Indicator Bacteria: Sentinels of Safe Water?

Think Management Toolbox, not Silver Bullet

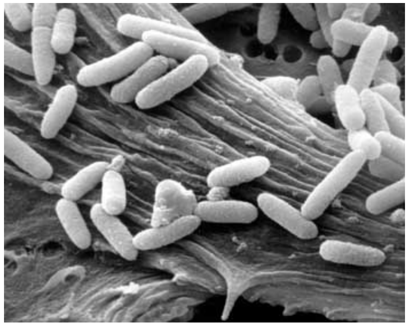
K. Tate, E. Atwill, H. George, D. Lewis, D. Lile, K. Knox, and R. Dahlgren

Collaborative Research Efforts – Calif.

- **Scope:** Microbial pollutants in livestock systems, wildlife, and associated waters.
- **Control Points:** Management and environmental risk factors.
- **Management Measures:** Controls on survival, transport, etc.

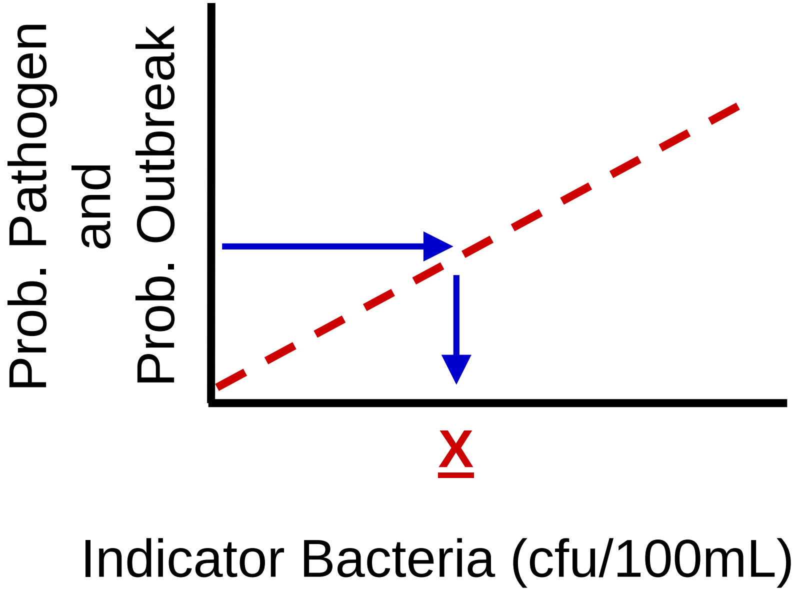
UC, ranchers, water districts, regulators, USDA, NGOs

Indicator Bacteria: Sentinels of Safe Water? or Agents of Angst?



WE ASSUME: Indicator bacteria in surface waters are correlated with:

1. occurrence of pathogen(s), thus
2. probability of illness.



X = indicator bacteria concentration at which pathogen occurrence and risk of outbreak is unacceptable.

