA
22	Nov-Dec	2006	MN, IA, WI	81	Iceberg lettuce (TJ)	Central Valley, CA

Many in the US are wondering…

What's going on?

Has something changed?



Opening line of "East of Eden", by John Steinbeck:

"The Salinas Valley is in Northern California. It is a long swale between two ranges of mountains, and the Salinas River winds and twists up the center until it falls at last into Monterey Bay."

Leafy Vegetable Production

- California-Arizona
  - **Salinas/Santa Maria valleys**
    - Temp: cool, to warm, to cool
    - Rainfall: 12-15 in, between Nov to Mar/Apr
    - **2-3 crops per year**
  - San Benito County
  - Huron (Central Valley)
  - Imperial Valley/Yuma, AZ (winter)
- 70-80% of the US supply

Low incidence in the environment may be amplified and/or spread
- How long does it survive in the environment?

One theory is that expansion of bagged salad industry may lead to an increase in cross-contamination of more product = more cases of *E. coli* O157:H7

E. coli O157:H7 in the Environment

Islam et al, 2004, J Food Protection	• 154 to 217 d in soil amended with spiked compost • 77 d on lettuce, 177 d on parsley
Mukherjee et al, 2006, J Appl Microbiol	• Child illness due to: - O157:H7 in garden soil fertilized with cow manure - This "naturally occurring" strain survived >69 days

E. coli O157:H7 in the Environment

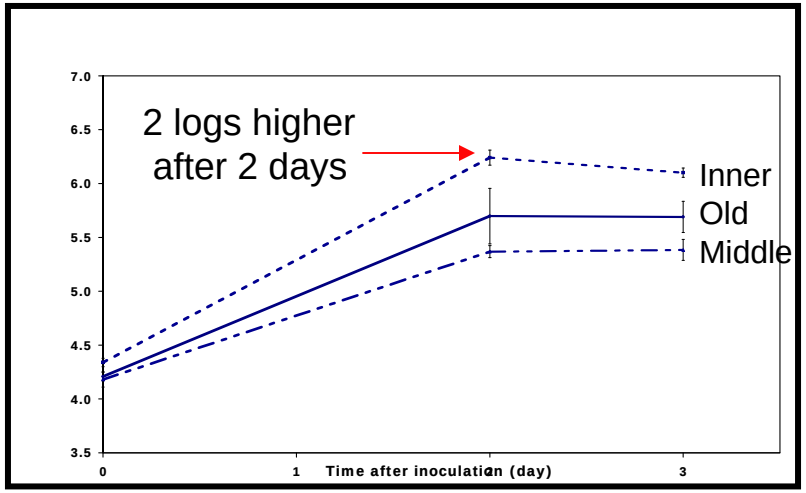
Elder et al, 2000, *Proc. Nat. Acad. Sci.*	• 28% in feces of cattle at slaughter • ~50% on hides
LeJeune et al., 2006, *J. Clin. Microbiol.*	• Most cattle have <100 CFU/g feces • Some, >10,000 CFU/g feces = "Super Shedders" • These high shedders may be most important epidemiologically

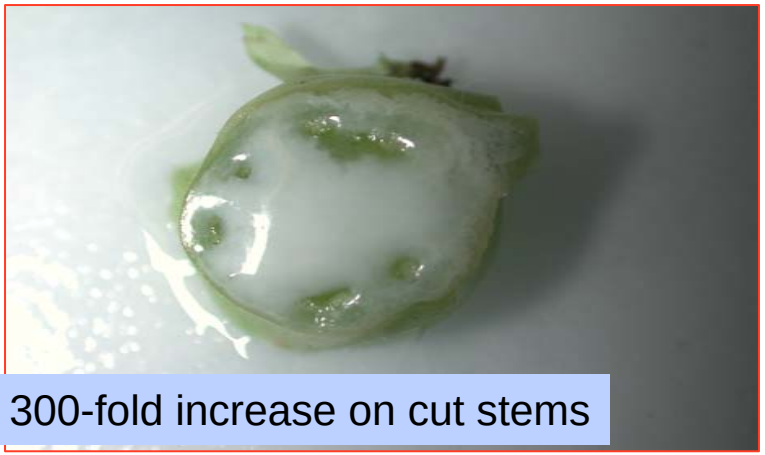
What happens if enteric pathogens get on plants?

Do human pathogens survive and grow on or in produce?

