Water quality of streams in Johnson County, Kansas

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http://ks.water.usgs.gov/Kansas/studies/qw/joco/

USGS

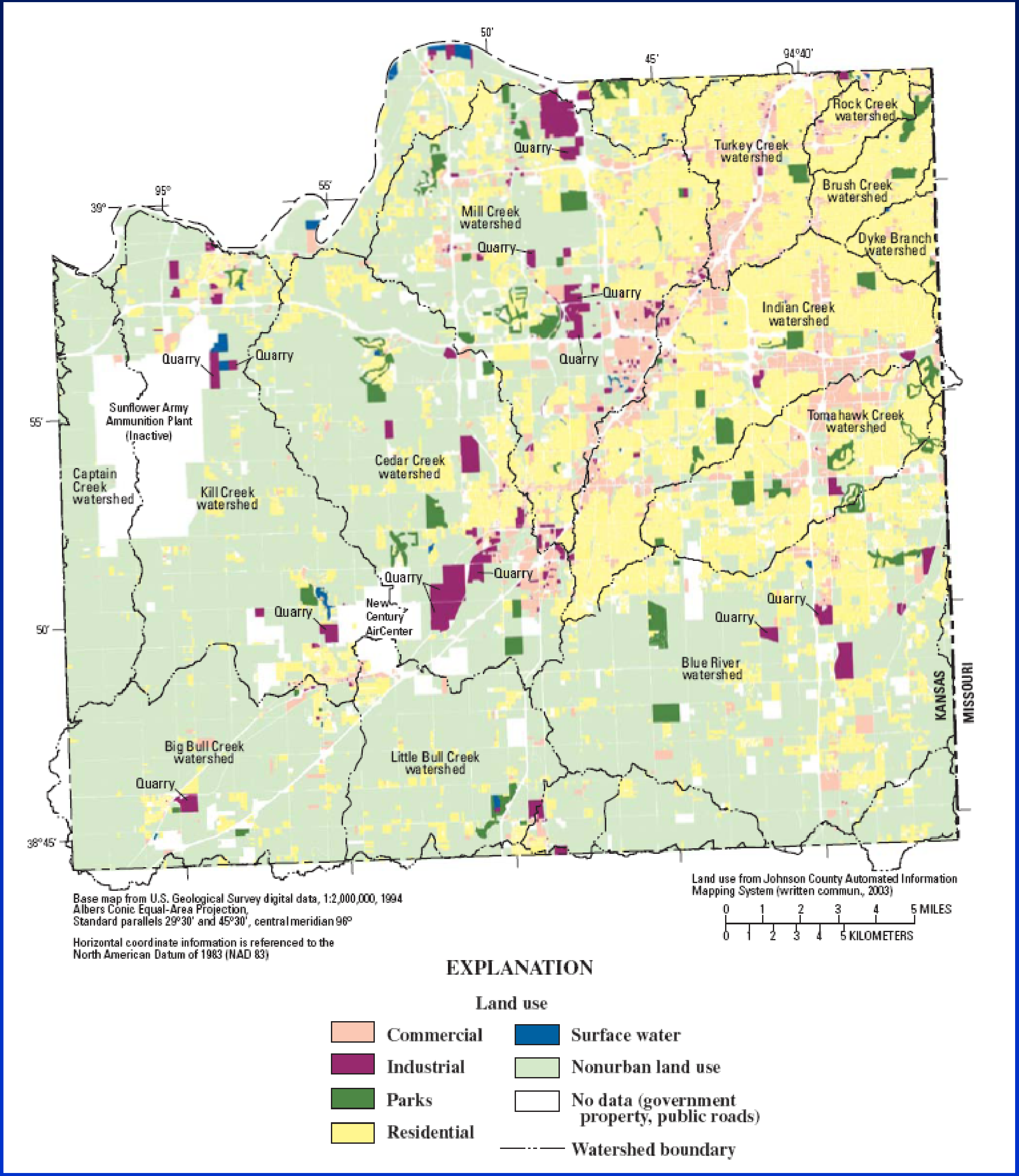
Lower Kansas River WRAPS

Aug 21, 2008

Johnson County
Stormwater Management

Population growth in Johnson County has led to increasing interest in stream quality

- Human and environmental health
- Drinking water supply
- Recreation
- Aesthetic value
- State and federal regulations



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Most water-quality impairments in Johnson County are related to excessive bacteria, nutrients, and sediment

Impairments (303d listings) and associated watersheds

Biological	Mill
Chloride	Mill
Chlordane	Blue, Mill
Dissolved oxygen	Blue
Fecal coliform bacteria	Blue, Cedar, Indian, Kill, Mill
Nitrates	Cedar, Indian
Nutrients	Blue, Mill
Sediment impact	Mill
Eutrophication	Lakes - Gardner City, Hillsdale, Olathe and Cedar

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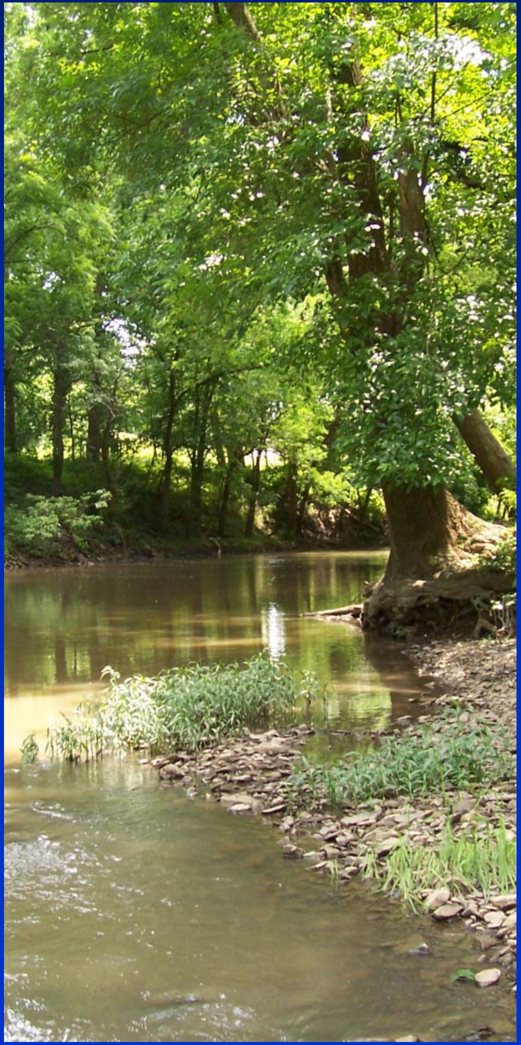
Cooperative water-quality studies between USGS and the Johnson County Stormwater Management Program, 2002-07

Objectives:

- To characterize water-quality of Johnson County streams and determine baseline (current) conditions
- To identify chemical and sediment source areas
- To estimate chemical concentrations and loads
- To evaluate effects of urbanization on water quality
- To monitor changes in water quality
- To provide information for developing effective water-quality management plans
- To help meet requirements of the Clean Water Act



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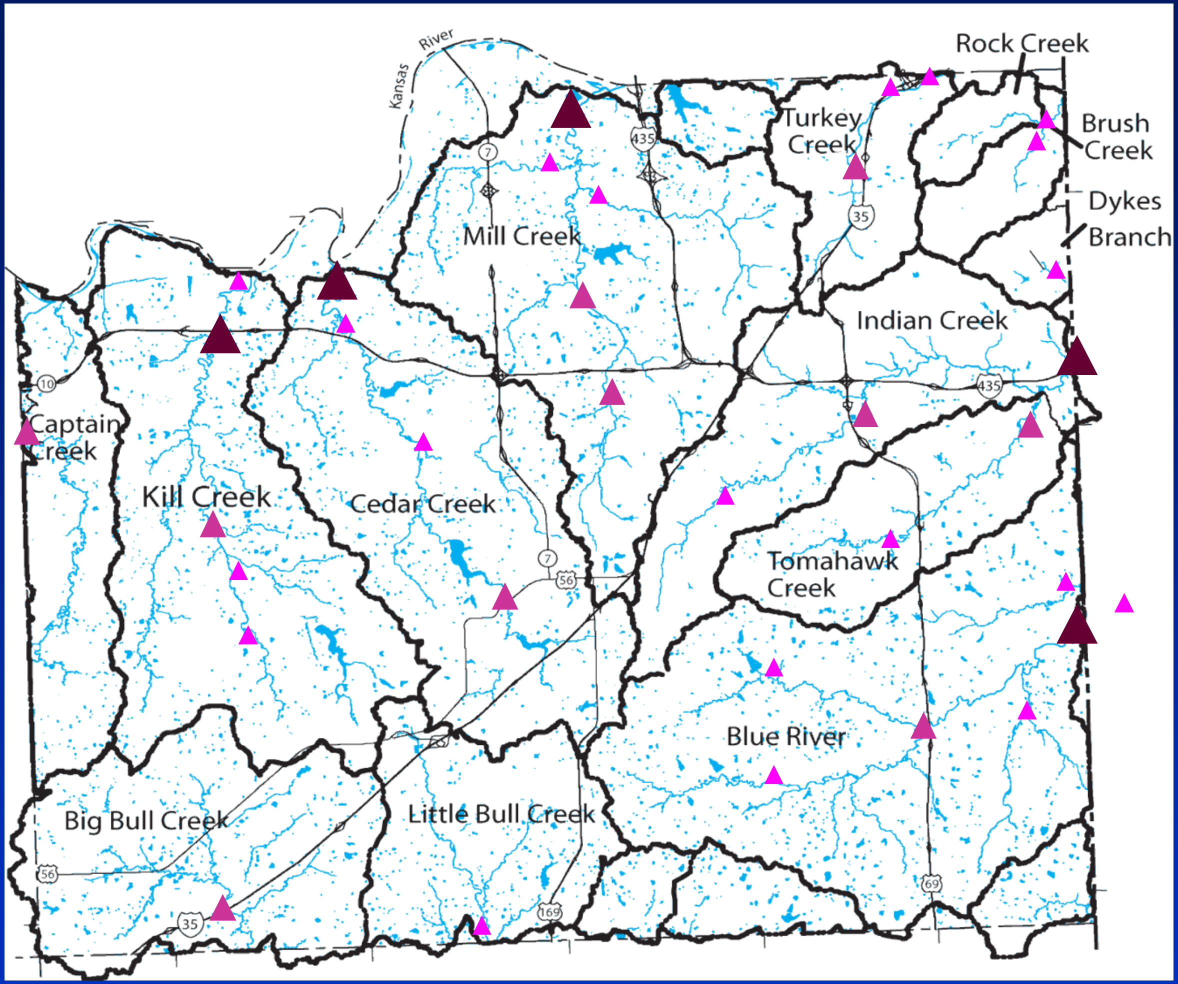
Overall study approach