Indicator Bacteria Standards: Surface Waters

commensal *E. coli* : 126 or 235 cfu/100mL – mean or grab – USEPA

fecal coliform: 20 to 2,000 cfu/100mL – varies by water board & use

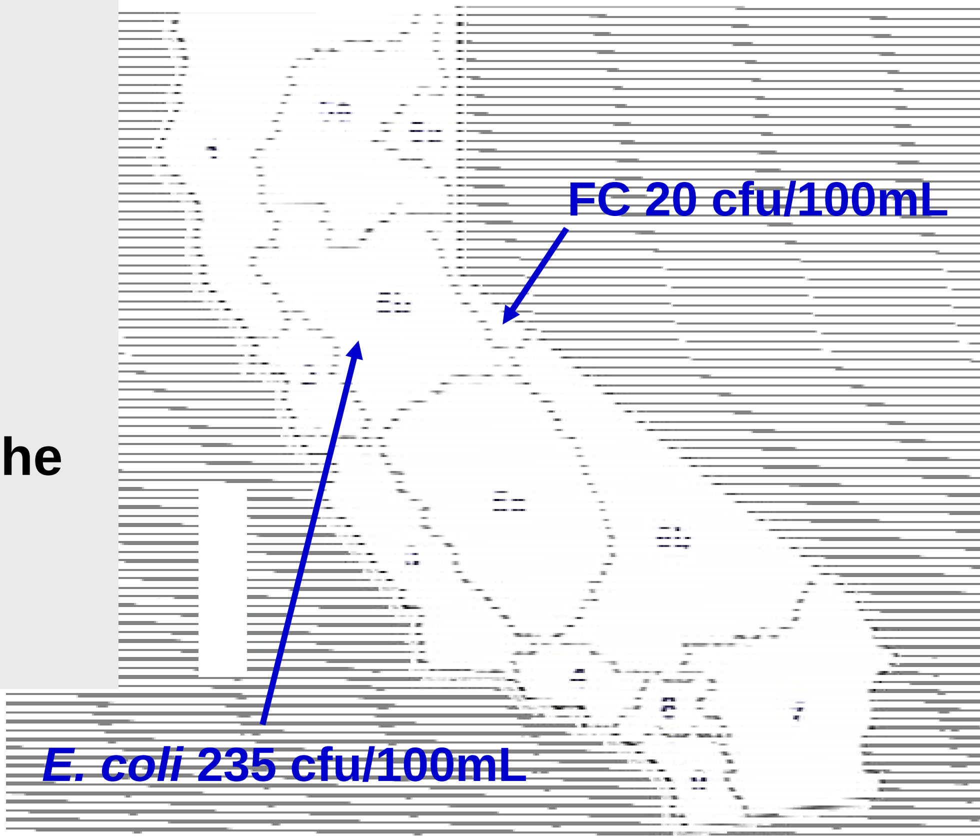
<u>Monitoring and Enforcement</u>

"Pathogen" TMDLs

