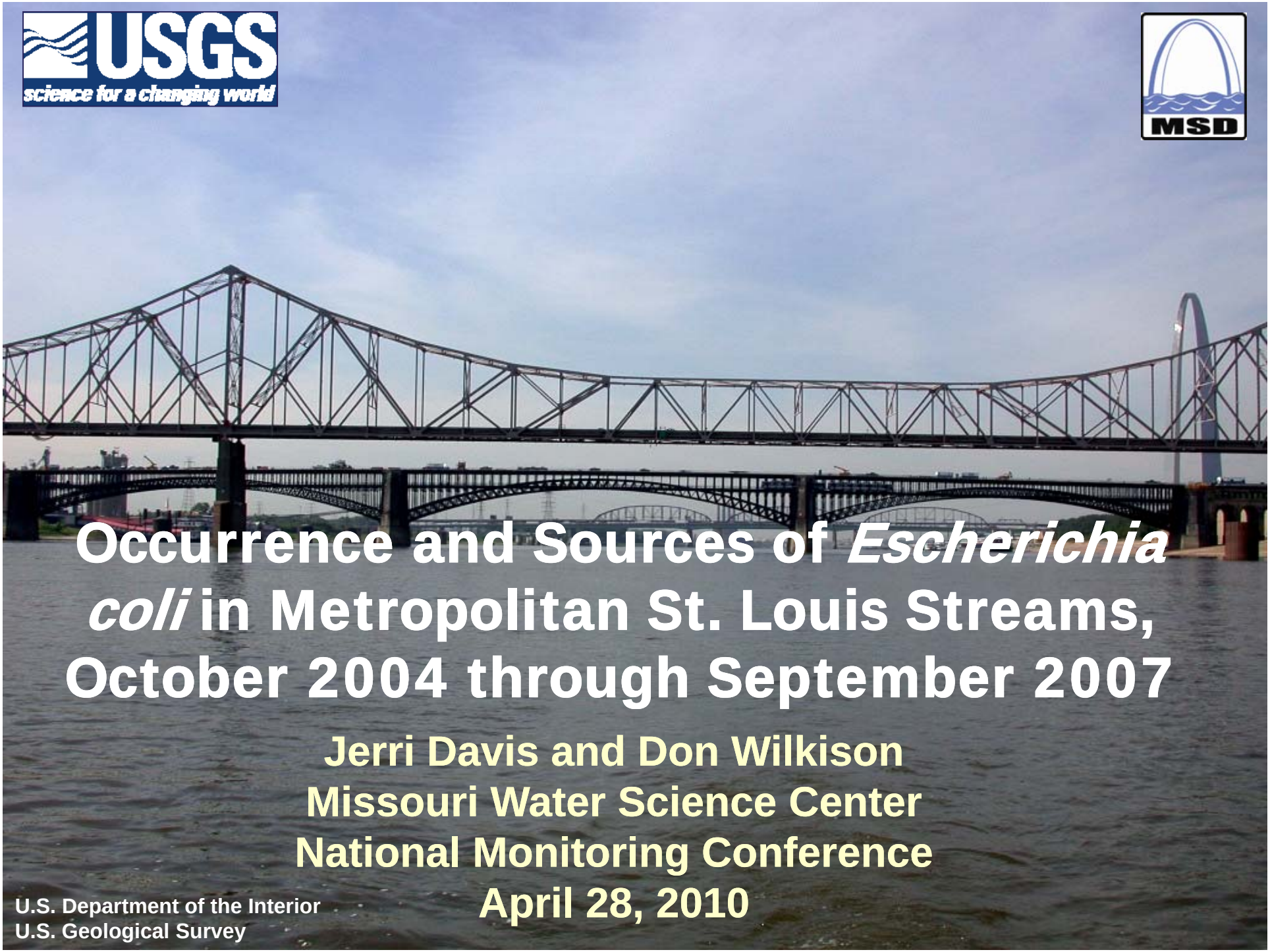


Occurrence and Sources of *Escherichia coli* in Metropolitan St. Louis Streams, October 2004 through September 2007

Jerri Davis and Don Wilkison
Missouri Water Science Center

National Monitoring Conference
April 28, 2010

U.S. Department of the Interior
U.S. Geological Survey

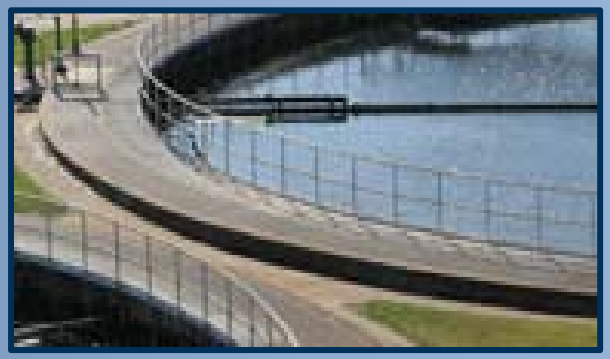
Overview

- Background
- Problem
- Study area
- Objective and approach
- Results
- Conclusions
- Questions

