

# *Land Cover in Riparian Buffer Areas Can Impact E. coli in Streams*



# *E. coli* is a Major Cause for Water Quality Impairment

## Causes of Impairment for 303(d) Listed Waters

Cause of Impairment Group Name	Number of Causes of Impairment Reported
<a href="#">Pathogens</a>	10,308
<a href="#">Nutrients</a>	7,169
<a href="#">Metals (other than Mercury)</a>	7,045
<a href="#">Organic Enrichment/Oxygen Depletion</a>	6,464
<a href="#">Polychlorinated Biphenyls (PCBs)</a>	6,061
<a href="#">Sediment</a>	5,993

(US EPA National Summary of Impaired Waters, accessed online April 14, 2016)

- Pathogens are the # 1 cause of impairment for 303(d) listed waters
- *E. coli* is becoming the “indicator organism” of choice for contamination in waters
  - Inexpensive, compared to testing for specific pathogens
  - More strongly correlated with recreational-associated GI illness

# Impairment of streams in Arkansas

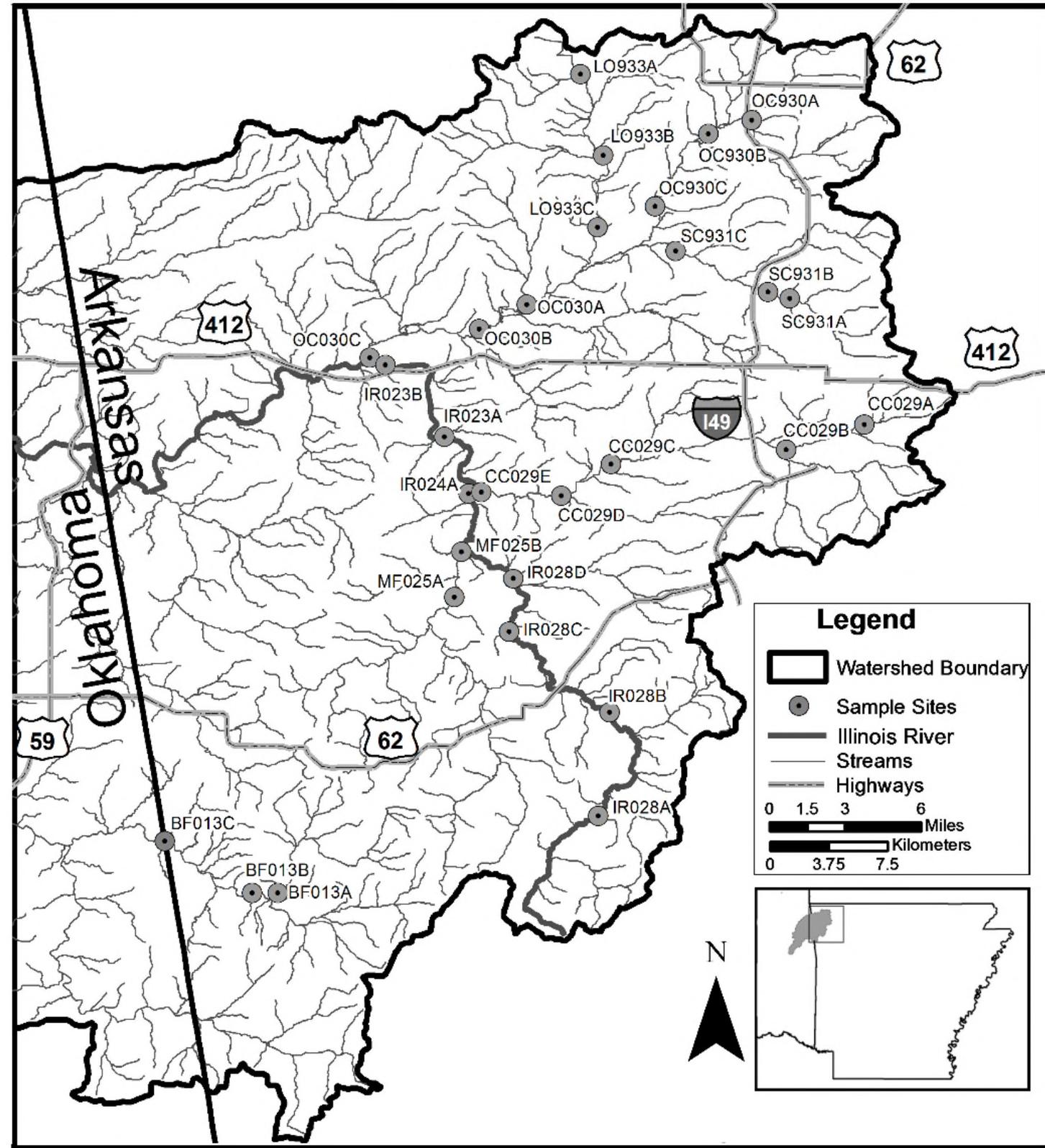


- 390 km of assessed streams and rivers listed because of *E. coli* violations
- Goal of WQS is to protect human health during primary contact recreation