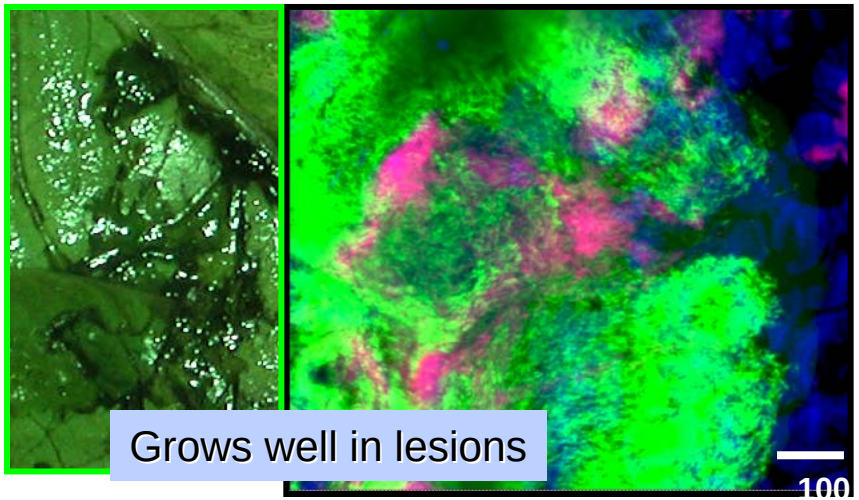
E. coli O157:H7 colonization of Romaine lettuce plants (growth chamber)