USGS

Background

- Metropolitan St. Louis Sewer District (MSD)
  - Customer-owned utility
  - Formed in 1954



  - 4th largest system in U.S. – 9,650 mi
  - Provides interception, collection, and treatment of wastewater and stormwater management to St. Louis City and County

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Background

- Metropolitan St. Louis Sewer District (MSD)
  - Sewer age – < 1 year to 150 years old
  - Develop stormwater management plan
  - Baseline discharge and water-quality data collection since 1996
    - Small sub-basins
    - Missouri and Mississippi Rivers

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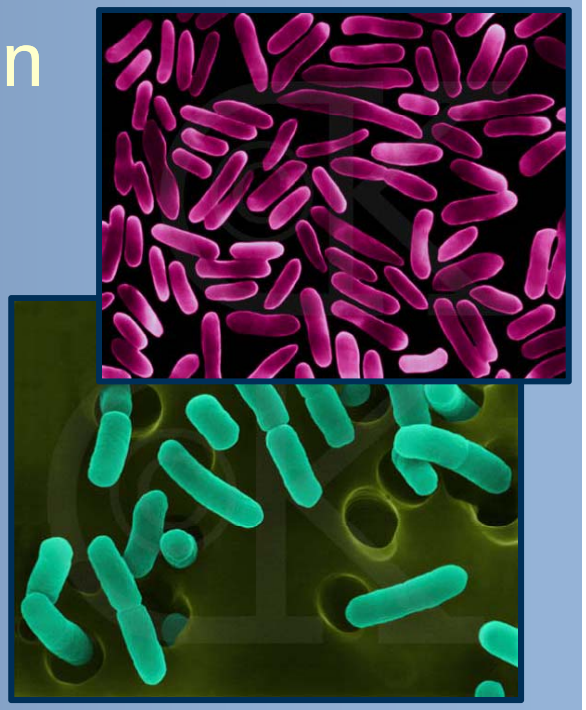
Problem

- Presence of large densities of fecal indicator bacteria, including *E. coli*, in classified streams
  - Whole-body-contact recreation
    - Class A – 126 col/100 mL
    - Class B – 206 col/100 mL
  - Secondary-contact recreation
    - 1,134 col/100 mL



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Problem

- Possible *E. coli* sources
  - Nonpoint source runoff
  - Combined sewer overflows (CSOs)– ~ 200
  - Sanitary sewer overflows (SSOs) – ~ 200
  - Wastewater treatment plants (WWTPs)
    - 2 to Missouri River
    - 3 to Mississippi River
    - 2 to the Meramec River

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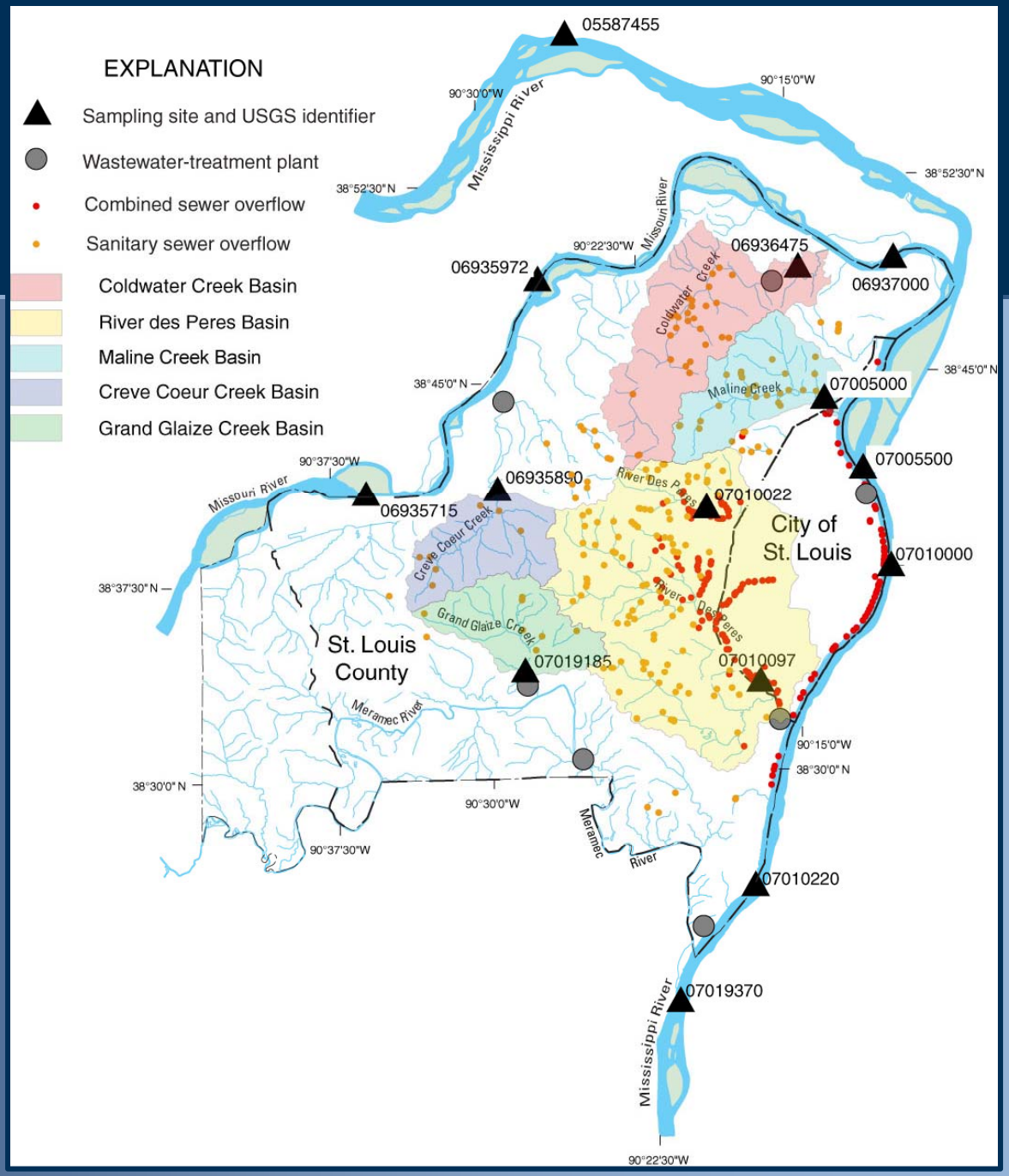
Study area: 14 QW sites