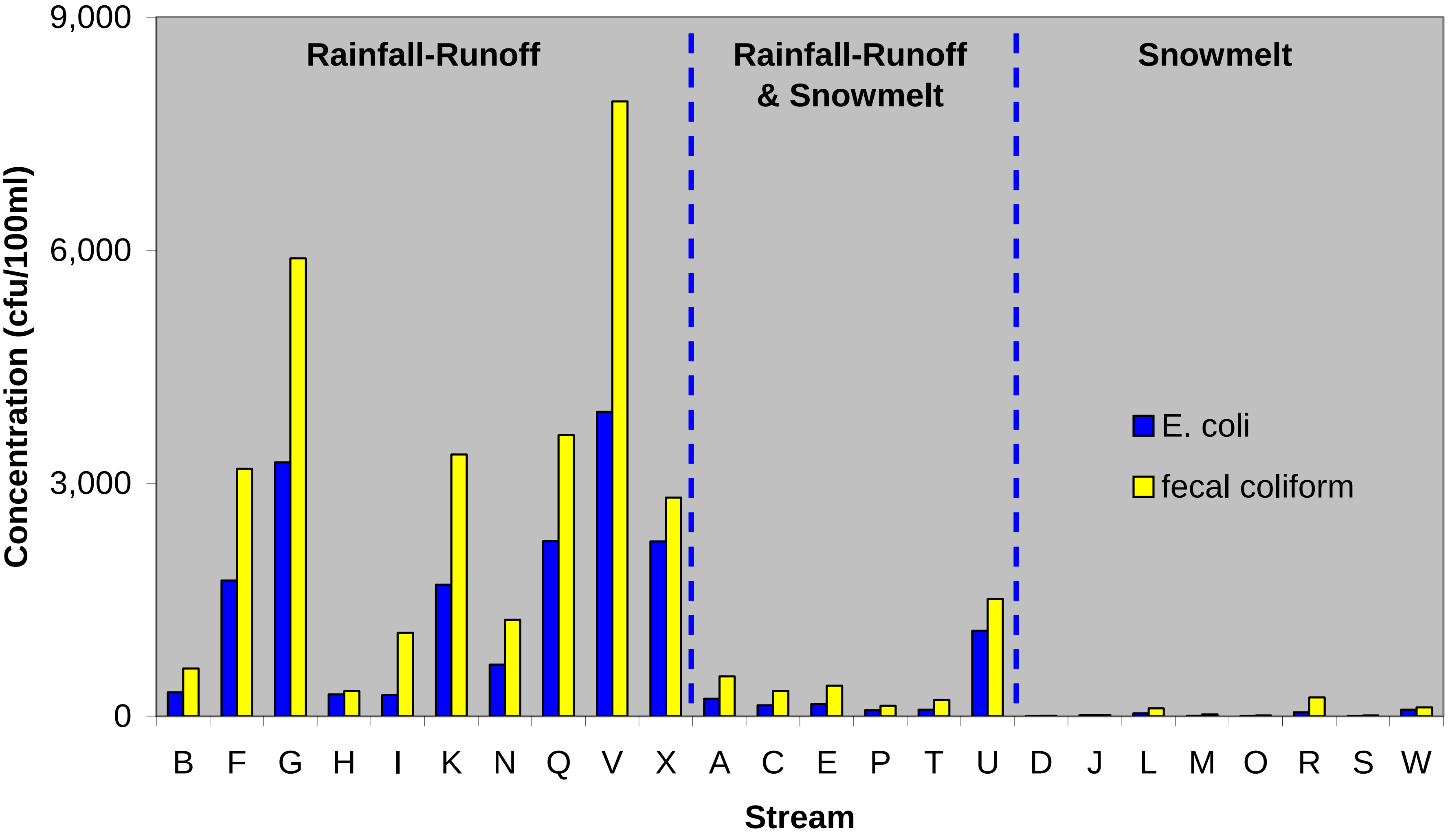
Agricultural Discharge Permit/Waiver

Widespread exceedence across the State

A LOT of angst and expense…



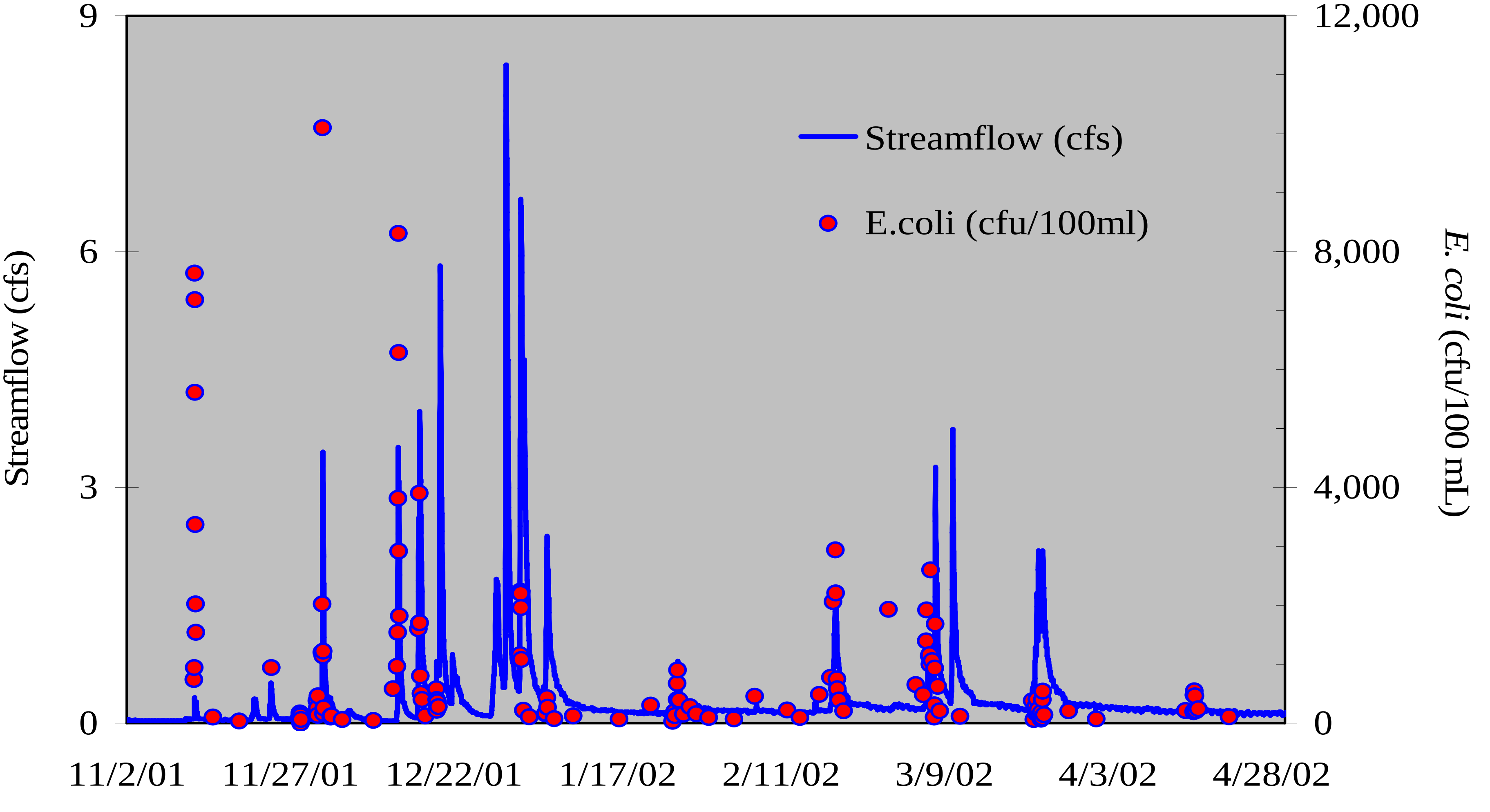
Mean commensal *E. coli* and FC concentrations in 24 rangeland streams over 2 years, ~1,000 samples