# Illinois River Watershed

- 7 streams
- 10 reaches

*Illinois River*  
*Osage Creek*  
*Little Osage Creek*  
*Spring Creek*  
*Clear Creek*  
*Muddy Fork*  
*Baron Fork*

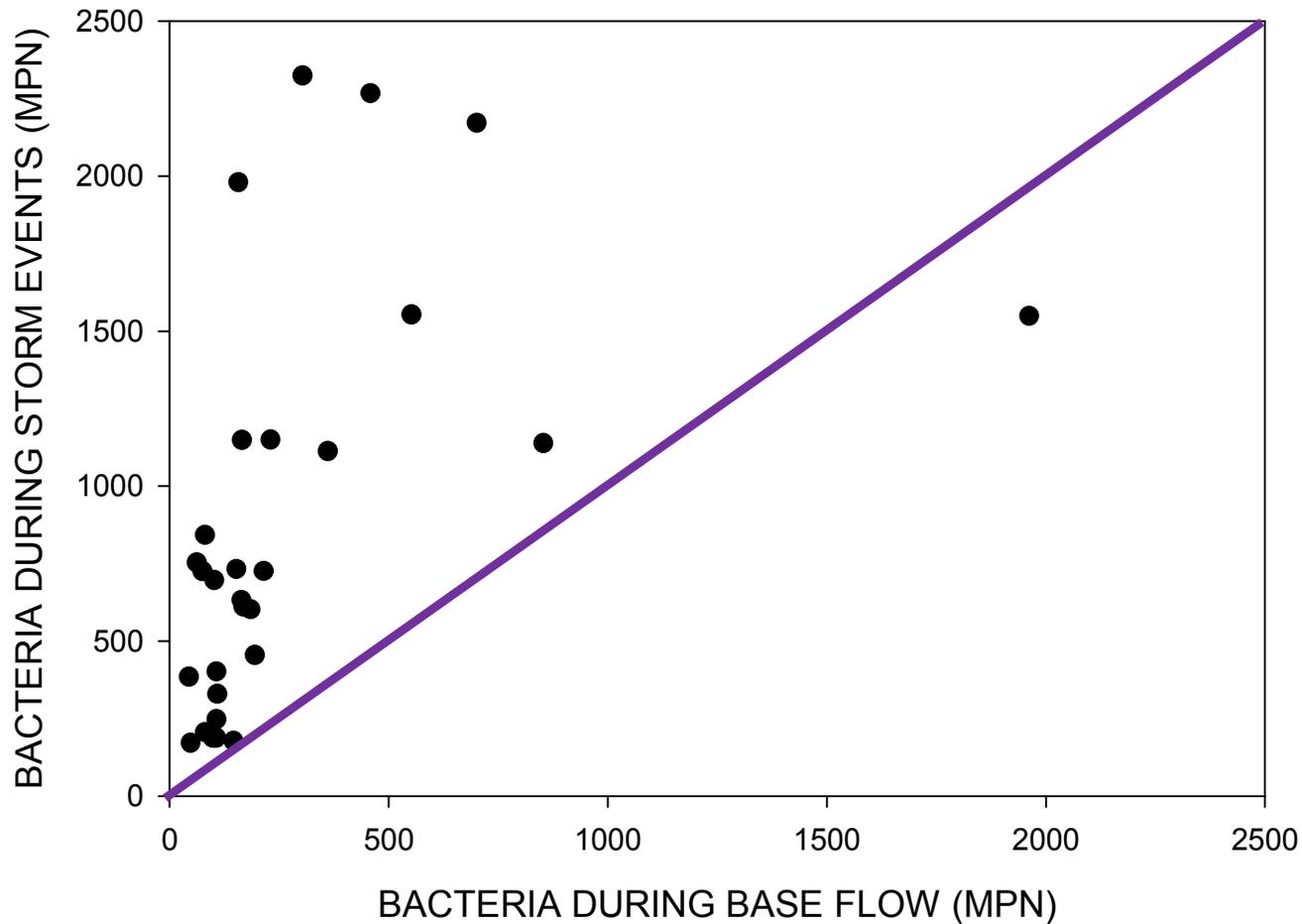


# Study Objectives

- Evaluate *E. coli* concentrations at different sites along each 303(d) listed reach
- Compare this data against the applicable water quality standards
- Investigate relationships between *E. coli* concentrations and land cover variables