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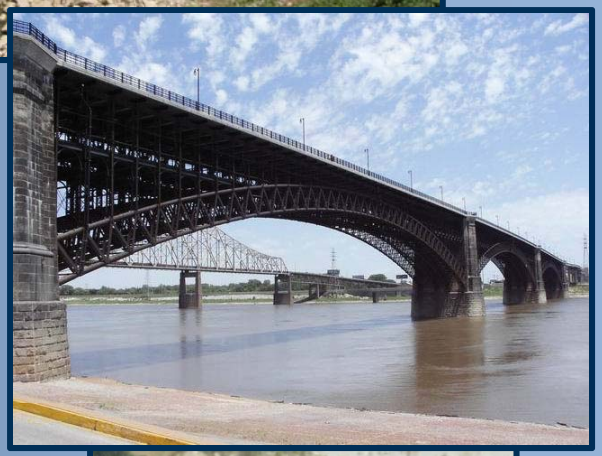
Study area:
14 QW sites



- 8 large river sites
  - 3 on Missouri River
  - 5 on Mississippi River
- 6 small basin sites
  - Missouri River tributaries
    - Creve Coeur Creek
    - Coldwater Creek
  - Mississippi River tributaries
    - Maline Creek
    - River des Peres (2 sites)
    - Grand Glaize Creek *via Meramec R.*

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Study Area

- 535 mi^2; ~ 1.4 million people
- > 60 percent urban land
- Limited filtration, natural degradation, or solar inactivation of bacteria
- Numerous channel modifications
- Short travel times between sites: 1-7 hours
- Instream velocities keep sediment and bacteria entrained

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Objective and approach

- Objective
  - Describe occurrence, distribution, and sources of *E. coli* in St. Louis streams
- Approach
  - Baseflow and storm event sampling
    - Indicator bacteria (*E. coli* and fecal coliform)
    - Analyze by site, stream reach, and land use

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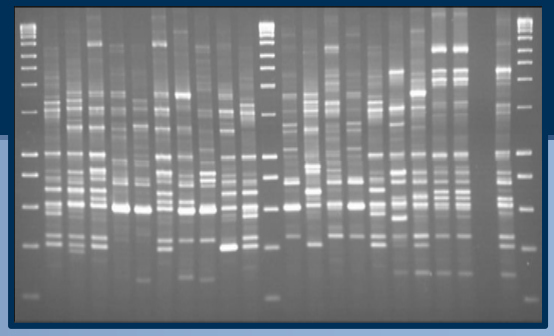
Objective and approach



- Approach
  - Microbial source tracking
    - Repetitive polymerase chain reaction (rep-PCR)
    - Develop local host-source library
    - Compare environmental isolates to library
    - Verify human with *Bacteroides thetaiotaomicron (B. tim)*
  - Load models for annual estimates
    - Fitted linear regression models
    - Annual estimates from daily values