Focused Examination of Indicators and Pathogens

8 grazed rangeland watersheds – 2 years

C. Parvum present in < 5% of ~600 stream samples



Bridgeport, Sierra, Goodrich Valleys

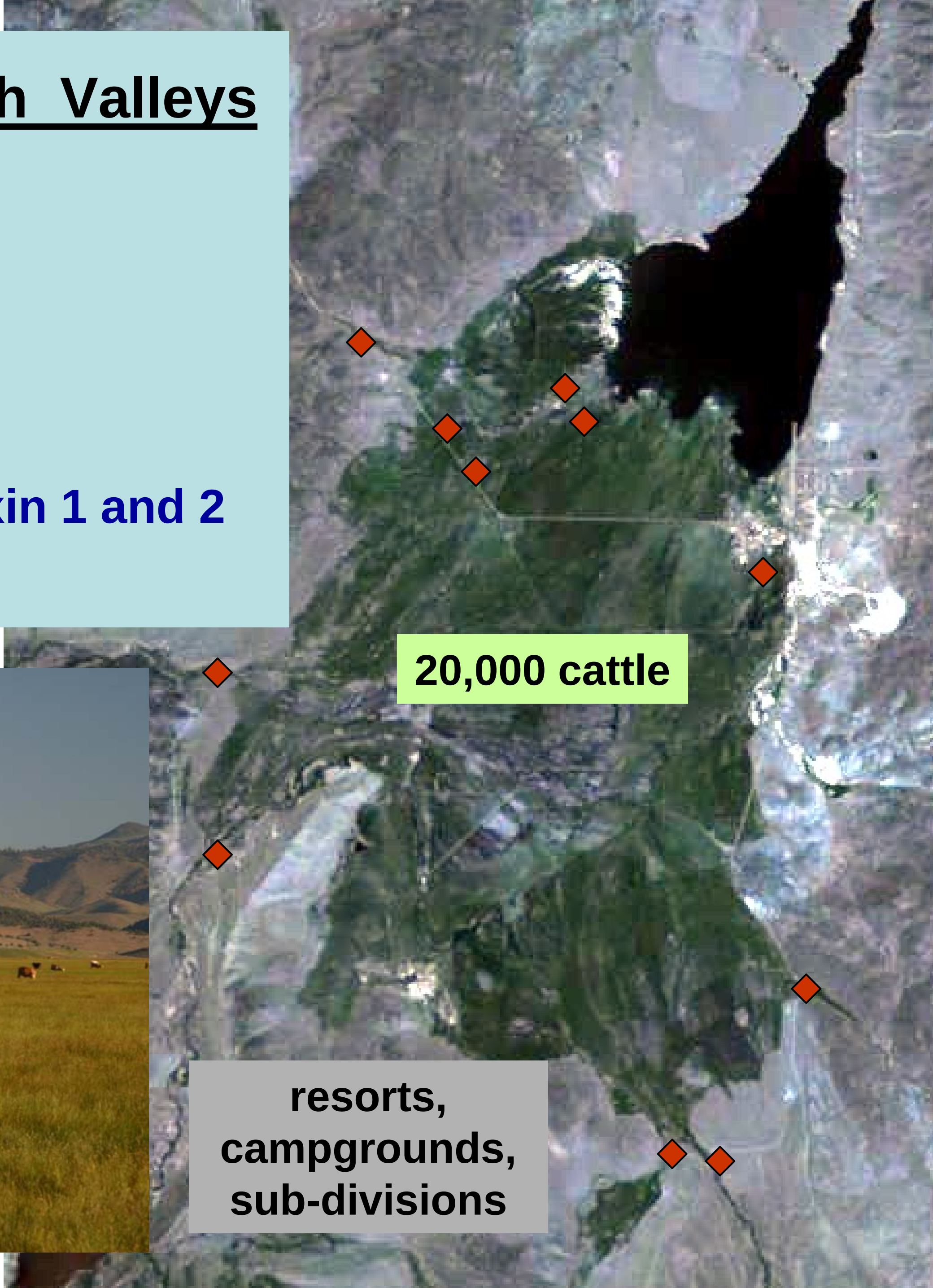
2007 Summer Grazing Season

Sample 19 sites monthly:

commensal *E. coli* and FC

***C. parvum*, *Salmonella*, shiga-toxin 1 and 2**

E. coli*, *Campylobacter



<u>63%</u> samples exceeded FC standard of 20 cfu/100mL

<u>26%</u> samples exceeded com Ec standard of 235 cfu/100mL

<u>7%</u> samples *C. parvum* +

<u>5</u> of the 8 *C. parvum* + samples were below com Ec standard

<u>11%</u> samples *Salmonella* +

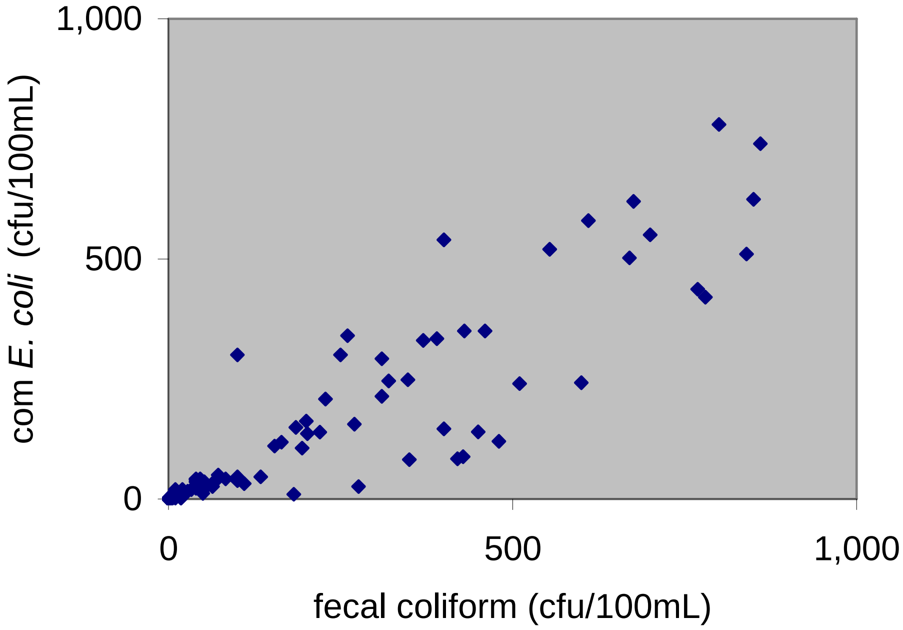
<u>9</u> of the 12 *Salmonella* + samples were below com Ec standard