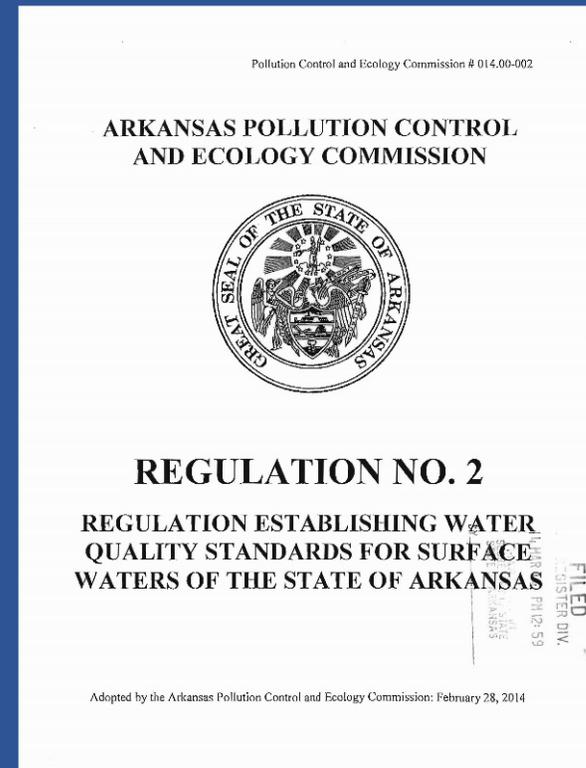
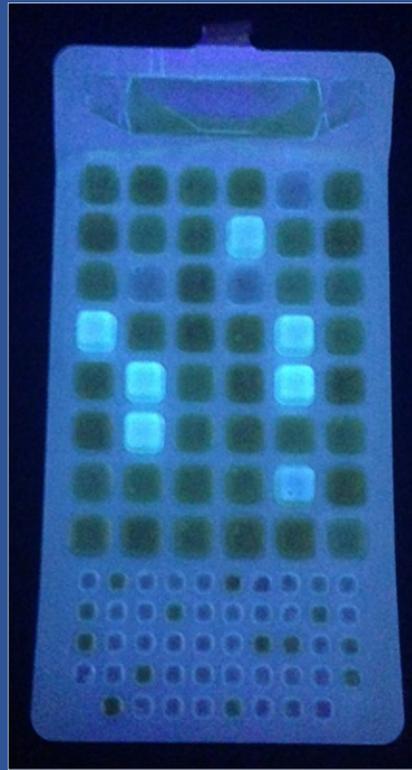


# Setting the Stage – Flow and Bacteria



- Flow can drive increases in bacteria
- We focused on base flow

# *E. coli* Sampling and Processing



- Collected water samples 8 or 9 times during the primary contact season – May through September – in 2012, 2013, 2014
- Collected water sample in sterile containers and kept on ice
- Returned to the AWRC WQL (certified for bacteria), analyzed for *E. coli* using IDEXX Colilert Total Coliform and *E. coli* method (APHA 9223B)
- Enumerated as most probable number of colonies per 100 mL (col/100 mL)
- Data evaluated against the applicable water quality standard