I. Water and sediment sampling to identify contaminant sources



Collected 2 synoptic base-flow samples from about 45 stream sites (Nov 2002, July 2003)

Measured streamflow, suspended sediment, dissolved solids and major ions, nutrients, indicator bacteria, pesticides, wastewater compounds, pharmaceuticals

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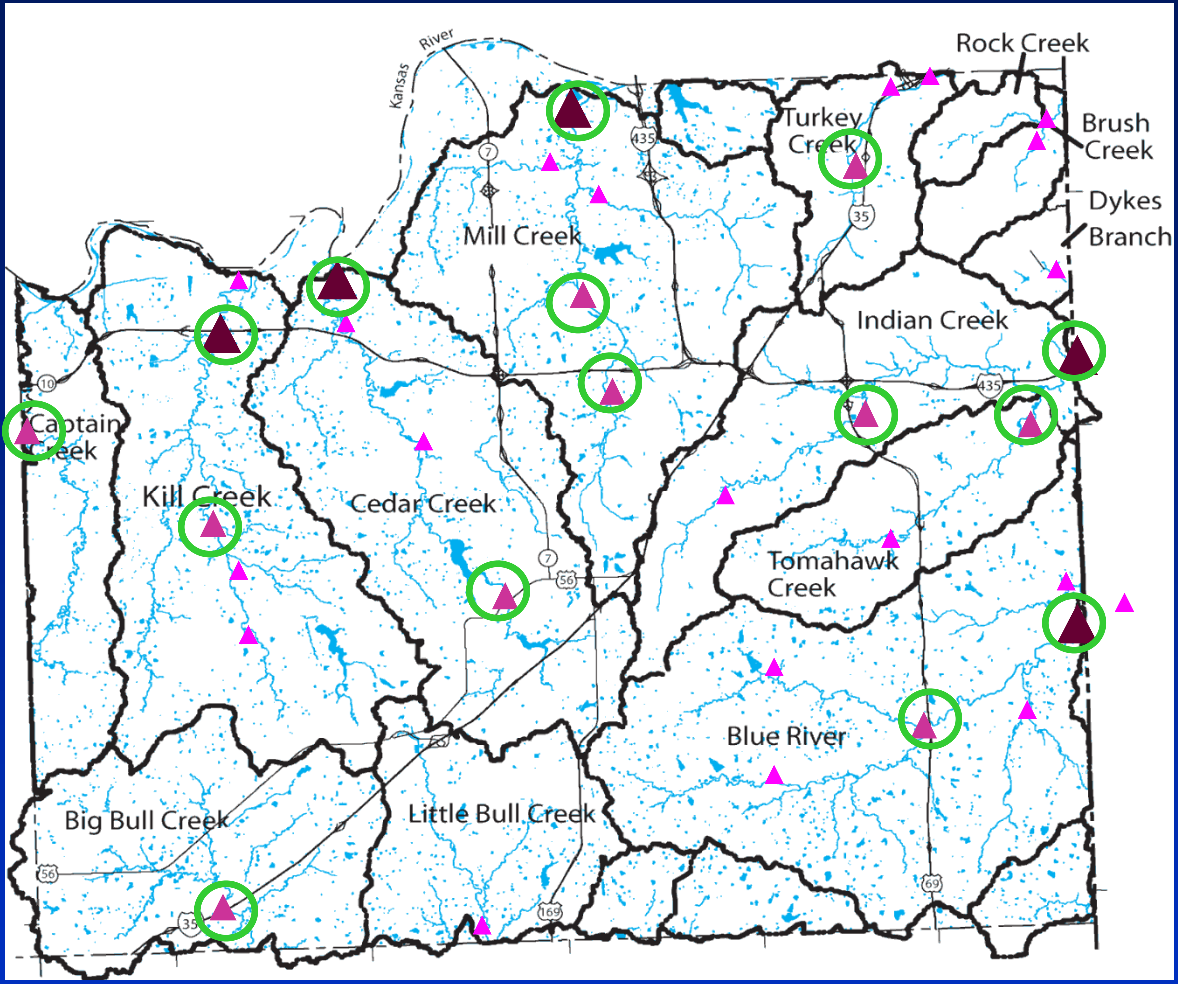
Overall study approach

II. Macroinvertebrate assessment to describe biological conditions

Stonefly

Riffle beetle



- Sampled 15 stream sites in Johnson County, 2003 and 2004
- Evaluated published data from 7 additional sites, 1 in Johnson County and 6 in Missouri
- Available land use and water- and streambed-sediment quality data also evaluated

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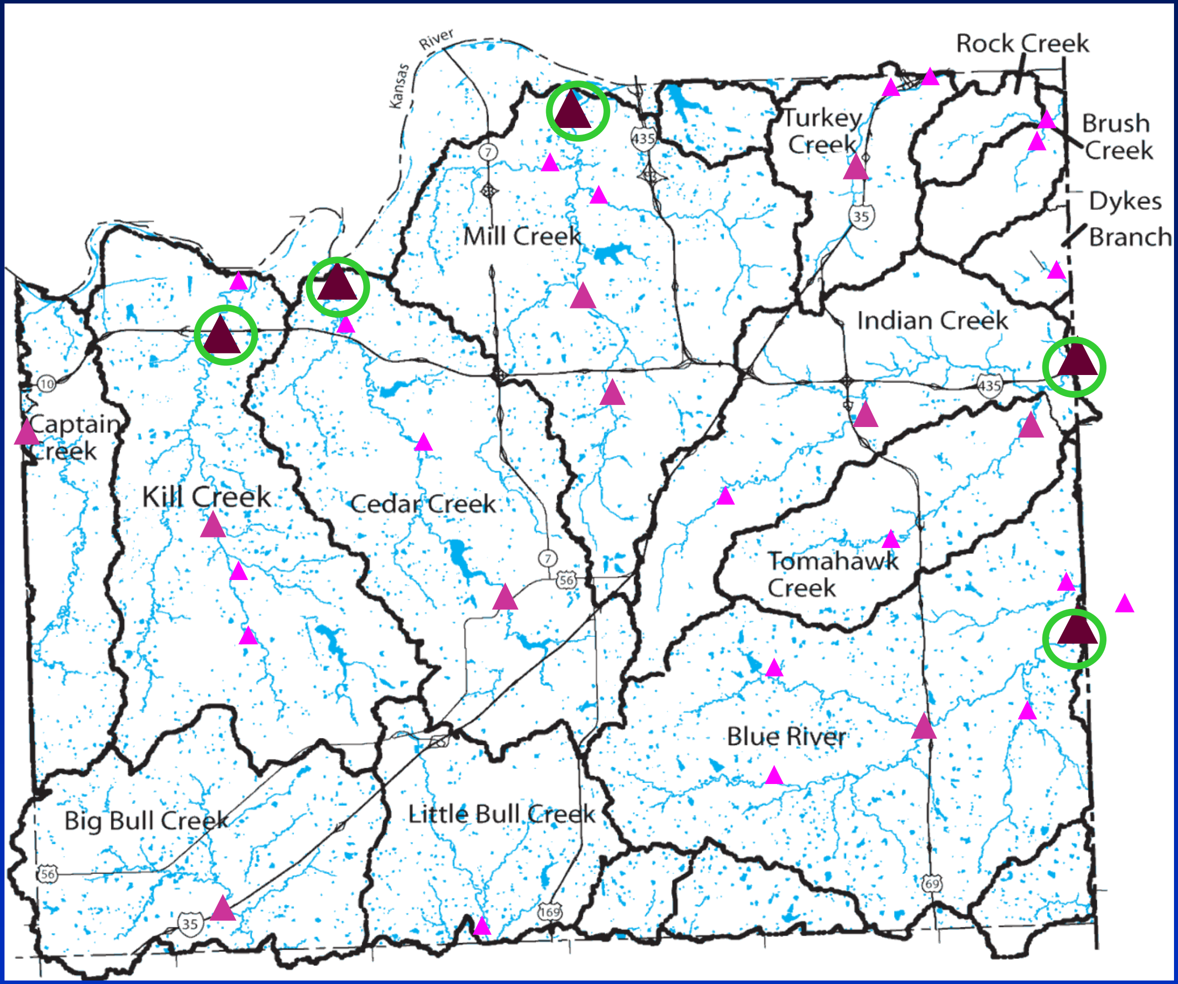
Overall study approach

III. Continuous water-quality monitoring to compute chemical concentrations and loads



Cedar Creek at 83rd St

Monitors installed at downstream site in the 5 largest watersheds, 2002-2007

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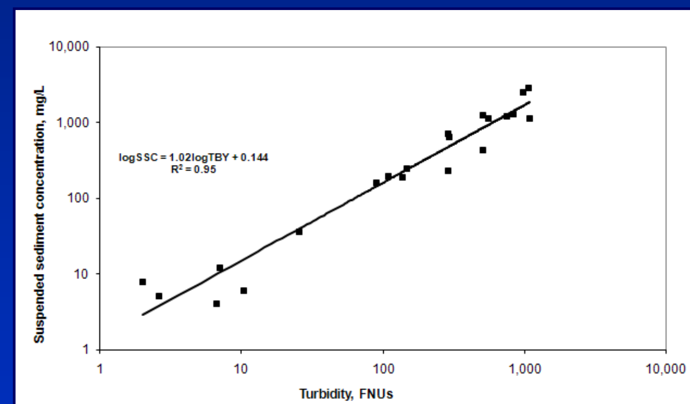
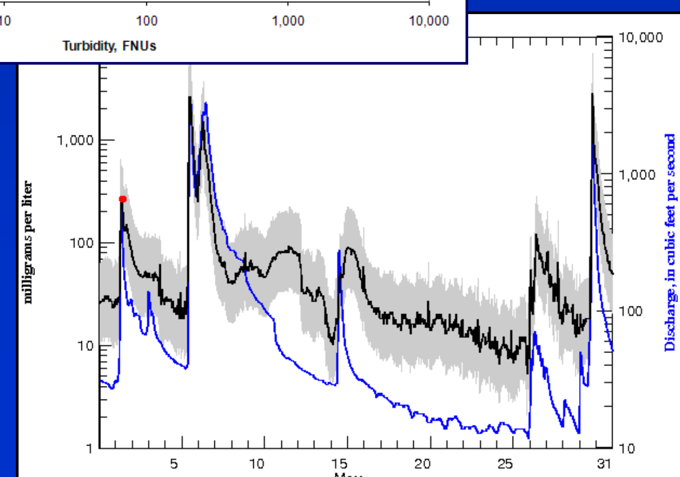
Continuous water-quality monitoring