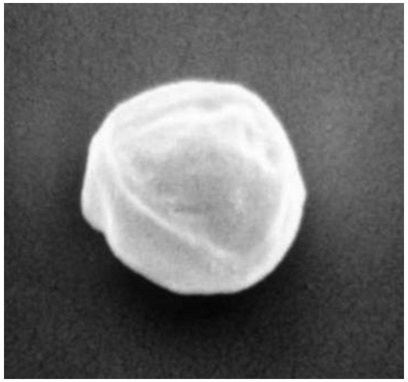
<u>0%</u> samples *Campylobacter* +

<u>Pending</u> Shiga toxin producing Ec

n = 102 samples

95% + confirm rate for com Ec



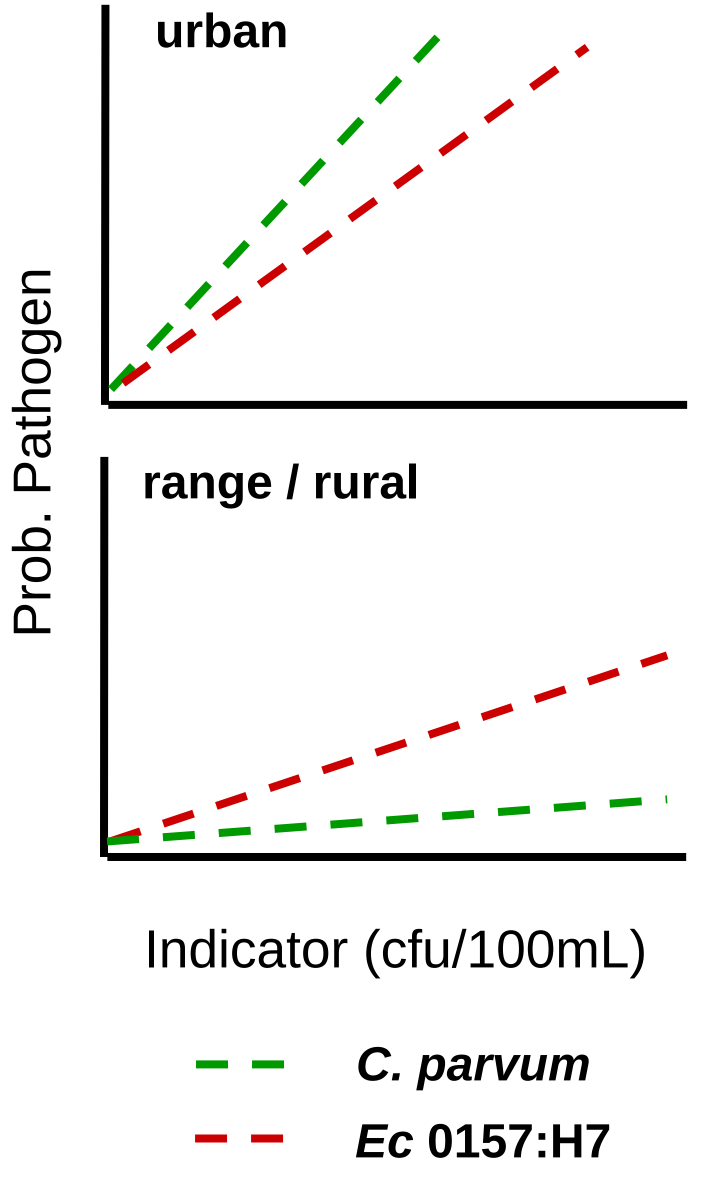


C. parvum

Salmonella

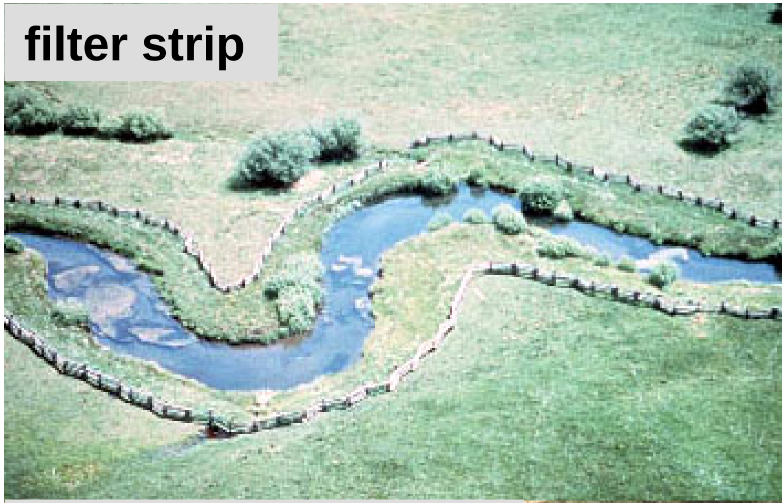
Some Research Needs

- Data to evaluate correlations between indicators and pathogens of concern
- Specific to key watershed characteristics – e.g., land use / source, weather, hydrology
- Evaluation of application and interpretation of indicator data and standards