M. Brandl, Appl. Environ. Microbiol. In press





300-fold increase on cut stems

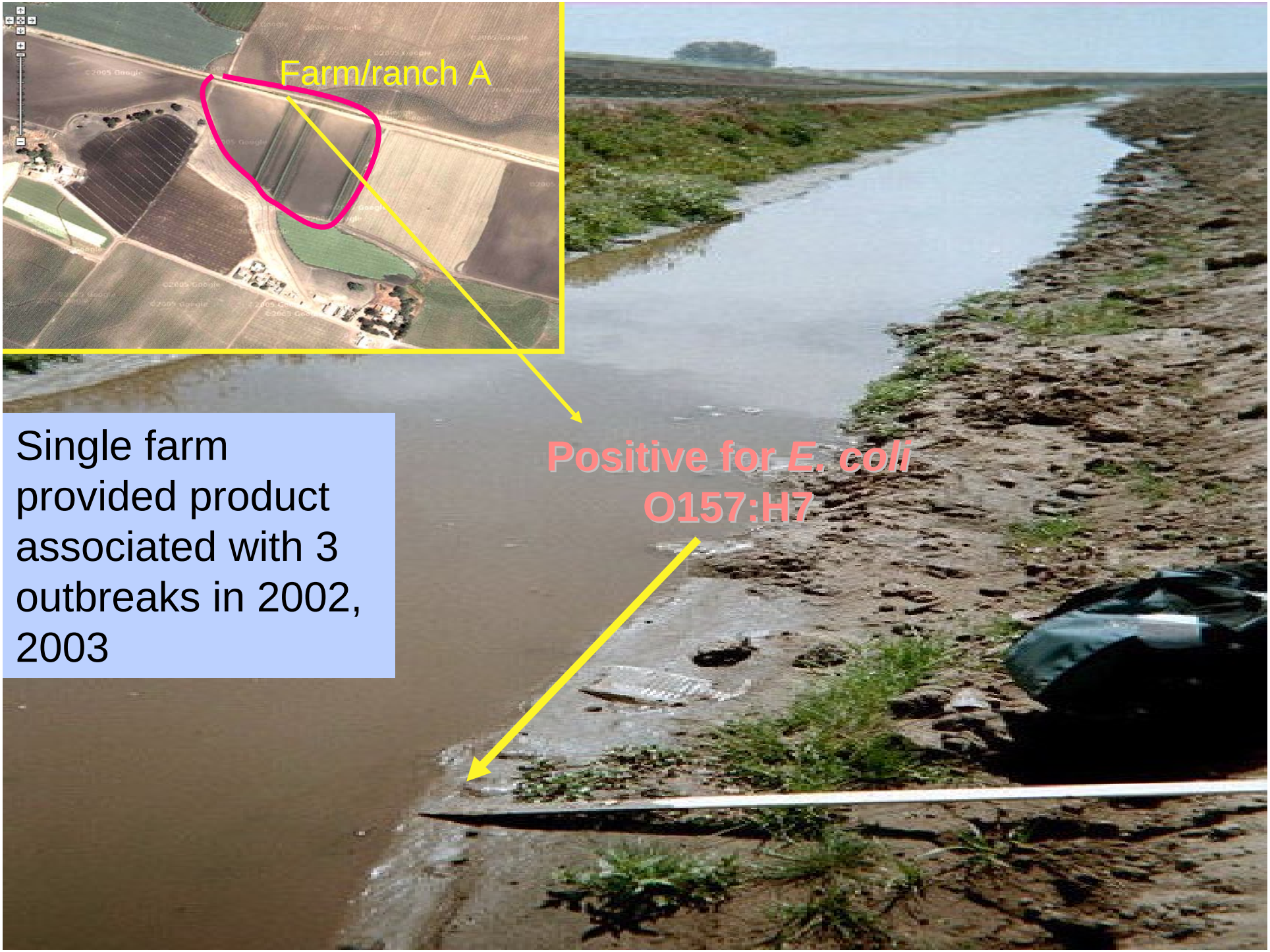


Grows well in lesions

Erwinia (green) and
E. coli O157 (pink)

“Is the pathogen in the production environment?”

Identifying sources and transport of pathogens may assist in understanding how pre-harvest contamination of produce occurs