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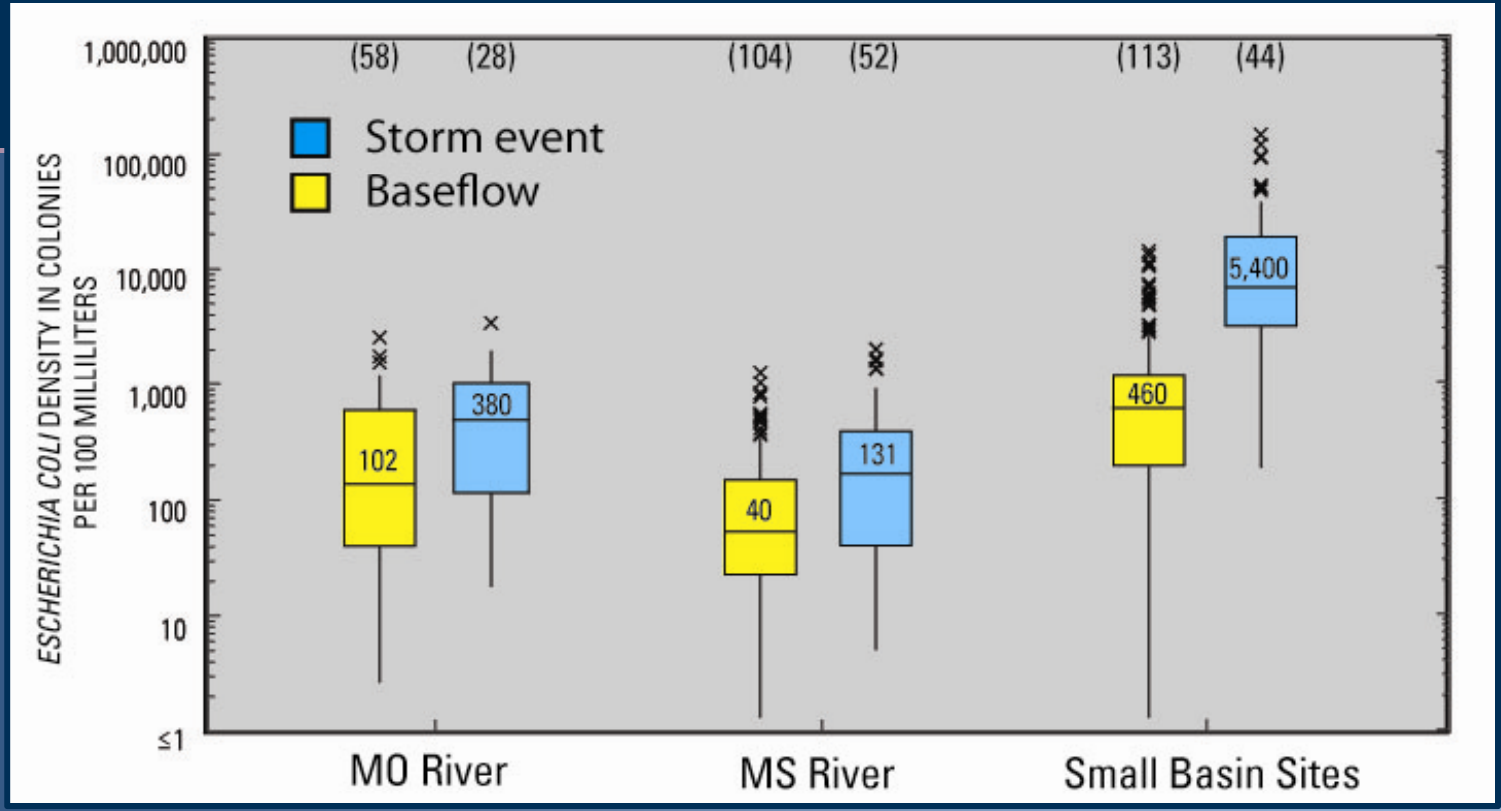
Results: *E. coli* densities by site type



- Densities highest in storm event samples
- Densities lowest at MS River sites
- Densities largest at small basin sites