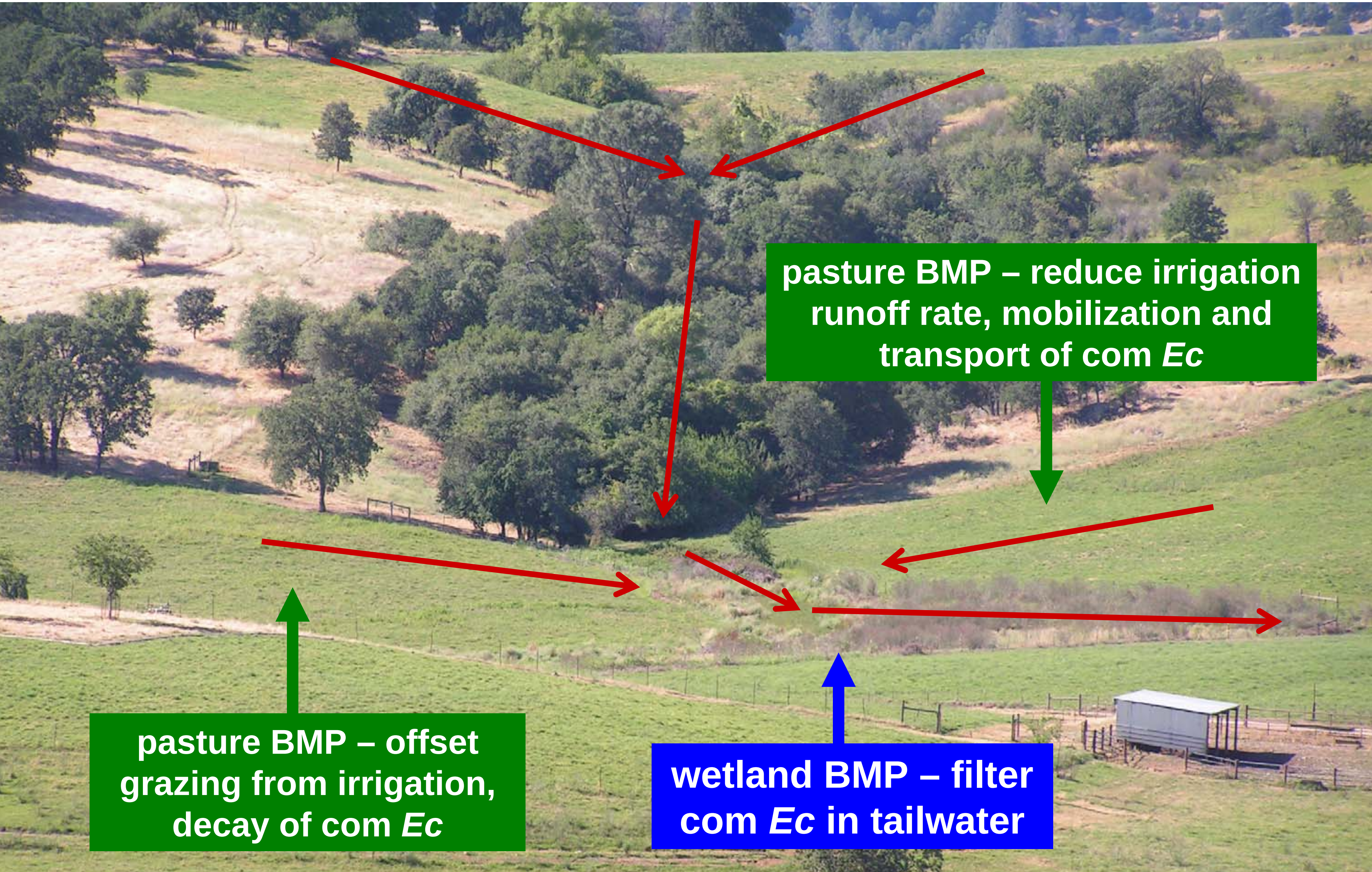


Think Management Toolbox: Not Silver Bullet

1. The expected cumulative benefits of simultaneously implementing several BMPs are logical - HACCP.
2. Problem: which combinations? what designs? under what site conditions?
3. Uni-BMP studies, experimental scale, limited range of environ & manage variation.



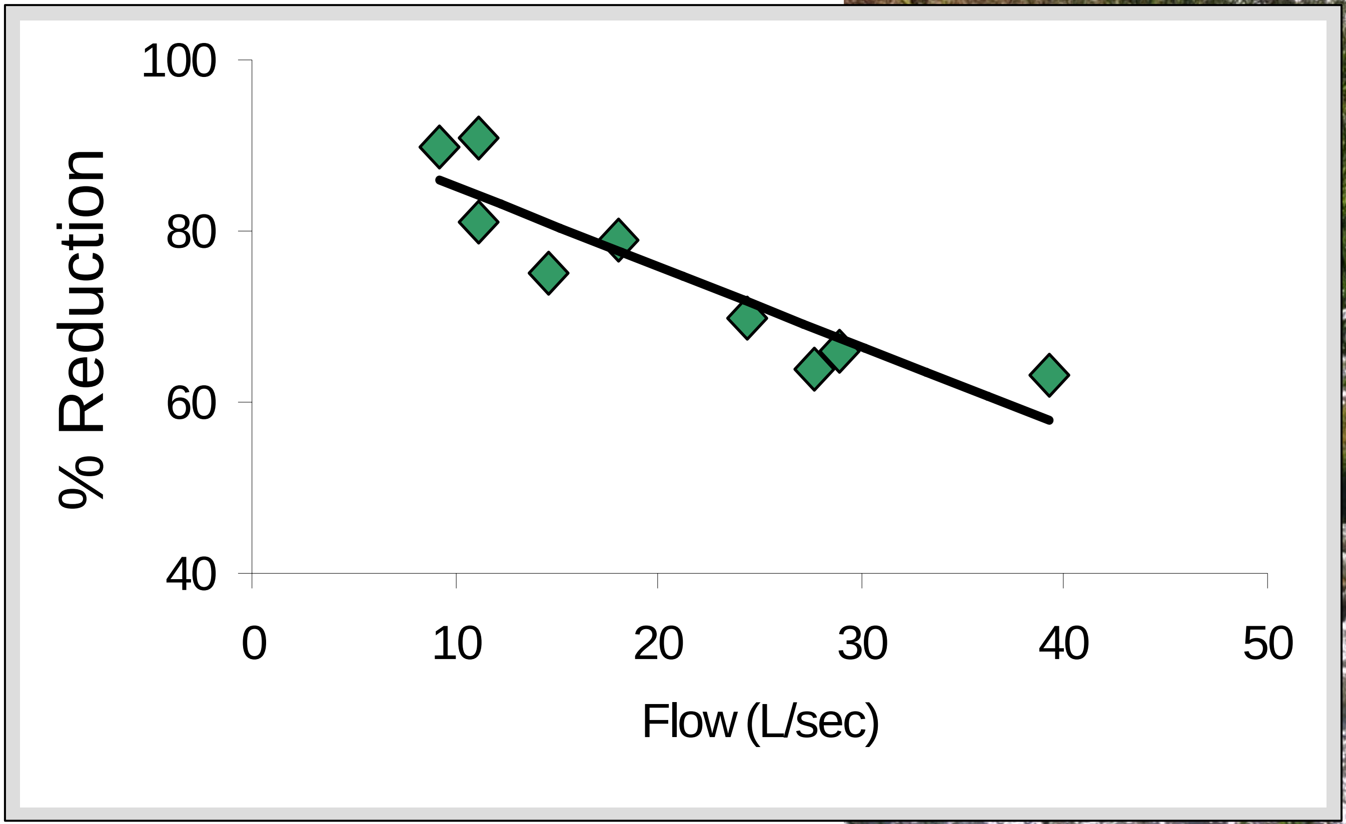
Case Study – Irrigated Foothill Pasture



Field Scale Approach

1. Intensively sample tailwater com *Ec* (cfu/100mL) and flow rates.
2. Exiting pasture (above wetland) and below wetland.
3. Typical range of irrigation application / runoff rates.
4. Typical range of grazing rest before irrigation.
5. 14 irrigation events