1. Continuously measure in-stream Q, SC, pH, temp, turbidity, and DO
2. Collect discrete water samples throughout range of conditions and analyze for sediment, nutrients, bacteria, major ions
3. Develop regression models for sediment, nutrients, bacteria, major ions
4. Provide continuous concentrations and loads based on in-stream sensor measurements and regression models





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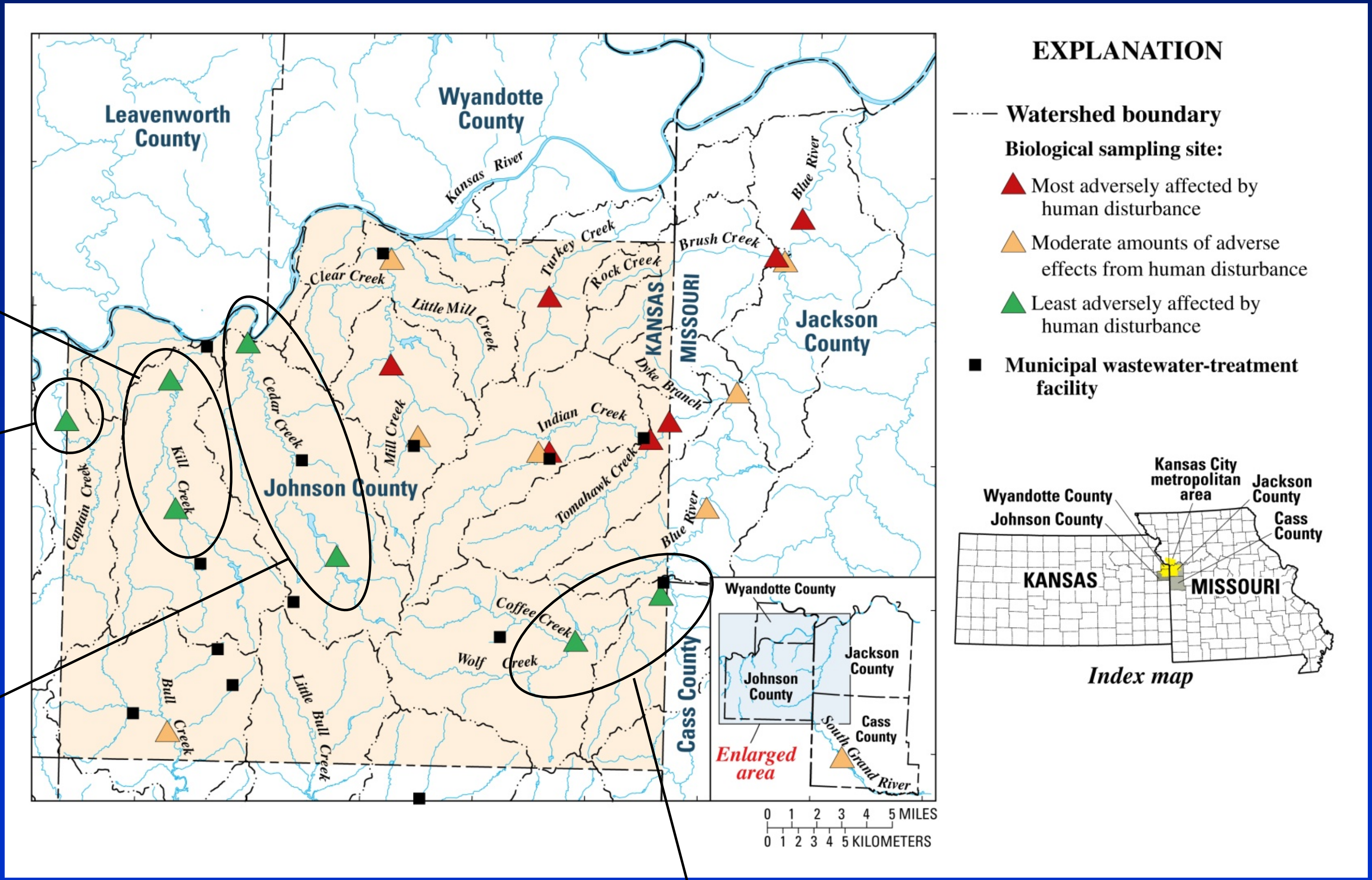
Biological conditions

Rural sites consistently scored among those least affected by human disturbance.

Kill Creek sites

Captain Creek

Cedar Creek sites



Upstream Blue River sites

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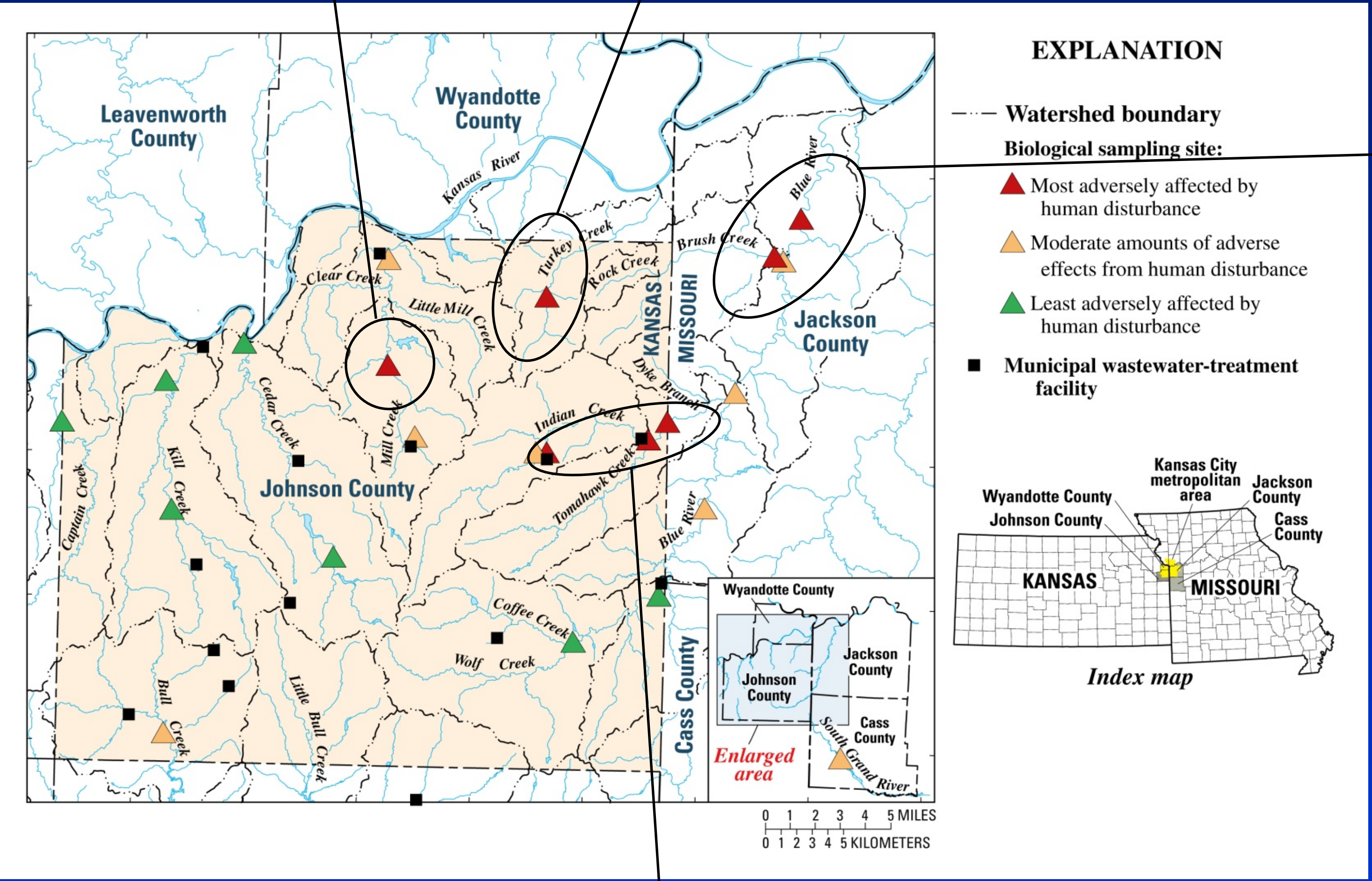
Biological conditions

Sites downstream from urban areas and wastewater facilities consistently scored among those most impacted.