# Water Quality Standards for *E. coli*

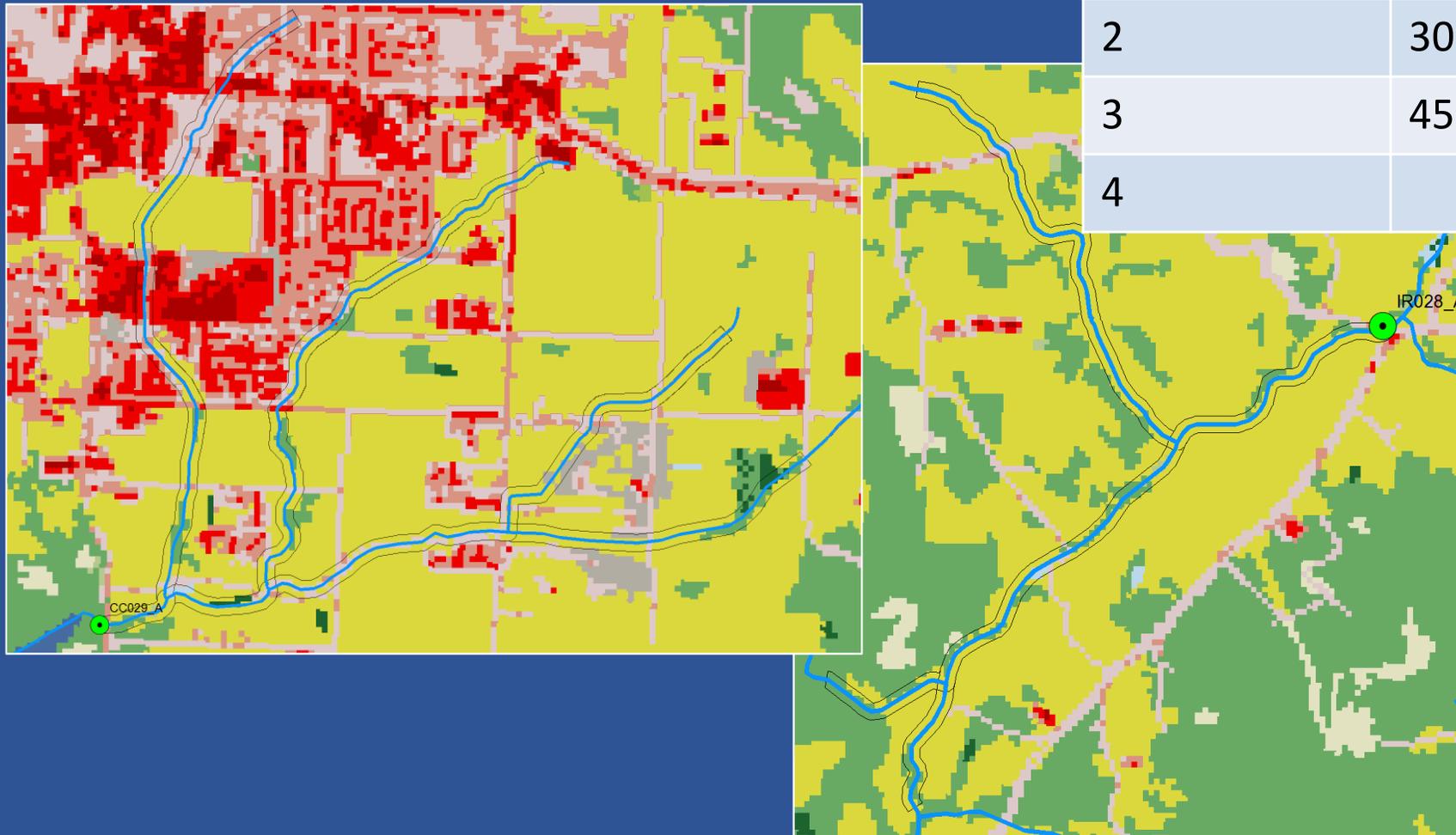
- Based on the concentration of the indicator organism *and* the intended use of the water body (primary contact recreation)

## APCEC Regulation 2

- *E. coli* numbers should not exceed the applicable limit in more than 25% of the water samples collected in no less than 8 samples taken during the primary contact season.
- The limits are:
  - 298 col/100 mL in the Illinois River (ecologically sensitive waterbody, Neosho Mucket mussel)
  - 410 col/100 mL in all other streams