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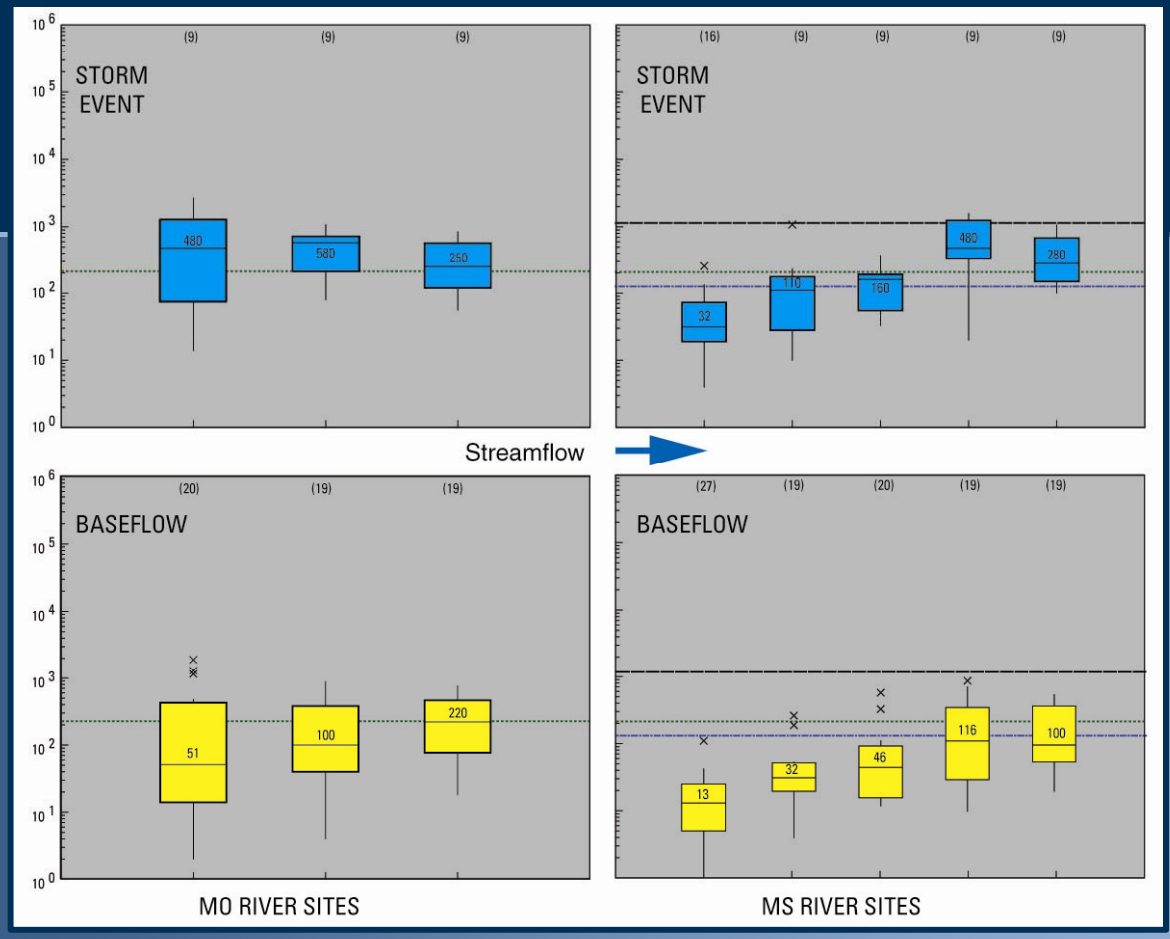
Results: *E. coli* densities – large rivers



- Densities generally increase through St. Louis
- MS River sites generally below applicable criteria at baseflow and 75% of storm event samples
- MO River sites below applicable criteria in 60% baseflow and 36% storm event samples

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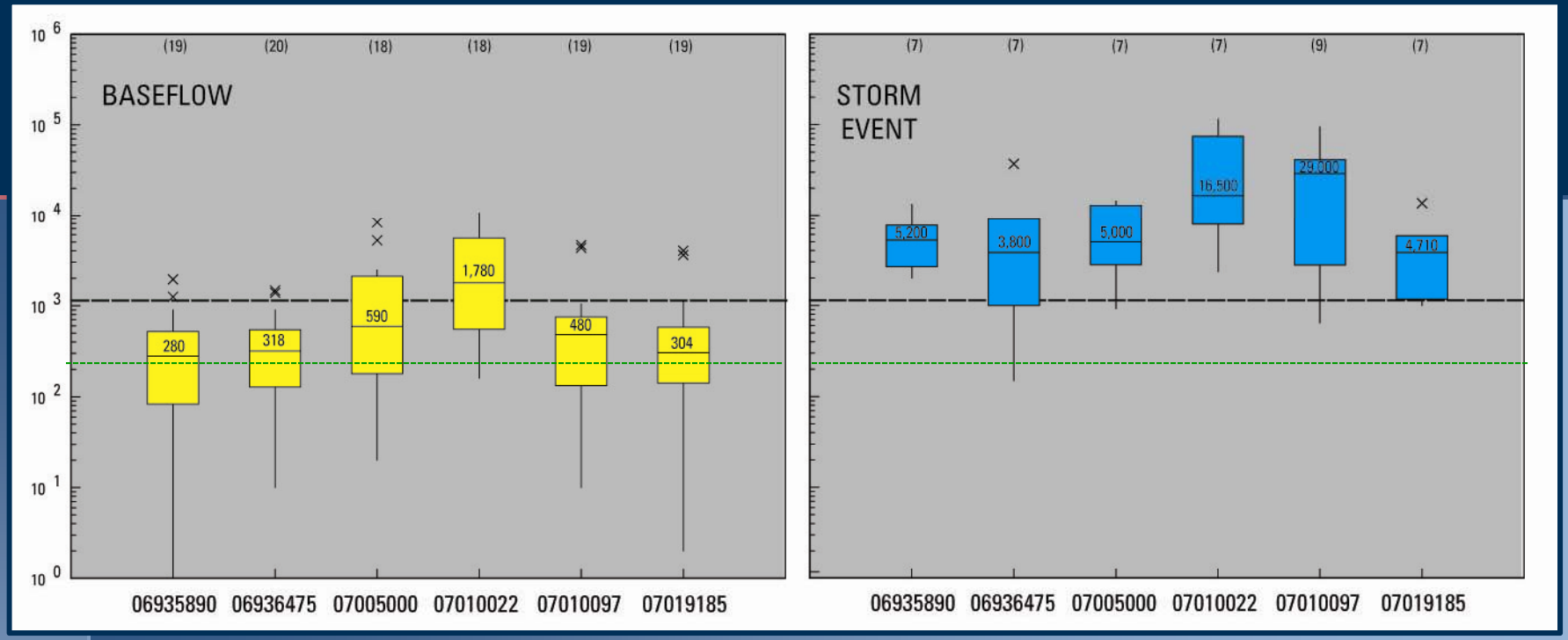
Results: *E. coli* densities – small basins