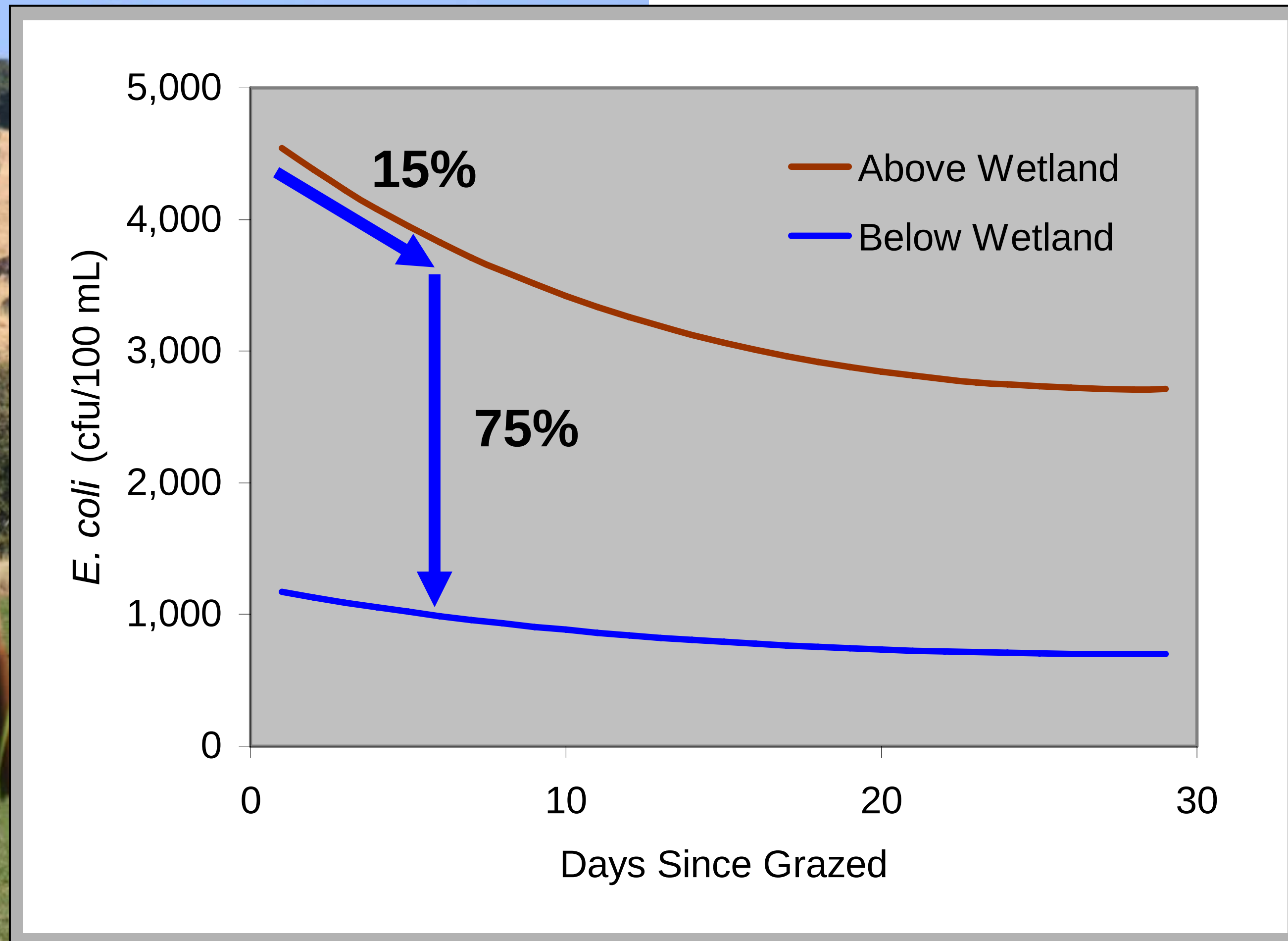
E. coli Reduction by a Functioning Wetland



60 to 90% reduction in commensal *E. coli* load

Efficiency decreased with increased tailwater runoff rate

E. coli reduced by rest from grazing before irrigation



5 d rest reduced com *Ec* concentrations exiting pasture by 15%

The wetland reduced resulting com *Ec* concentration by another 75%

Some Research Needs

- Multiple BMP implementation for key systems – effectiveness and conditions of success/failure
- Integration of management and experimental scale studies – scaling up to recommendations
- Does BMP effectiveness for indicator bacteria translate to pathogens?