Mill Creek at 87th

Turkey Creek

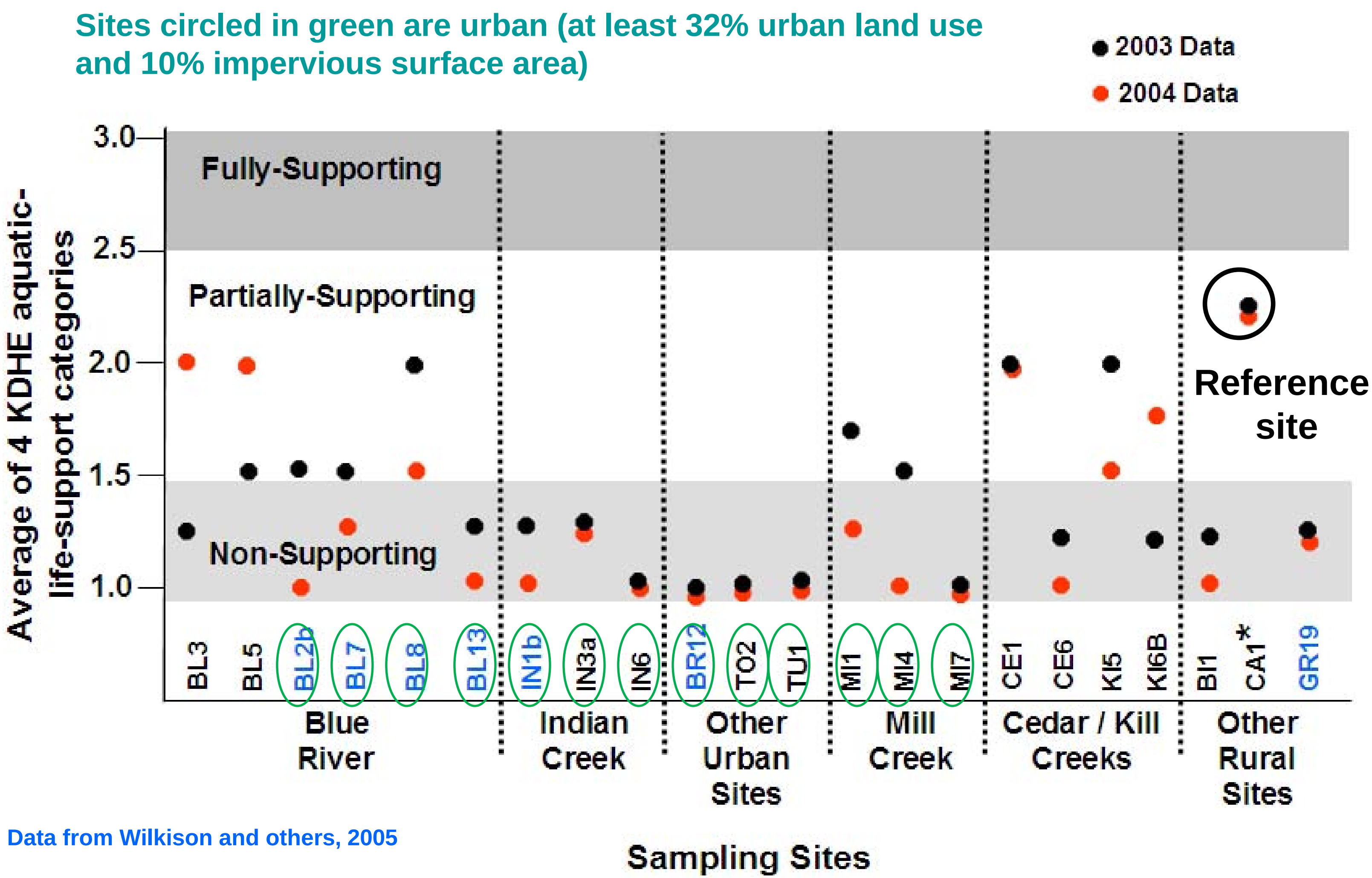


Downstream Blue River sites

Indian and Tomahawk Creek sites

Biological conditions

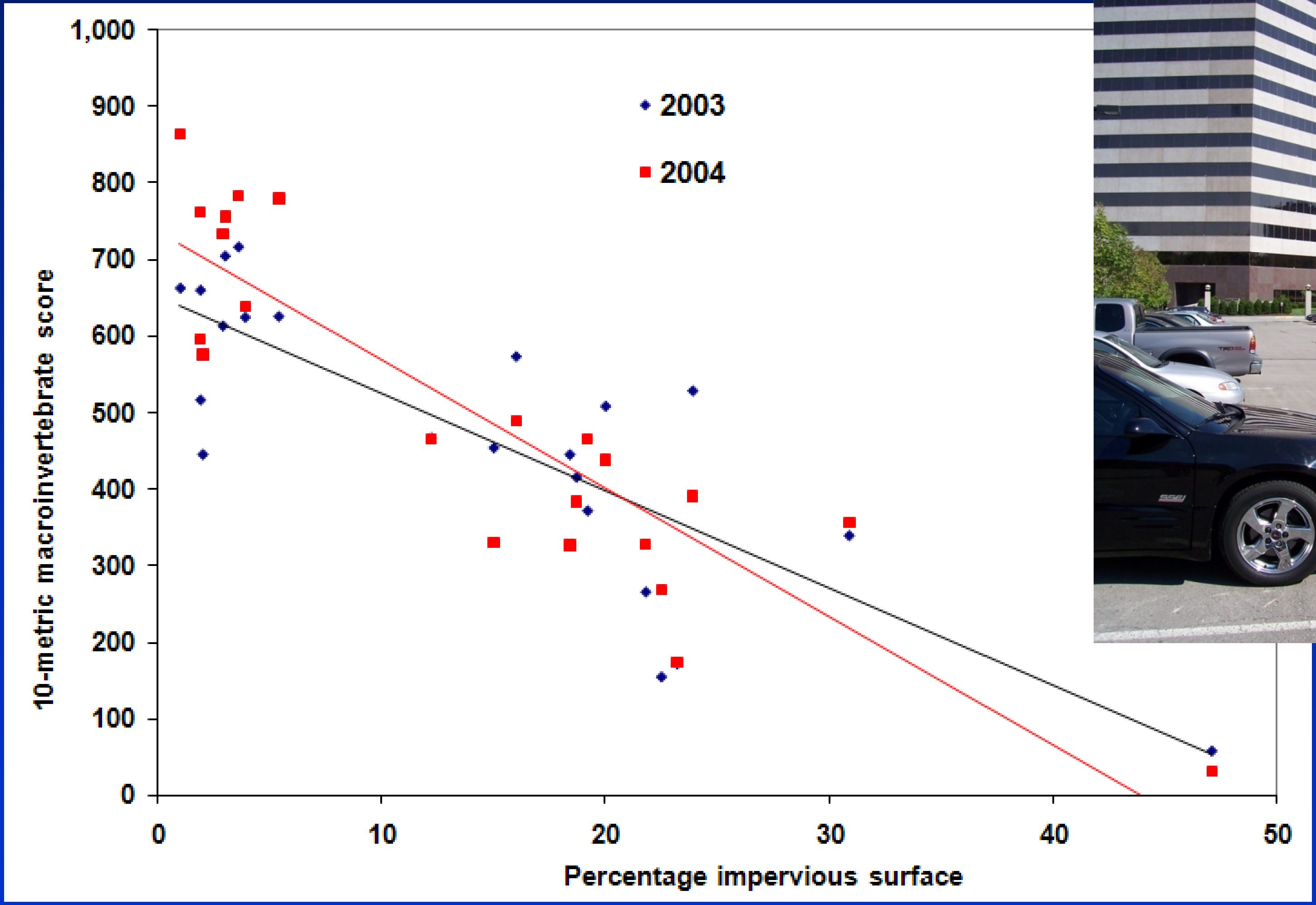
No sites, including the reference site, met State criteria for full support of aquatic life.



Data from Wilkison and others, 2005

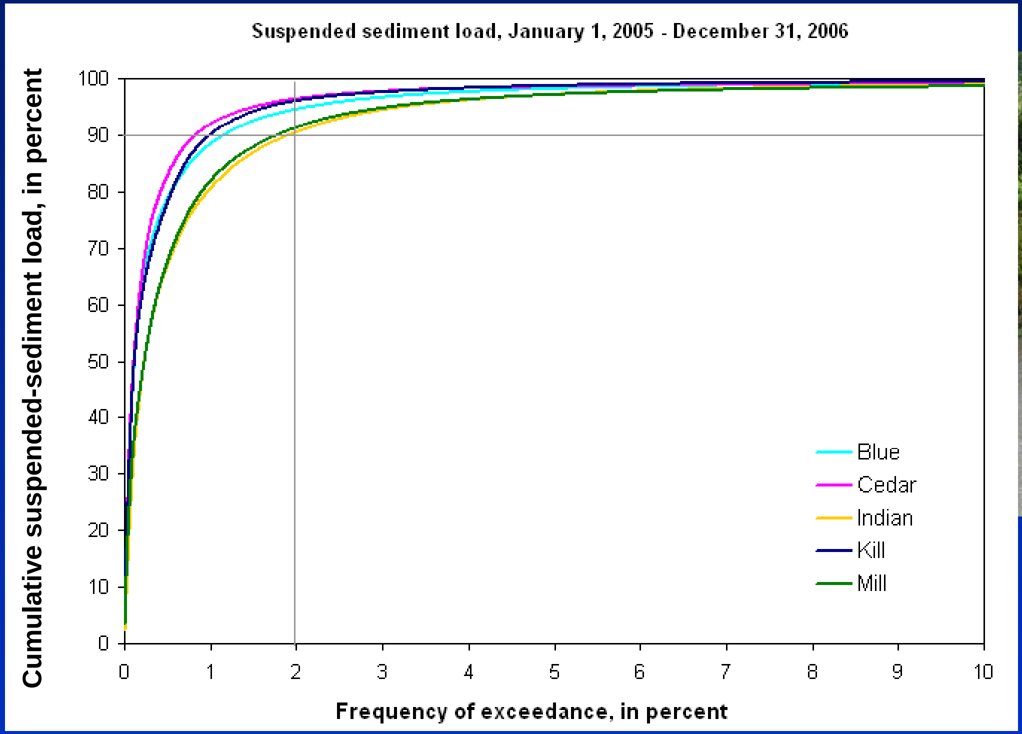
Biological conditions

Generally, as urban land use (percent impervious surface and wastewater) upstream from the sampling sites increased, biological quality decreased.



Suspended sediment

In 2005-06, 90% or more of the total suspended sediment load occurred in less than 2 percent of the time (during large streamflows) at all 5 sites.



- Continuous monitoring measures extreme hydrologic events when most loading occurs.
- Management practices that reduce sediment loads also should decrease sediment-associated constituents such as nutrients and bacteria.