- **Densities higher during storm events**
  - Baseflow samples < secondary contact criterion
  - Storm samples > secondary contact criterion
- **Highest densities at sites with**
  - Larger number of CSOs/SSOs
  - Greatest amount of impervious cover

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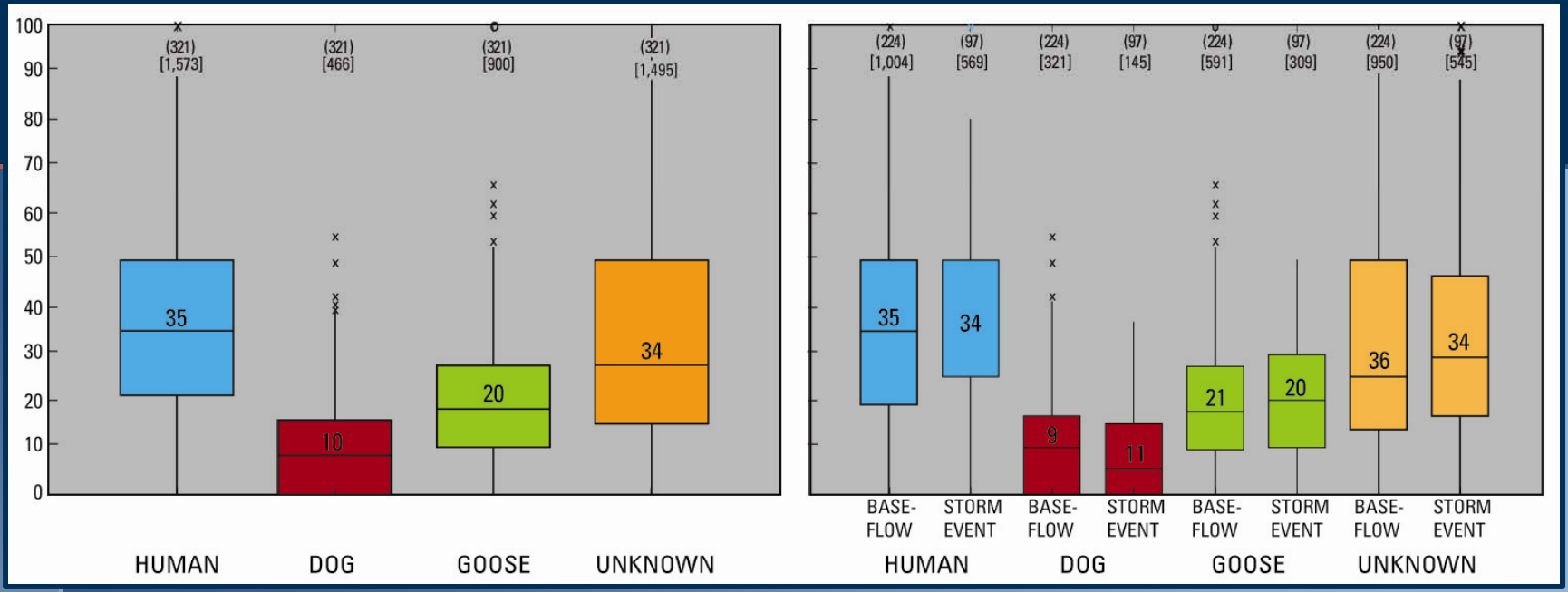
Results: *E. coli* sources – densities



- **Focus MST results on data central tendency**
  - **More than 4,000 isolates by rep-PCR**
- ***E. coli* is ~ 1/3 human and 2/3 non-human**
  - **92% of samples with human *E. coli* confirmed by *B. tim***
- **Baseflow and storm event sources are similar**