# Land Cover

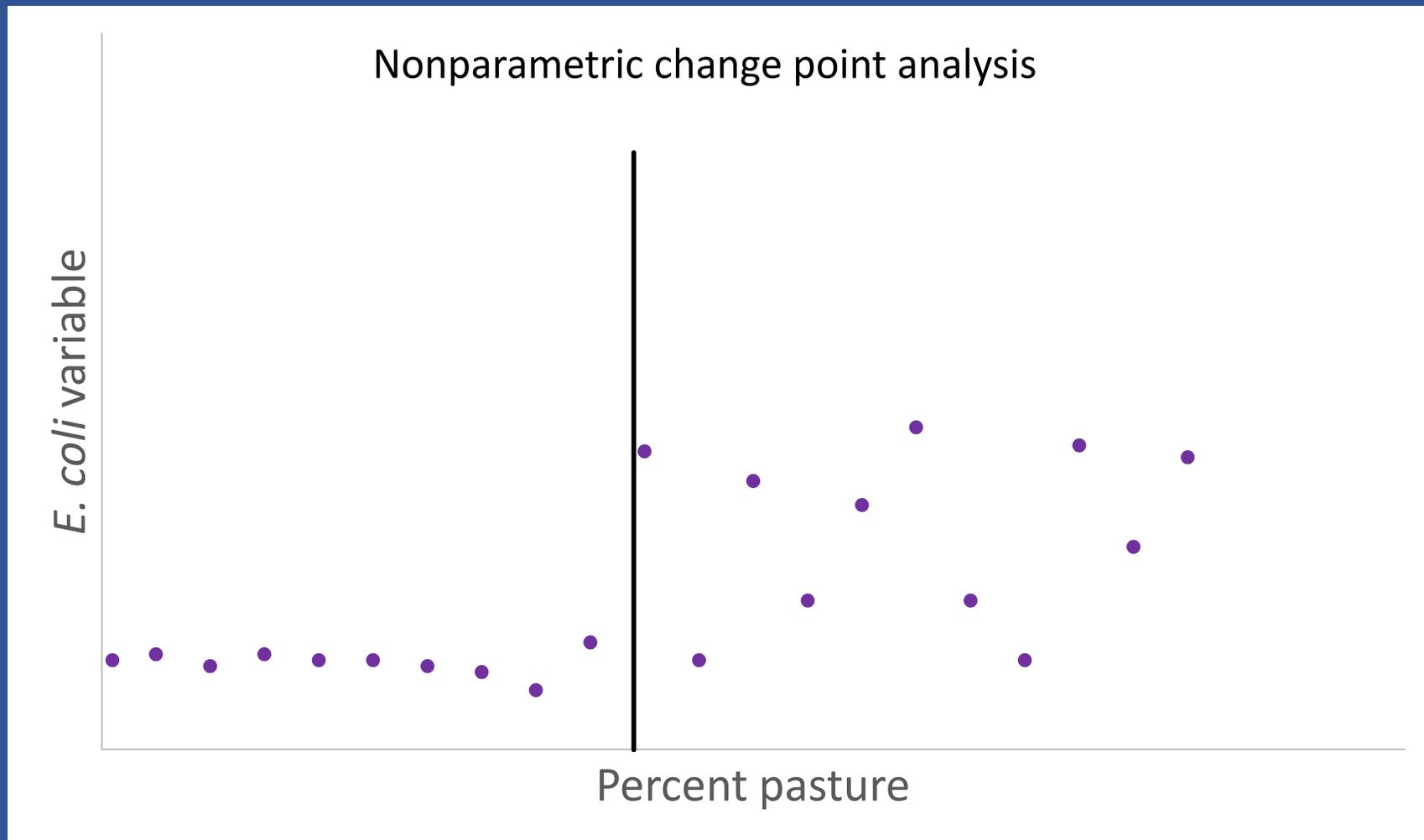
- Calculated land cover in different riparian buffer area designations and for the entire drainage area
  - ArcMap (ESRI) for USGS 2011 National Land Use Land Cover dataset