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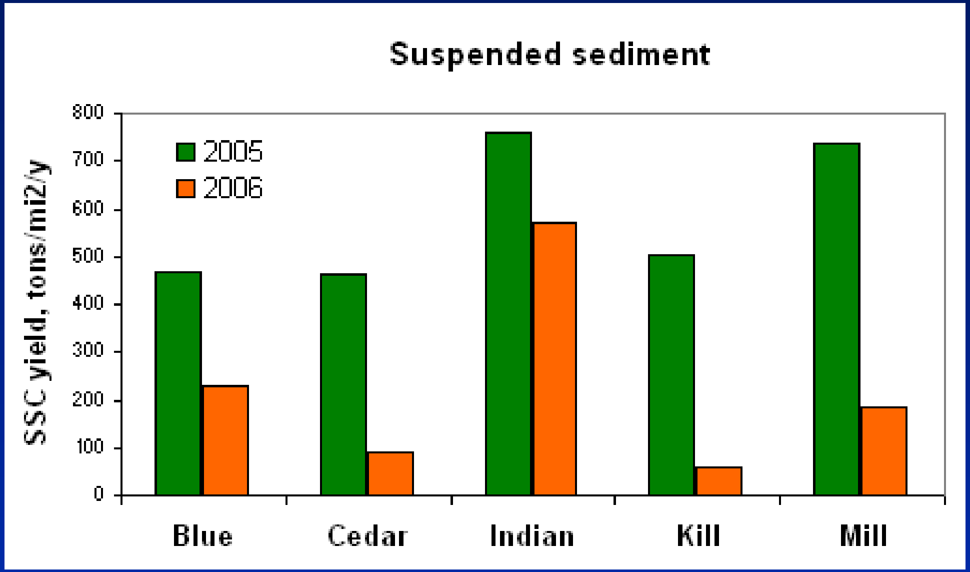
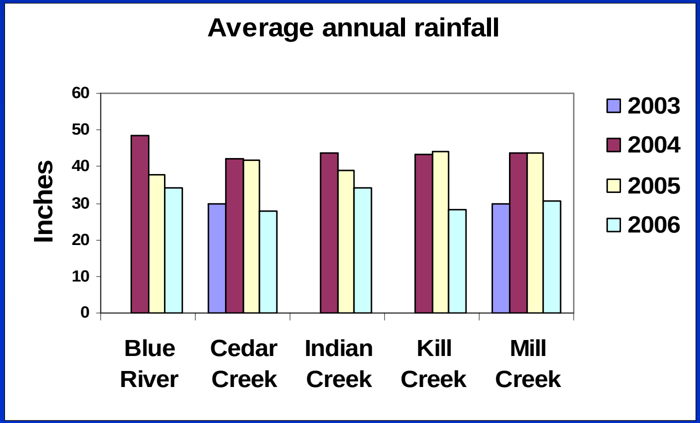
Suspended sediment

Annual sediment yields were larger in 2005 than 2006 because of larger streamflow.

The differences were much larger at the least urban site (Kill, 5 times larger) than the most urban site (Indian, 25% larger).

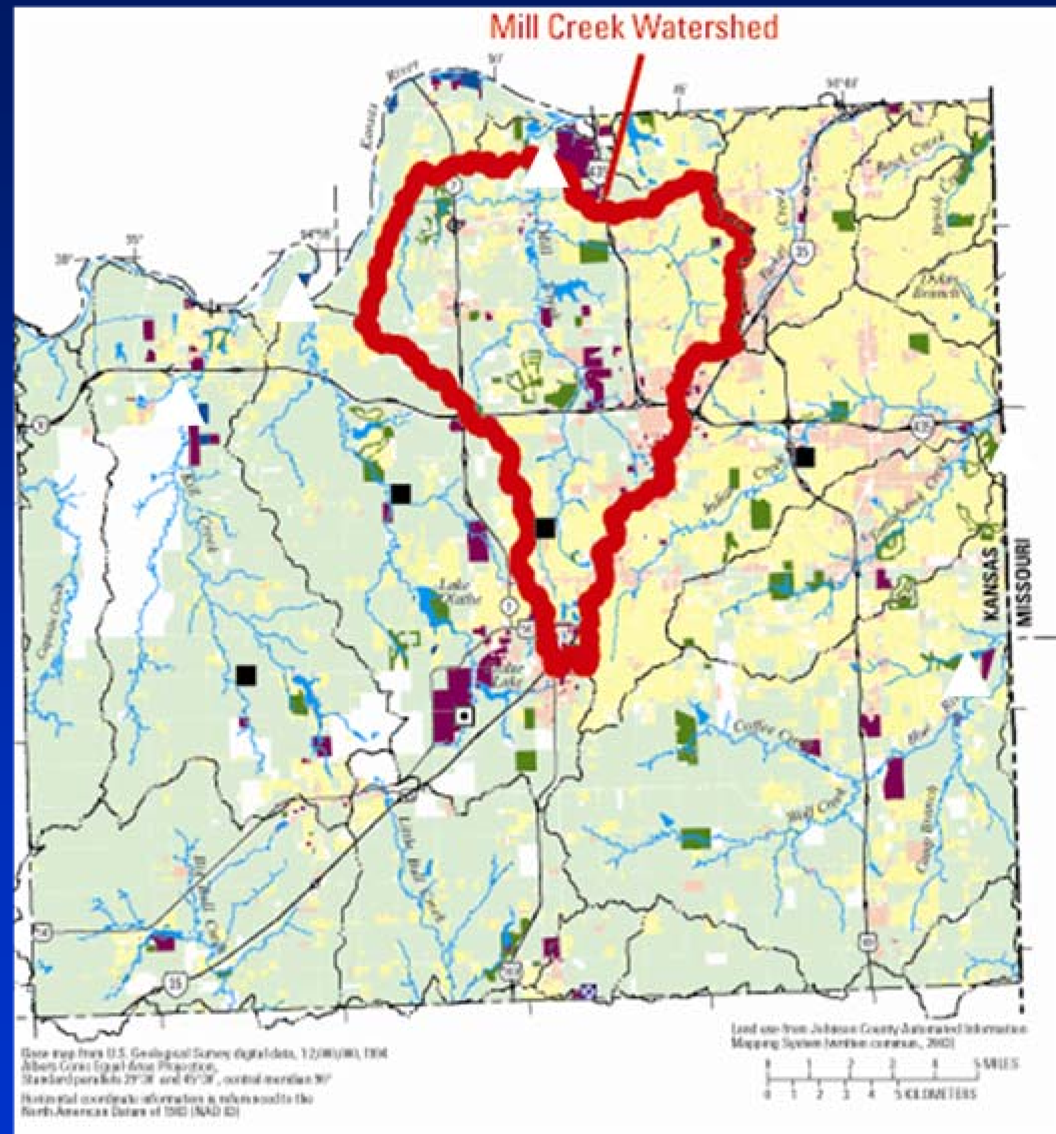


Average rainfall in 2005 was about 30% larger than in 2006.



Suspended sediment

- Largest sediment yields in urbanizing areas in the west and central portions of the basin
- Smaller yields in urbanized portions to the east
- Smaller yields at impounded watersheds
- Generally smaller yields downstream



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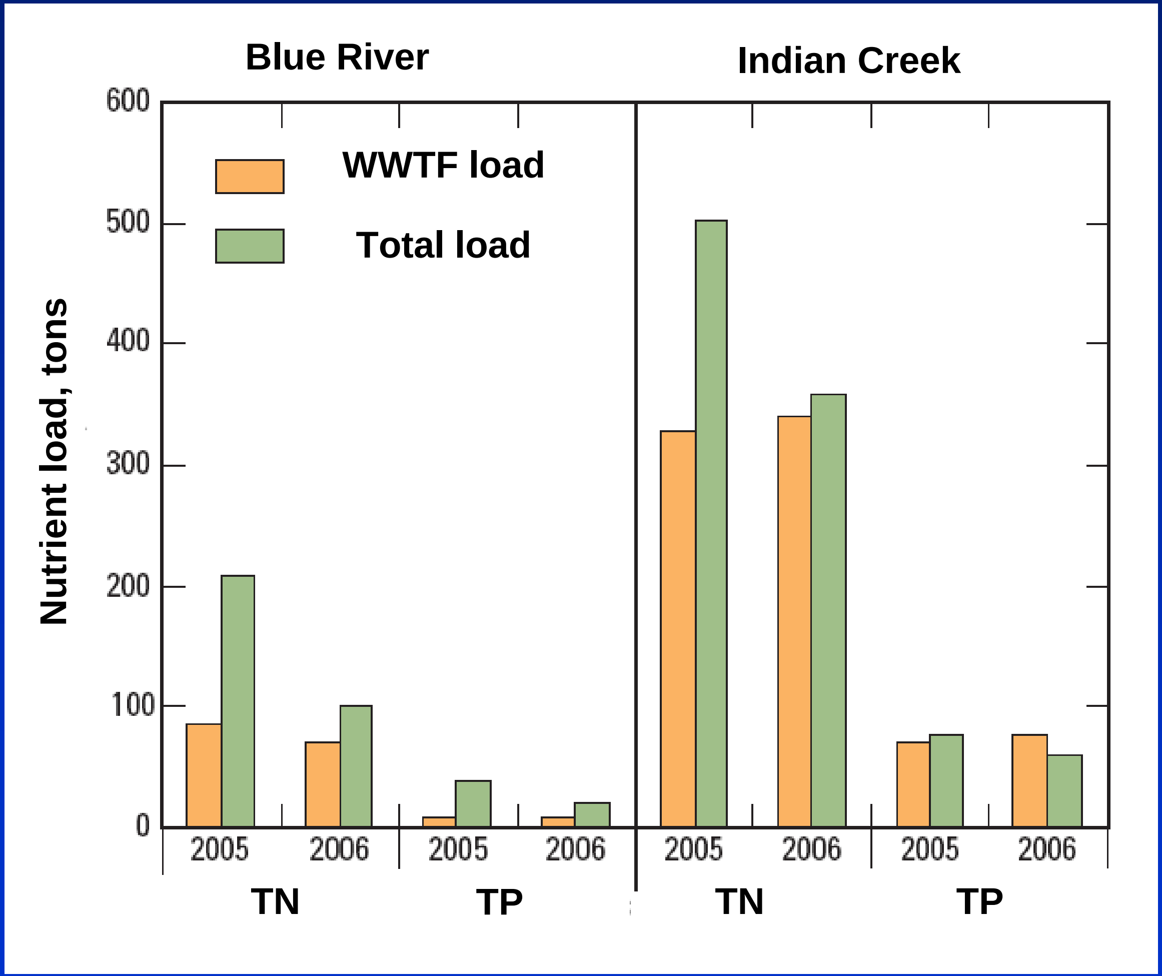
Nutrients

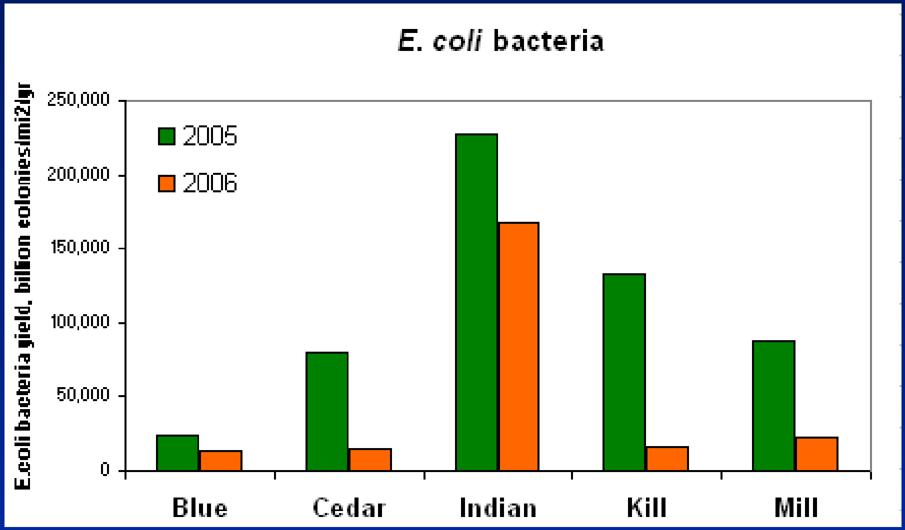
At least one-third of the annual nitrogen load and less than one-third of the annual phosphorus load in the Blue River originated from wastewater. At least two-thirds of the nutrient load in Indian Creek originated from wastewater.