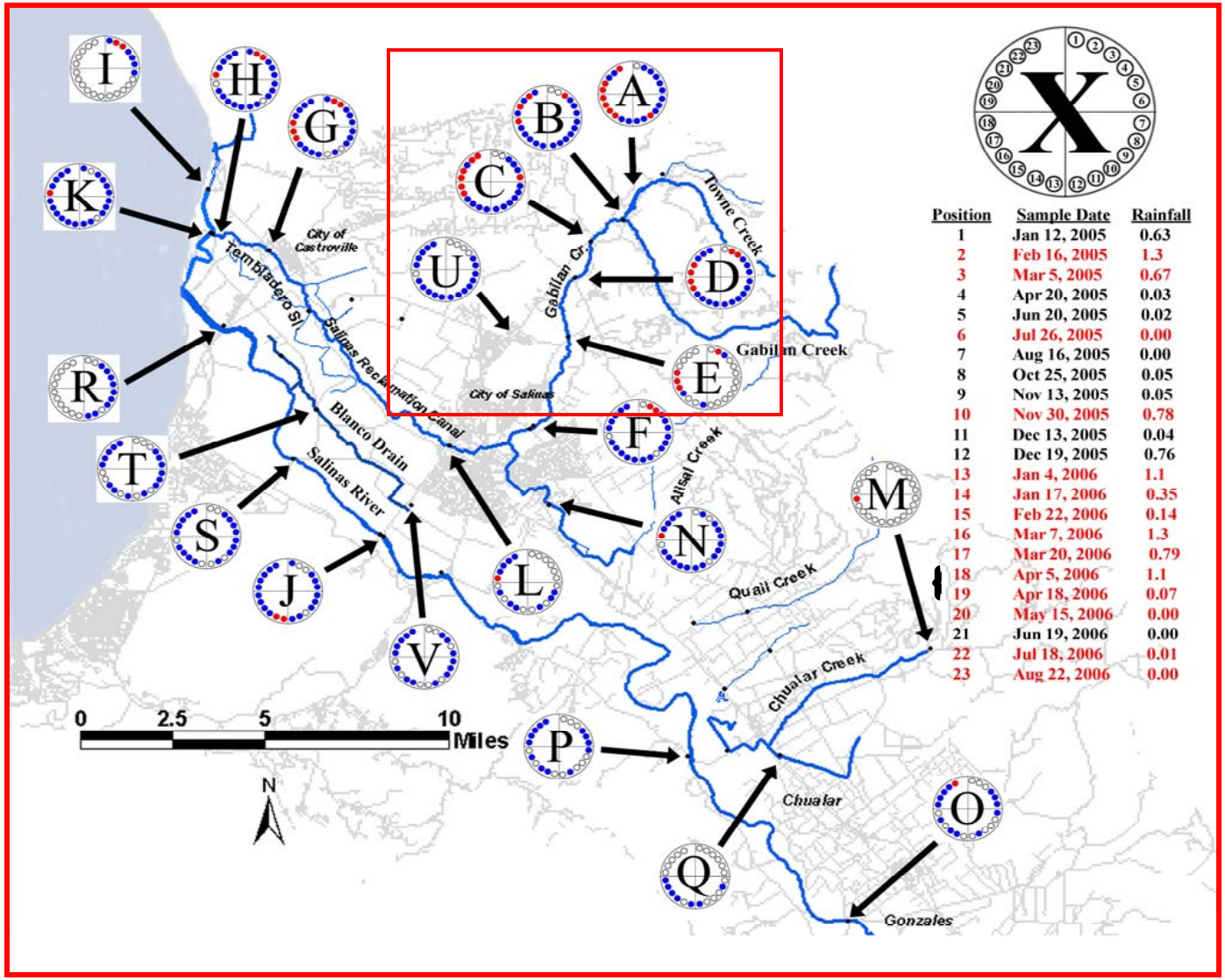

Farm/ranch A
Positive for *E. coli* O157:H7
Single farm provided product associated with 3 outbreaks in 2002, 2003

E.coli O157:H7: Salinas Valley Watershed

- Study was expanded in coordination with CDPH and CCRWQCB (TMDL surveys)

- Jan-2005 to Sept-2006 (19 mo.)
- ~ 1200 samples analyzed for *E. coli* O157:H7

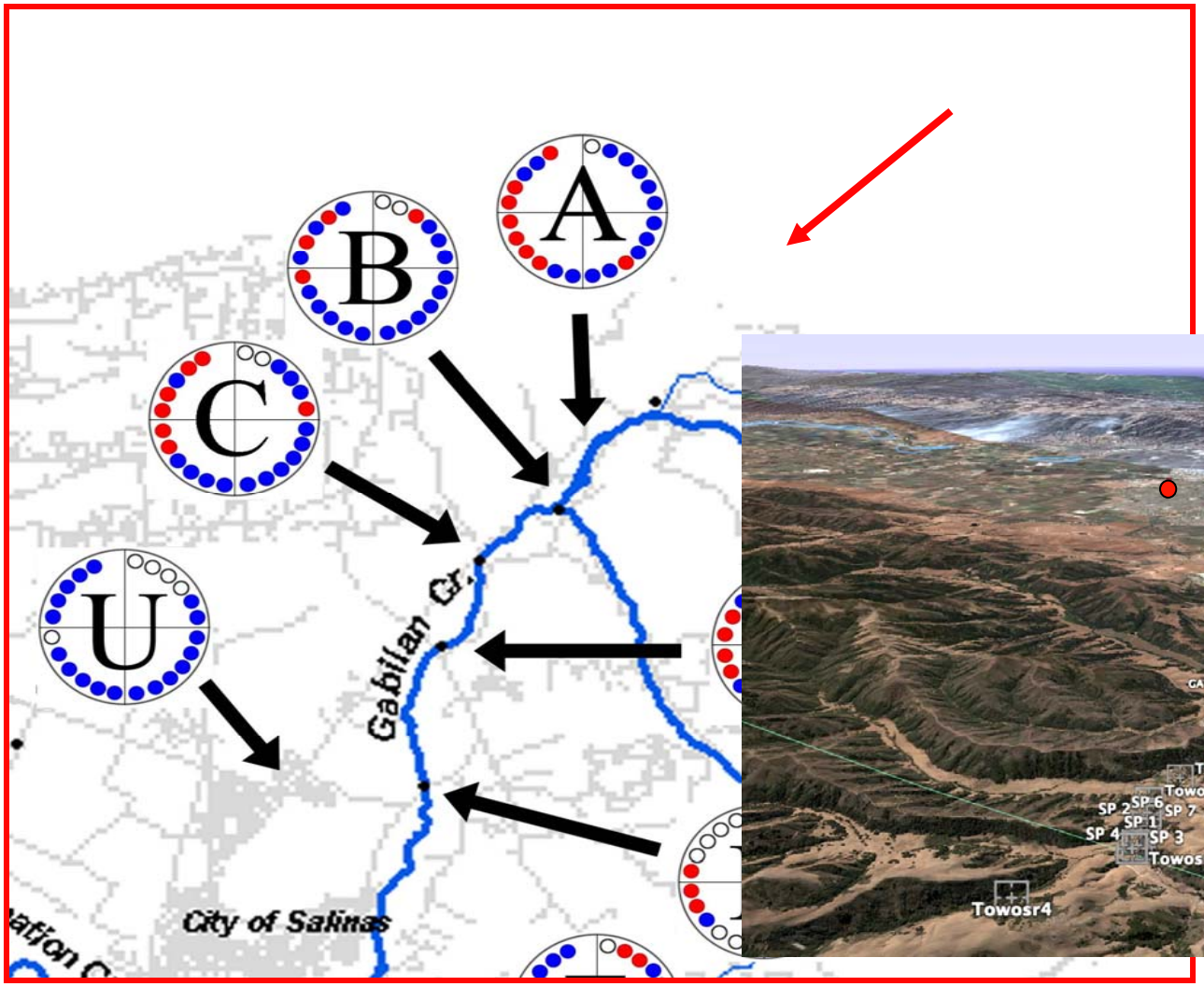
Summary of results of isolation of *E.coli* O157:H7 from the Salinas Valley Watershed