Upstream distance (km)	Horizontal distance (m)
0.5	10
1	20
2	30
3	45
4	

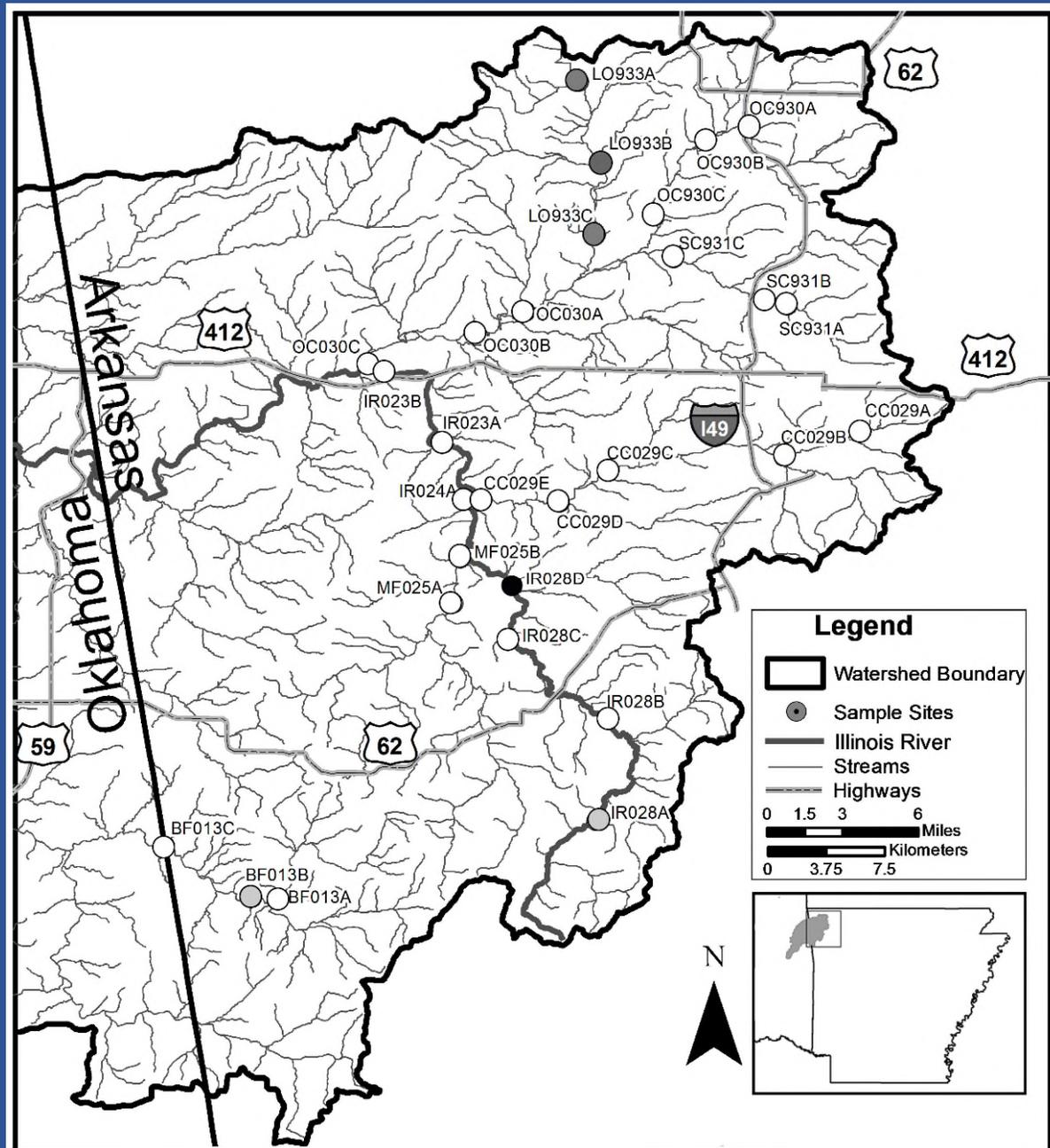
# Statistical Analyses

- Linear regression analysis on PERCENT PASTURE vs the GEOMEAN of *E. coli* for a given site and season
- Nonparametric change point analysis on PERCENT PASTURE vs GEOMEAN and vs PERCENT EXCEEDANCE based on applicable WQS