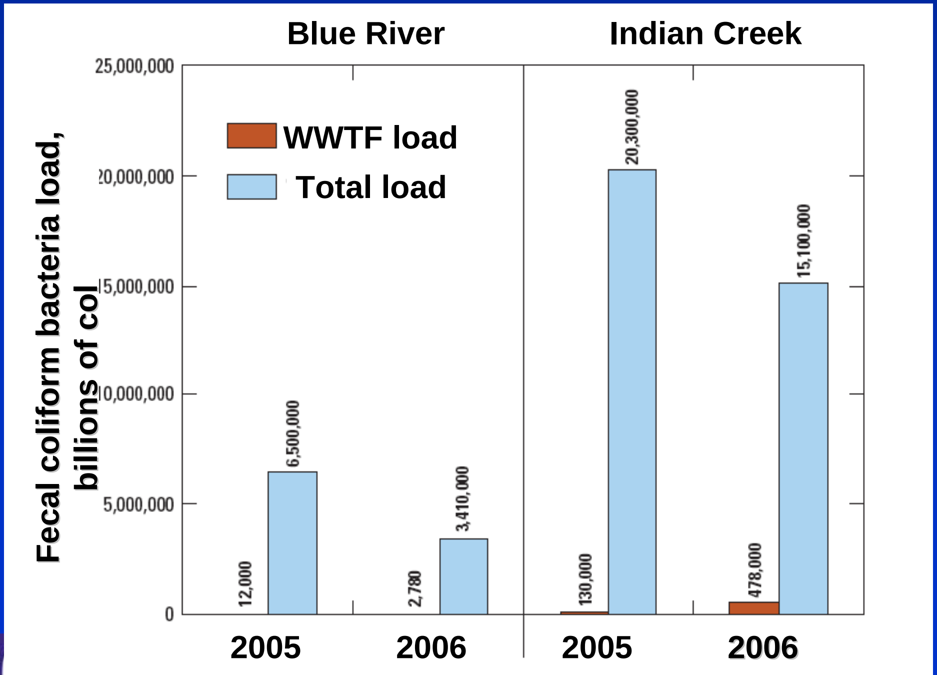


Bacteria

Bacteria originated primarily from stormwater runoff.

Annual bacteria yields were largest at the most urban site.

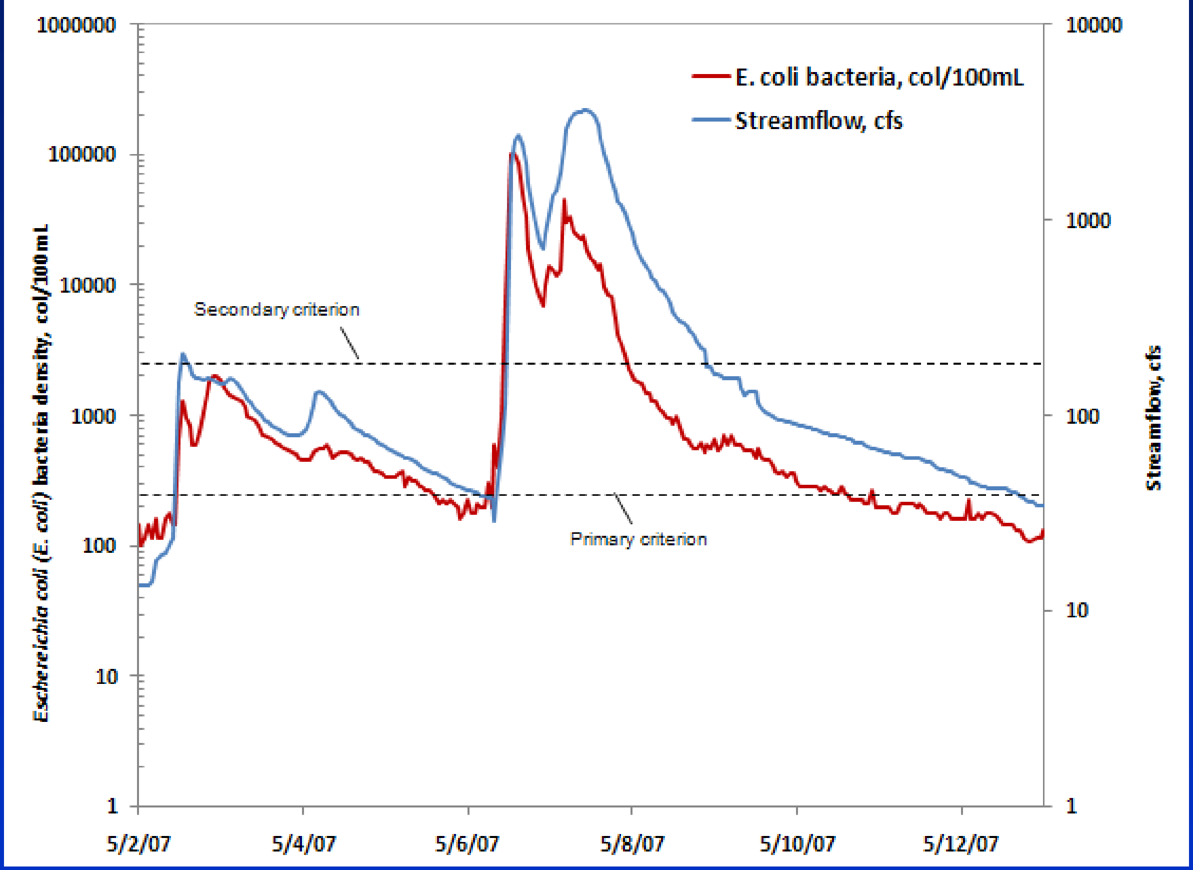




At least 97 percent of the annual fecal coliform bacteria load in the Blue River and Indian Creek in 2005 and 2006 originated from stormwater runoff.

Bacteria

Conditions change rapidly during storm runoff.



For example, *E. coli* increased from 180 to 100,000 col/100 mL during a 12-hour period in May 2007.

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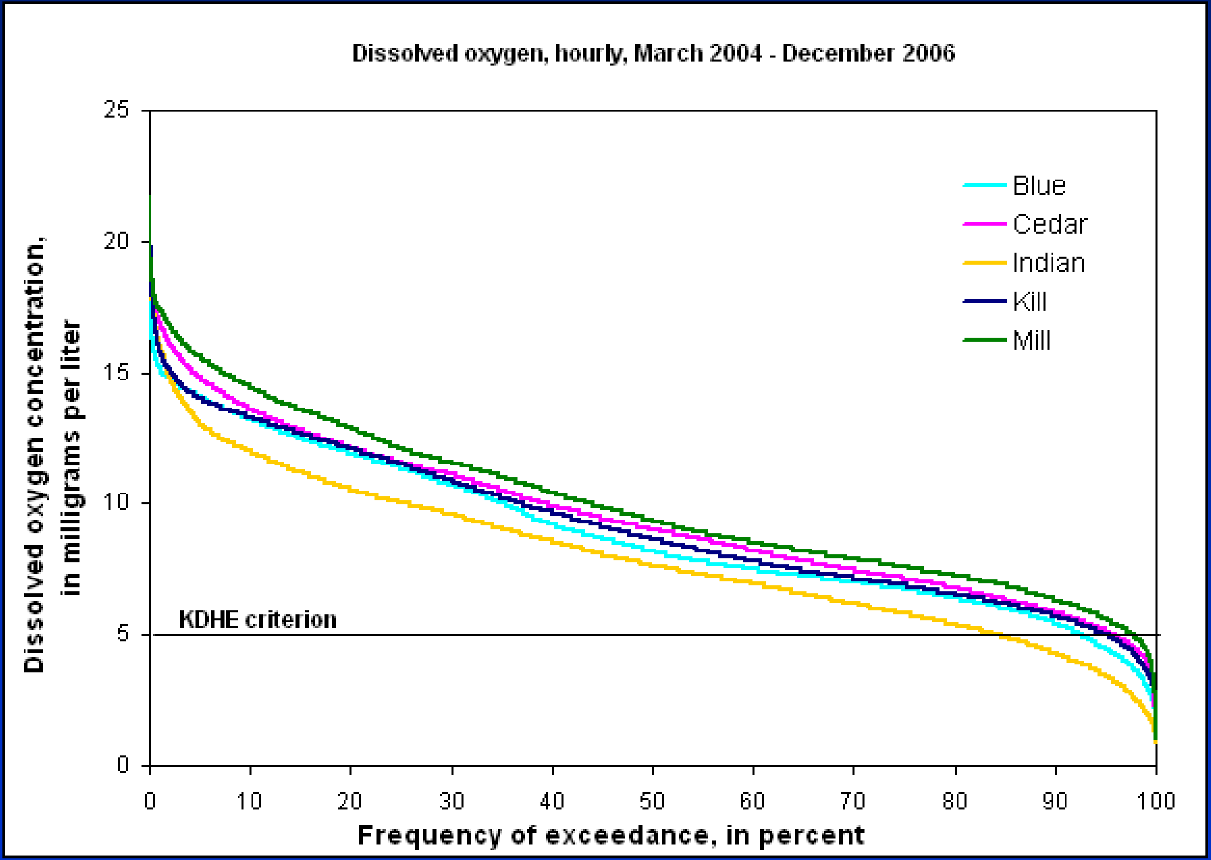
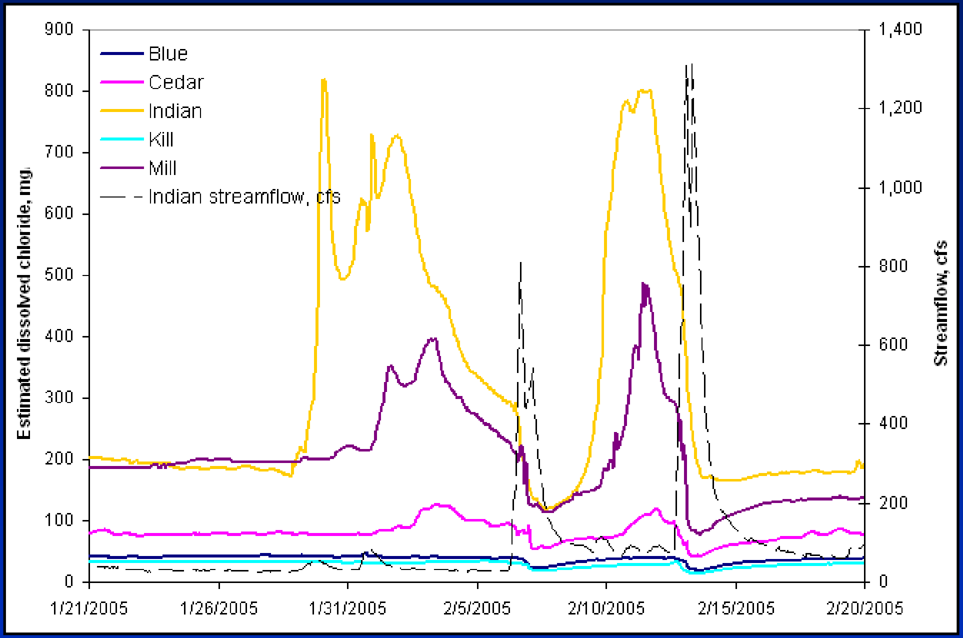
Dissolved oxygen