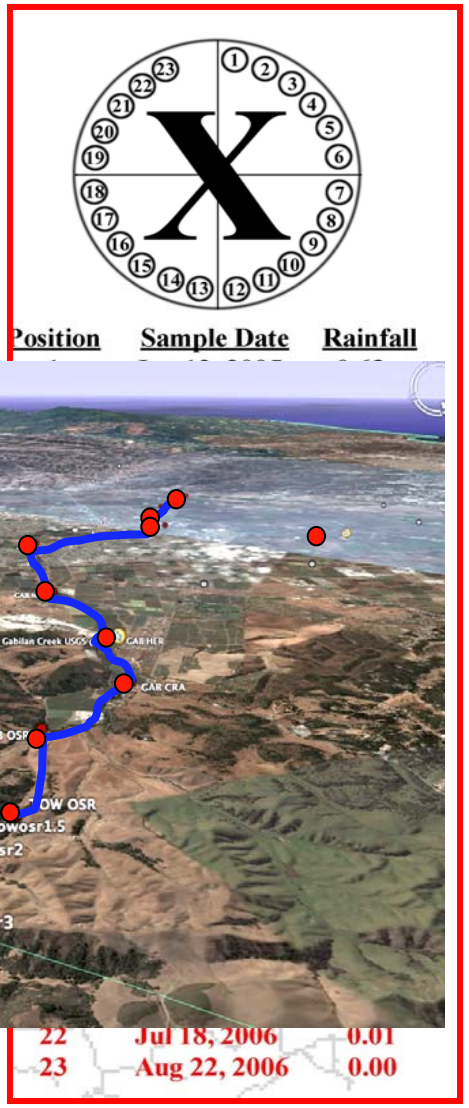


Position	Sample Date	Rainfall
1	Jan 12, 2005	0.63
2	Feb 16, 2005	1.3
3	Mar 5, 2005	0.67
4	Apr 20, 2005	0.03
5	Jun 20, 2005	0.02
6	Jul 26, 2005	0.00
7	Aug 16, 2005	0.00
8	Oct 25, 2005	0.05
9	Nov 13, 2005	0.05
10	Nov 30, 2005	0.78
11	Dec 13, 2005	0.04
12	Dec 19, 2005	0.76
13	Jan 4, 2006	1.1
14	Jan 17, 2006	0.35
15	Feb 22, 2006	0.14
16	Mar 7, 2006	1.3
17	Mar 20, 2006	0.79
18	Apr 5, 2006	1.1
19	Apr 18, 2006	0.07
20	May 15, 2006	0.00
21	Jun 19, 2006	0.00
22	Jul 18, 2006	0.01
23	Aug 22, 2006	0.00