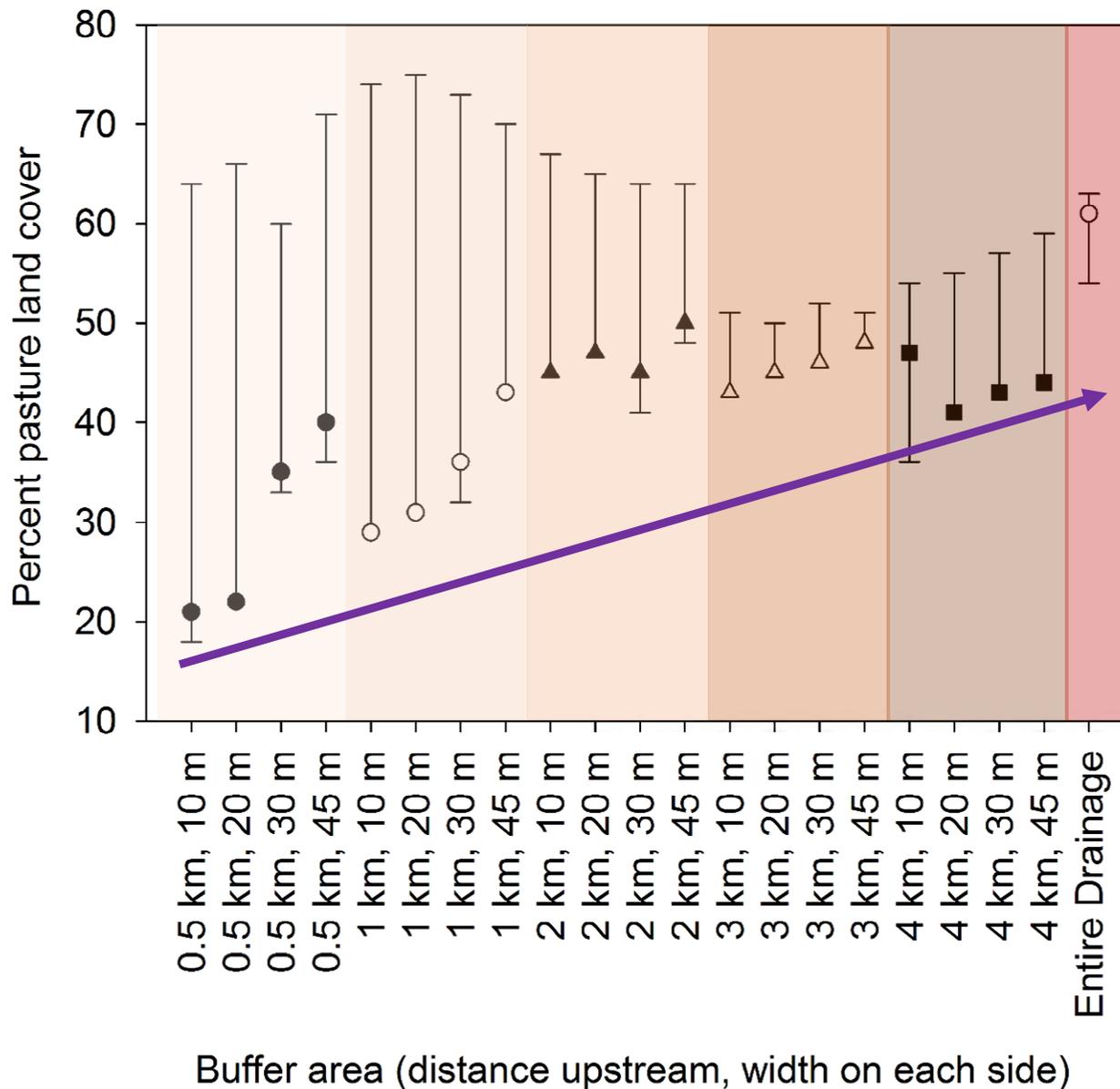
# *E. coli* Standard Violations



- Violation occurs when >25% of the water samples exceed the applicable standard
  - 410 MPN col/100mL
  - 298 MPN col/100mL
- Little Osage sites violated in 2012 and 2014
- IR028D violated every year
- IR028A and BF013B violated in 2014 and 2012, respectively
- Violations appear to be a localized issue (at base flow)
- Interannual variability in *E. coli* concentrations resulted in sporadic violations