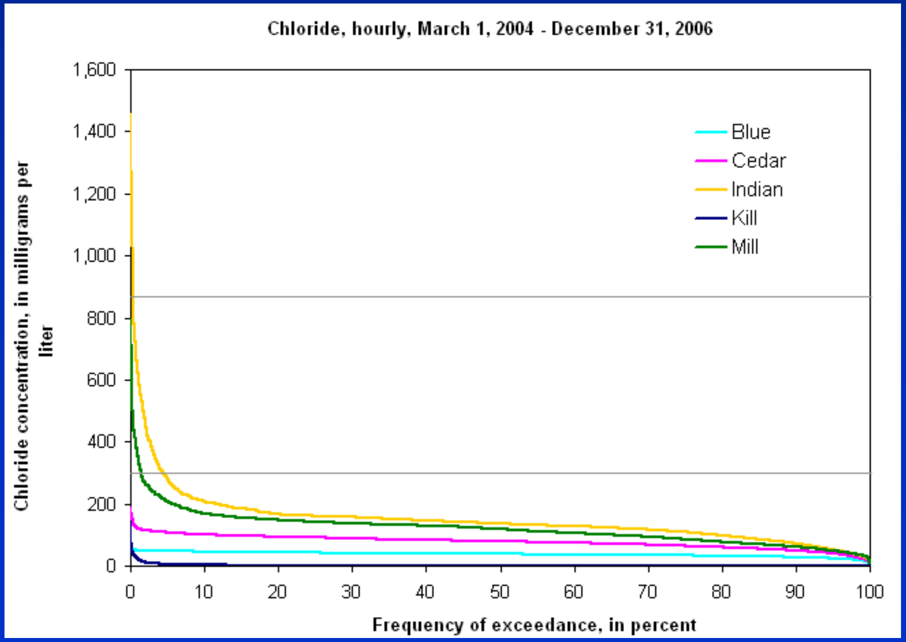
DO was less than State criterion less than 5% of the time at all sites except Blue (8%) and Indian (15%).



Chloride

About 10% of the time during 2005-06, chloride concentrations in Indian and Mill Creeks were affected by runoff from road salt application.





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Organic compounds - pesticides

Atrazine was detected in nearly all water samples, including base flow samples, and had the largest concentrations of all pesticides analyzed. Less than 5% of the atrazine samples collected exceeded 3 µg/L (aquatic life criterion).

During baseflow, urban sites had the largest number of pesticides detected and rural sites had the largest concentrations.

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Organic compounds - wastewater compounds and pharmaceuticals

The largest concentrations of wastewater compounds and pharmaceuticals were in urban areas and downstream from wastewater treatment facilities.

Some wastewater compounds originated from nonpoint sources.

More than half of the total concentrations in 80% of baseflow samples were comprised of:

- AHTN – musk fragrance
- caffeine
- DEET
- nonylphenol diethoxylate – surfactant
- tris(2-butoxyethyl) phosphate – flame retardant and plasticizer

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Current monitoring activities in Johnson County

1. Biological monitoring every 2 years (last sampled in March 2007)

   - Macroinvertebrates, habitat, water, and sediment samples at 20 sites

   - Periphyton (algae) at 10 sites

2. Continuous water-quality monitor operation at Blue, Indian, and Mill sites and display estimated data on web
3. Mill Creek watershed sediment sources study
4. Monitoring upstream and downstream from wastewater treatment plants – Blue River, Indian Creek

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Continuous Monitoring of Water Quality in the Kansas River, 1999-2005

- Compute concentrations, loads, and yields for nutrients, suspended sediment, and indicator bacteria

- Describe differences relative to changing hydrologic and seasonal conditions

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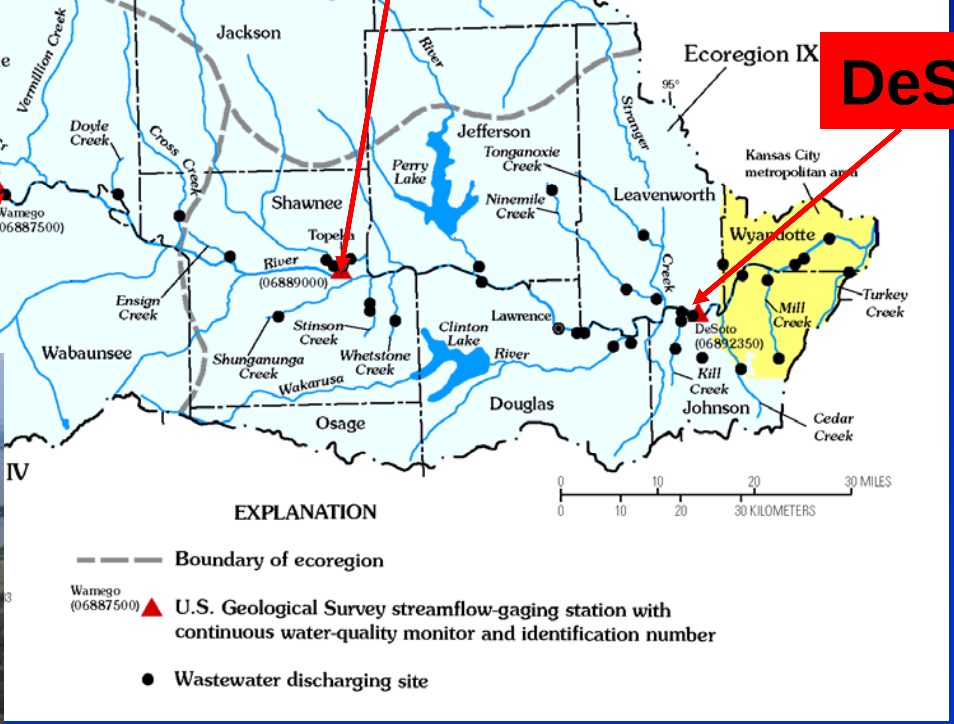
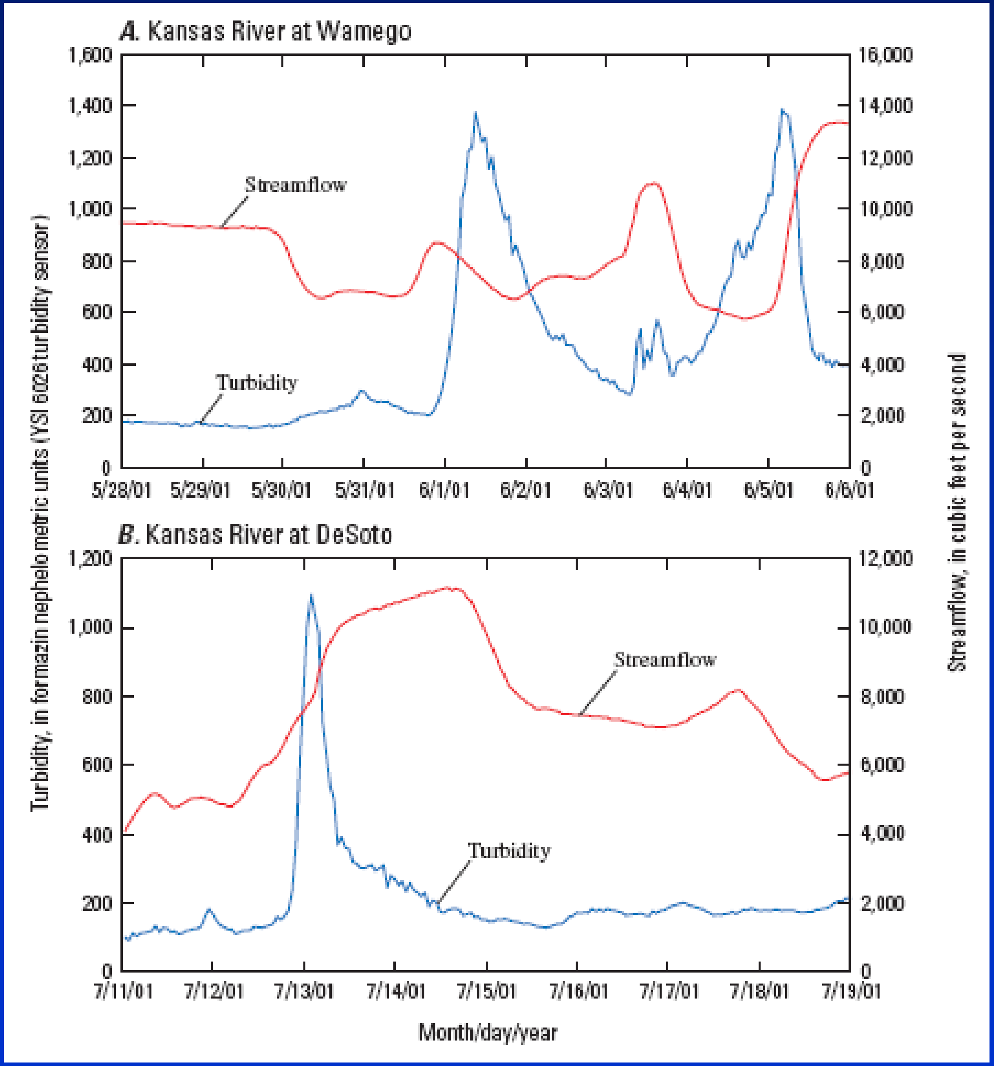
Study area – Kansas River Basin



Fluctuations in streamflow did not necessarily coincide with fluctuations in water quality.