*

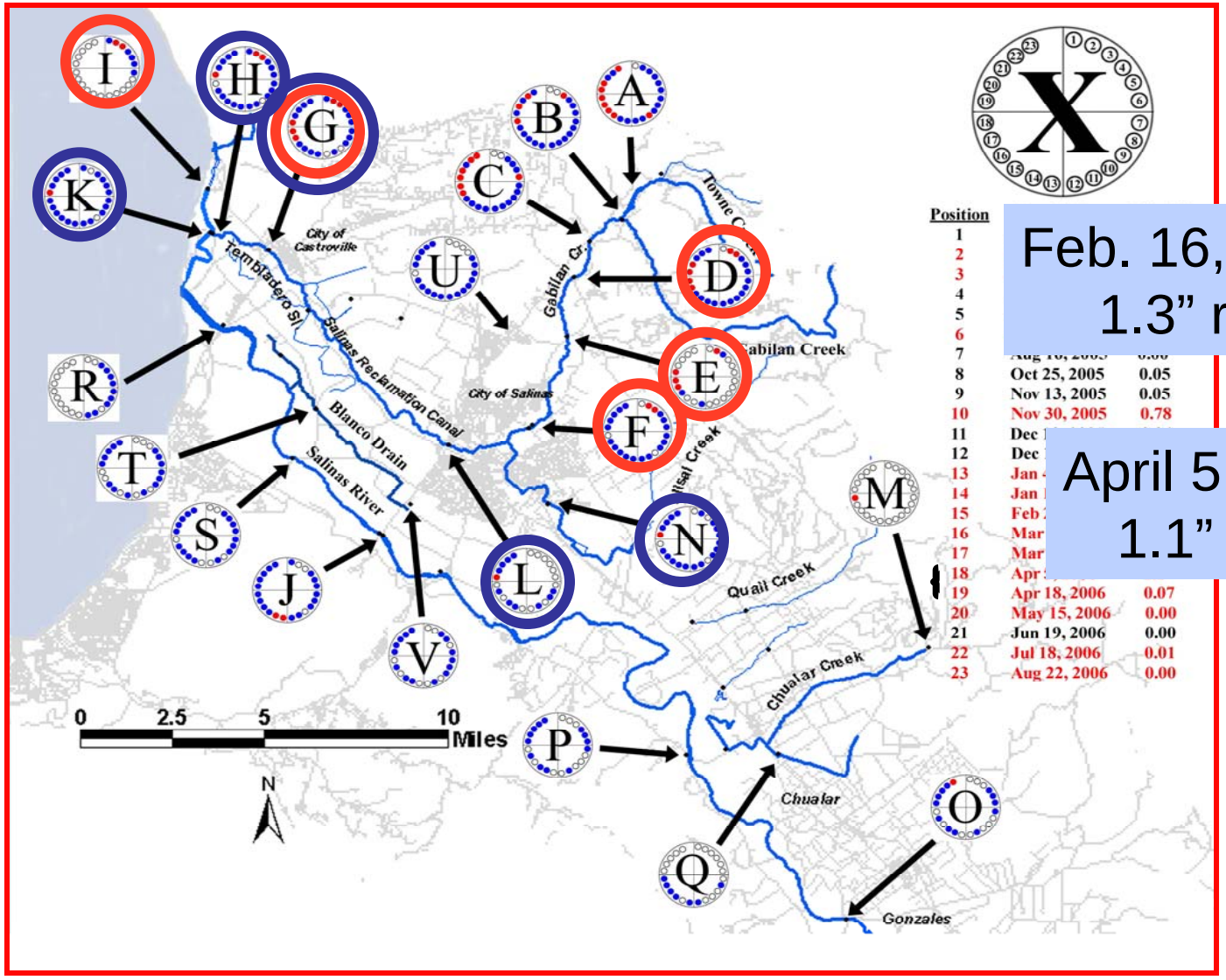
Selected region of the watershed with frequent isolation of *Ec*O157





Feb. 16, 2005 samples: MLVA 2 strains

April 18, 2006 samples: MLVA 100 strains



Feb. 16, 2005
1.3” rain

April 5, 2006
1.1” rain

*

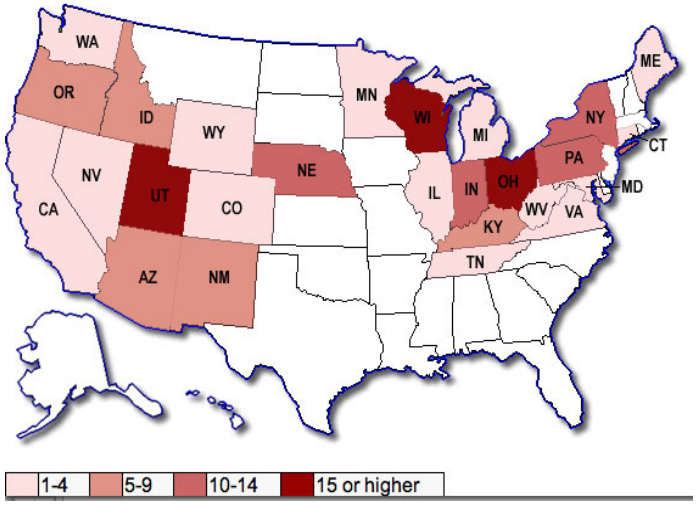
Salinas Valley watershed sampling ended in Sept., 2006