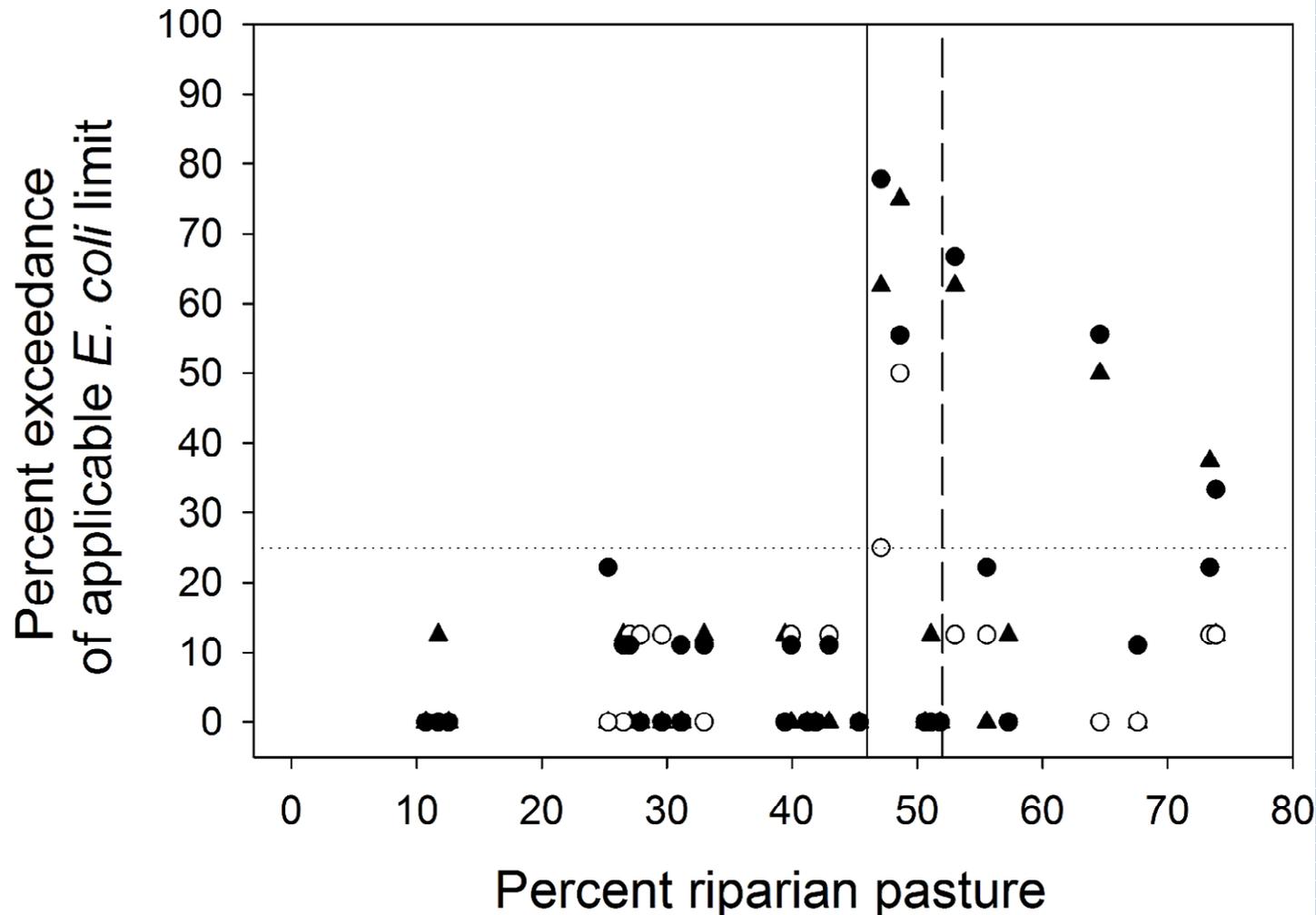
# Thresholds Depend on How We Define “Riparian Buffer Area”

Upstream distance (km)	Horizontal distance (m)
0.5	10
1	20
2	30
3	45
4	



- Change points generally increase with increasing buffer area
- But, 95% CI are large
- Range of CI decrease with increasing distance for the buffer area in the upstream direction
  - Less variability in percent pasture
  - 11 of 87 observations exceeded the WQS in >25% of samples
  - Most observations where pasture was above the change point didn't violate

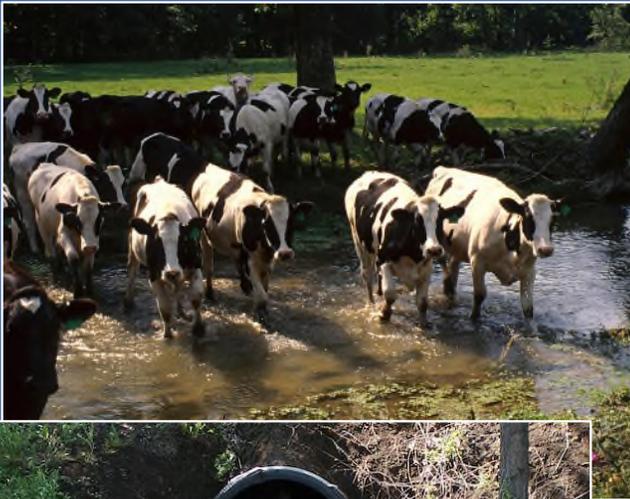
# Riparian Buffer Area: 3km and 30m Width



- When percent pasture is <46%, exceedances for *E. coli* were never greater than 25%
- When percent pasture is >46%, exceedances for *E. coli* ranged from 0 to 78%.
- The only sites where violations occurred had >46% pasture land in the riparian zone
- But, not all sites...
- Animal access?

# Take Home Message

- Need multiple years of data to properly assess potential impairment
- At base flow, *E. coli* concentrations appear to be a localized problem
- Threshold for the amount of pasture in the riparian buffer area is 46% - the only sites to violate the WQS had more than 46% pasture
- Most sites never violated the WQS, even when pasture was high...why?



# Thanks!



# Questions?