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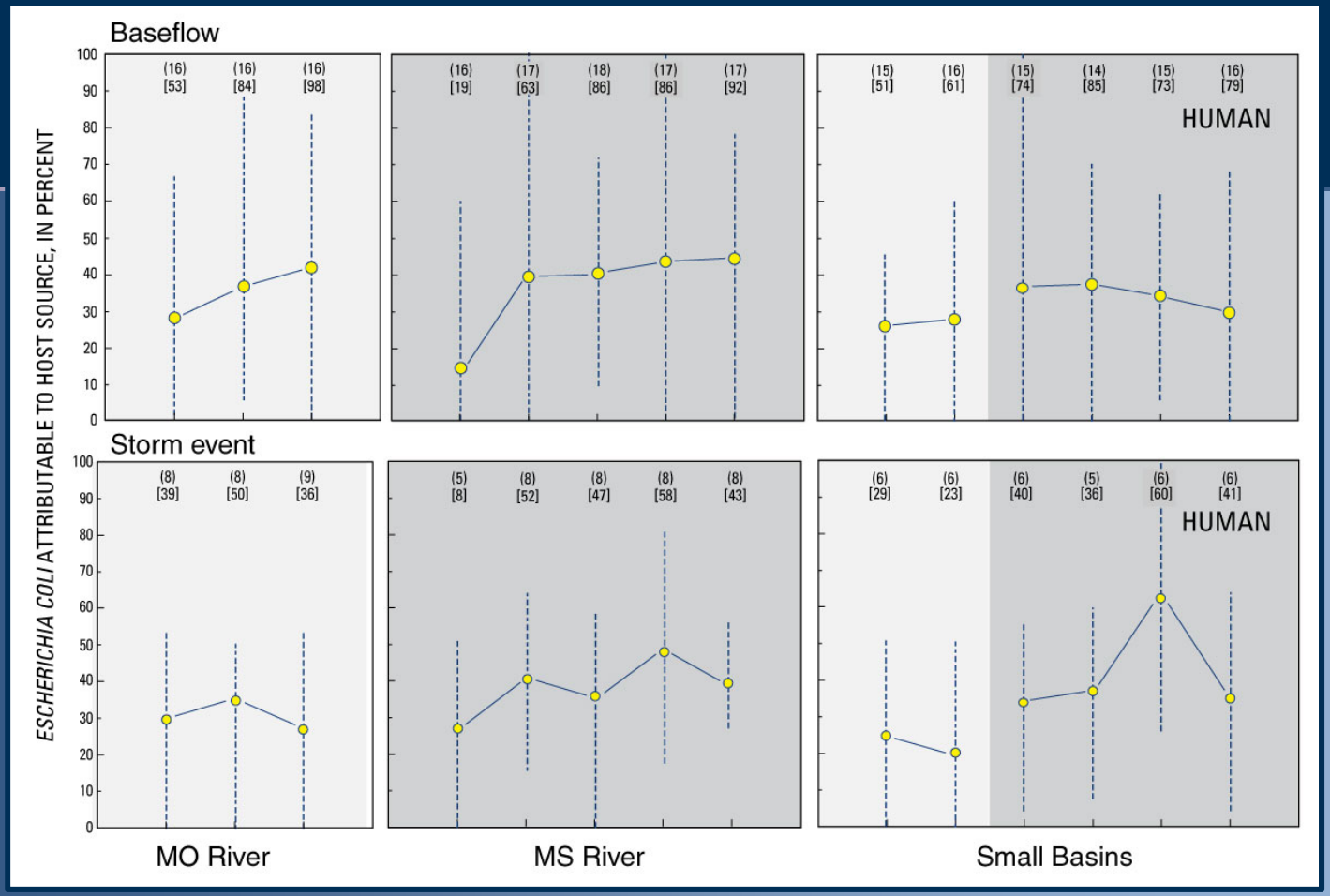
Results: *E. coli* sources – densities



- **Baseflow: % human increases in large rivers**
- **Storm event: % human increases with urbanization**

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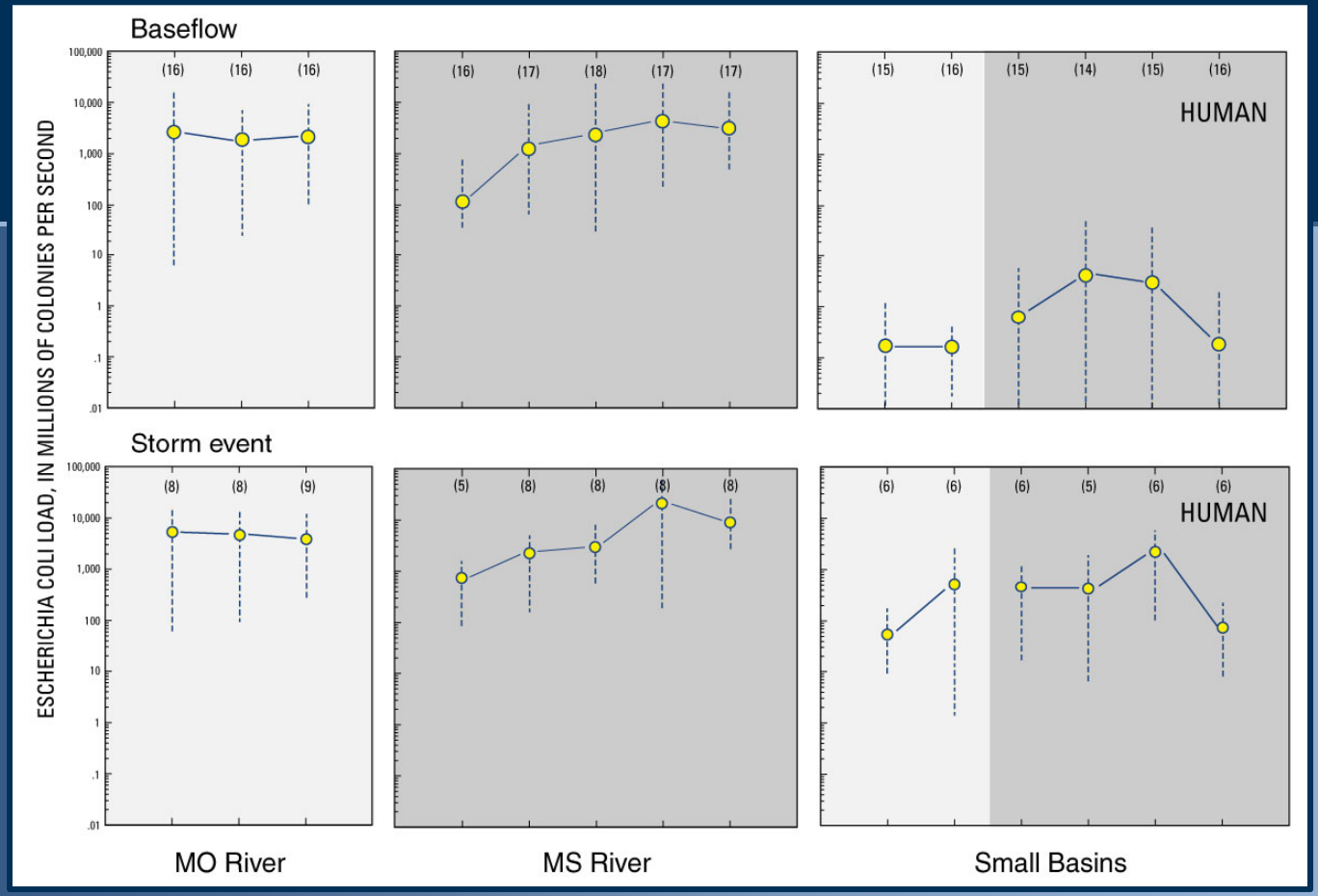
Results: *E. coli* sources – loads