Then…

The Spinach Outbreak of Aug/Sep 2006

Multi-State Outbreak of *E. coli* O157:H7 Infections From Fresh Spinach, October 6, 2006

- >200 illnesses
- 51% were hospitalized
- 16% developed hemolytic uremic syndrome
- 3 deaths



FDA-CFSAN, Oct. 6, 2006

- *E. coli* O157 was isolated from 13 packages of spinach supplied by patients living in 10 states
- Multi-agency (FDA, CDHS, USDA-ARS) investigation of the 4 farms and adjacent ranches was initiated: >1500 samples tested

E. coli O157:H7 outbreak associated with consumption of spinach, 2006

(Addendum to CDPH-FDA "*E. coli* O157:H7 Spinach Report" May 7, 2007)

Farm	Samples	*Ecoli* O157:H7 (% of total)
A	351	45/351 (13.5%); 28/45 match outbreak strain (62%)*
B	102	10/102 (9.8%); 0 match
C	132	1/132 (0.8%); 0 match
D	45	1/45 (2.2%); 0 match
Total	630	57/630 (9.0%)

* Cattle (15), wild pig (8), water (4), dirt/soil (1).

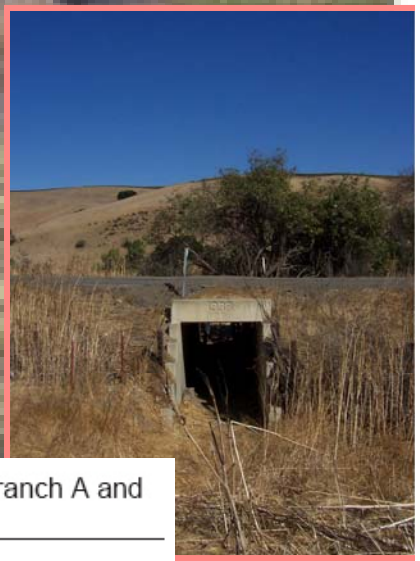


Table 2. Unique alphanumeric MLVA types of *Escherichia coli* O157:H7 isolated from environmental samples collected at ranch A and an upstream watershed, California, September–November 2006*

Sample type	No. samples	No. isolates	MLVA type
Reference (human stool, bagged spinach)	NA	NA	**E**
Cattle feces	26	34	**A**, **C**, **E**, **F**, I, **J**, L, **M**, P, Q, **R**, **S**, **T**, W, X, Z
Feral swine feces	11	14	**A**, **B**, **C**, **E**, L, O, P, X, 5, 6
Feral swine colonic feces (necropsy)	2	10	**A**, **C**, **D**, **G**, **H**, **K**, L, **U**, V, Y
Sediment (river)	2	8	**A**, **C**, L, **M**, **N**, W, **3**
Soil (cattle pasture)	1	1	**A**
Surface water	3	6	**A**, **C**, L, P, 4
Surface water Moore swab†	2	3	1, 2

*MLVA, multilocus variable number tandem repeat analysis; NA, not applicable. Samples indistinguishable from the major spinach-related outbreak strain by pulsed-field gel electrophoresis (*Xba*I-*Bln*I PulseNet profile EXHX01.0124-EXHA26.0015) are shown in **boldface**.
†Isolates collected from surface water (river) ≈32 km upstream of ranch A.

How do pathogens get to produce from watersheds?

- Wild animals
  - Which animals?
- Flooding
- Irrigation
  - Wells (defective, shallow)
  - Surface water
- Fertilizer/compost
- ??

Prevention of *E. coli* on Food

- Pre-harvest approaches
  - Maintain water quality
  - Minimize exposure of produce to wild animals, flooding, dust
  - Treat livestock: vaccines, feed, novel antimicrobials
  - Observe/inspect, common sense
- Post-harvest approaches
  - Sampling and testing product, processing water
  - Effective “kill step” (new sanitizers, irradiation)
- No major outbreaks in 2007 associated with leafy vegetables!

New fencing for feral swine

Acknowledgements

- ARS-PSMRU
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