- **Baseflow:** Upper MS River load 10 % of downstream MO River load
  Small basin loads < 1 % of MO or MS River loads
- **Storm:** Upper MS River load 14 % of downstream MO River load
  Small basin loads 1-16 % of MO or MS River loads

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Conclusions

- Majority of *E. coli* in MS River below the confluence originates from MO River
  - Lower MO River *E. coli* loads ~ 10 times greater than upper MS River loads
- Small basin contributions (loads) $\leq$ 16% of receiving streams
- Small basin sites with greatest number of CSOs and SSOs had:
  - Larger *E. Coli* densities and loads
  - Higher percentage of human *E. coli* during storm events

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Conclusions

- Approximately 35% of *E. coli* attributable to human sources
- Bacteria densities (and % human) increases through the study area
- Most Mississippi River sites are below applicable criteria
  - Baseflow = ~100% of time
  - Storm events = ~75% (average) of the time

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Conclusions

- Missouri River sites are below applicable criteria
  - Baseflow = ~60% of the time
  - Storm events = ~36% of the time
- Small basins sites are below applicable criterion
  - Baseflow = ~41% of the time
  - Storm events = ~5% of the time

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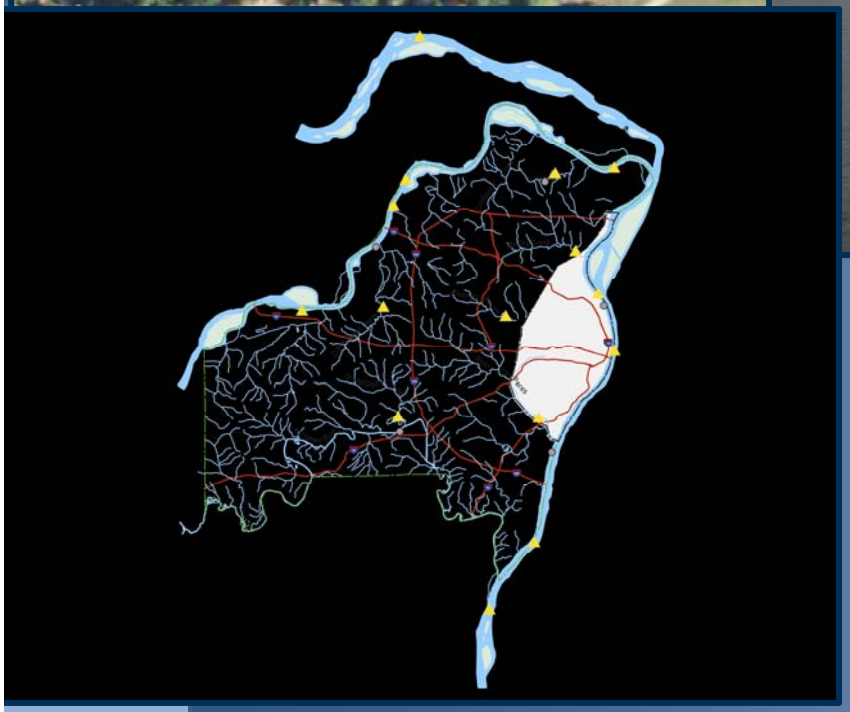

Questions?

jdavis@usgs.gov
wilkison@usgs.gov

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