Sediment-associated loads in the Kansas River were affected primarily by non-point sources during storm runoff.

During the 10% of the time generally corresponding with high runoff conditions,

- 63% of the annual suspended sediment load occurred,
- 40% of the annual nutrient load occurred, and
- 83% of the annual *E.Coli* bacteria load occurred.

About 11% of the total nitrogen load and 12% of the total phosphorus load at DeSoto originated from wastewater treatment facilities.

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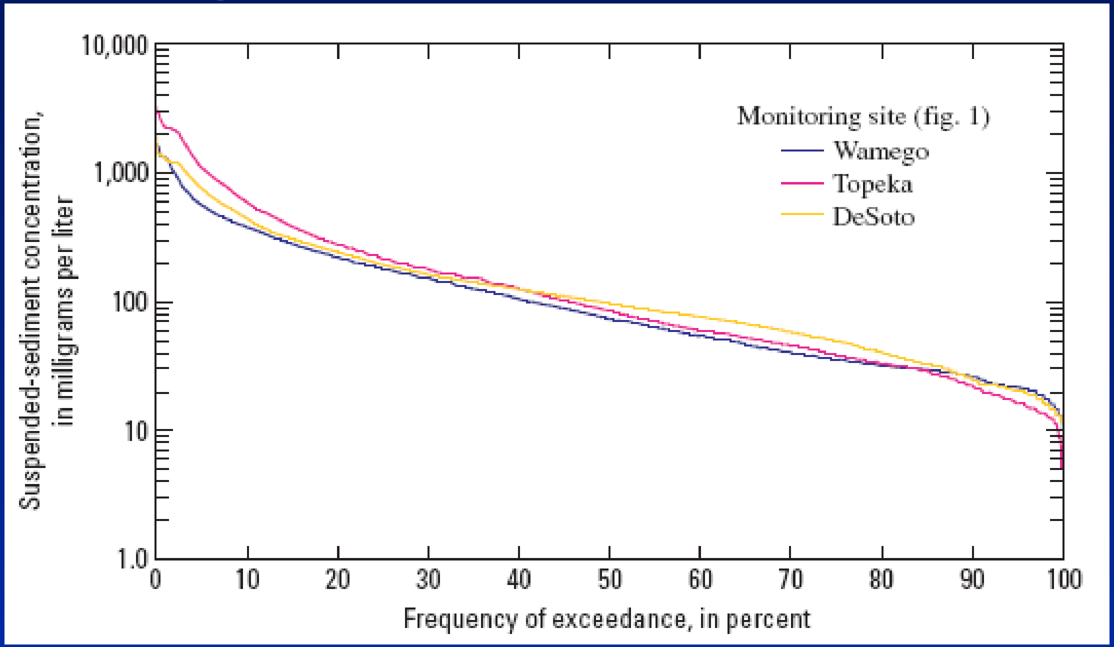
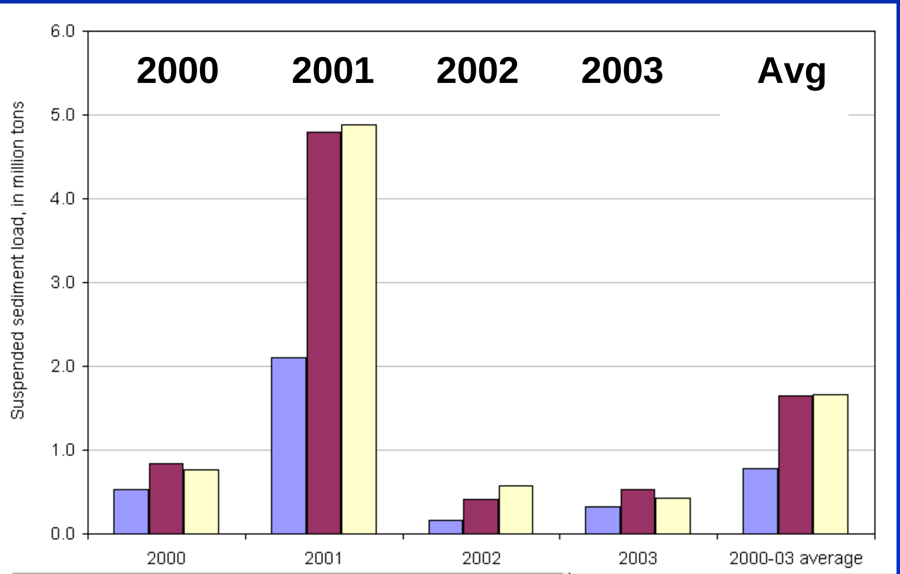
The largest suspended sediment concentrations and yields occurred at Topeka.

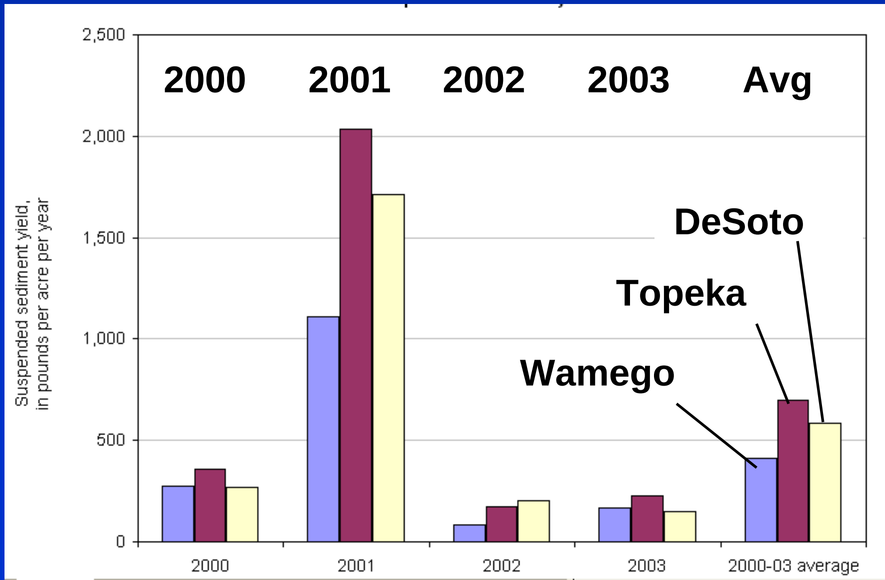
Suspended sediment concentration, 2000-03



Annual load



Annual yield



About 17% of the sand removed by commercial dredging in 2003 was transported in the water column.

- About 216,000 tons of sand were transported annually in the water column at DeSoto during 2000-03.
- About 1.4 million tons of material (90-95% sand) were removed by commercial dredging in 2003
- Quantity of bedload transport is unknown

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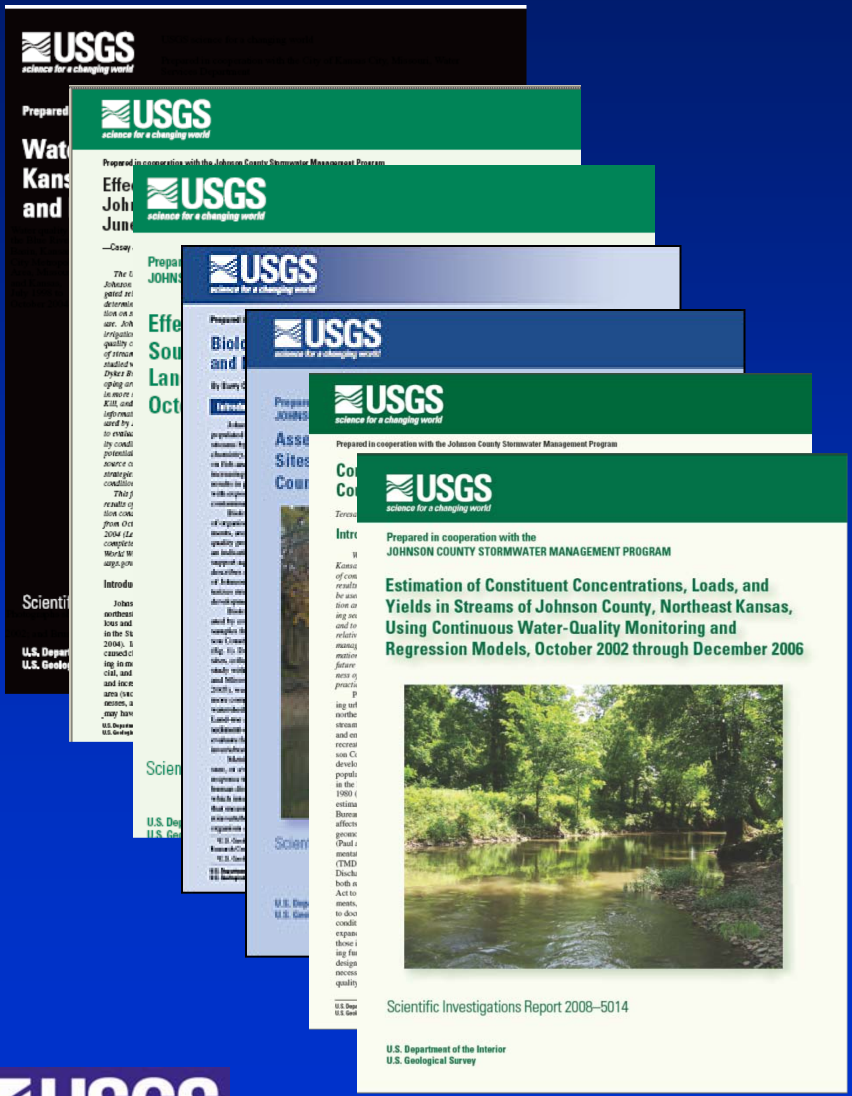
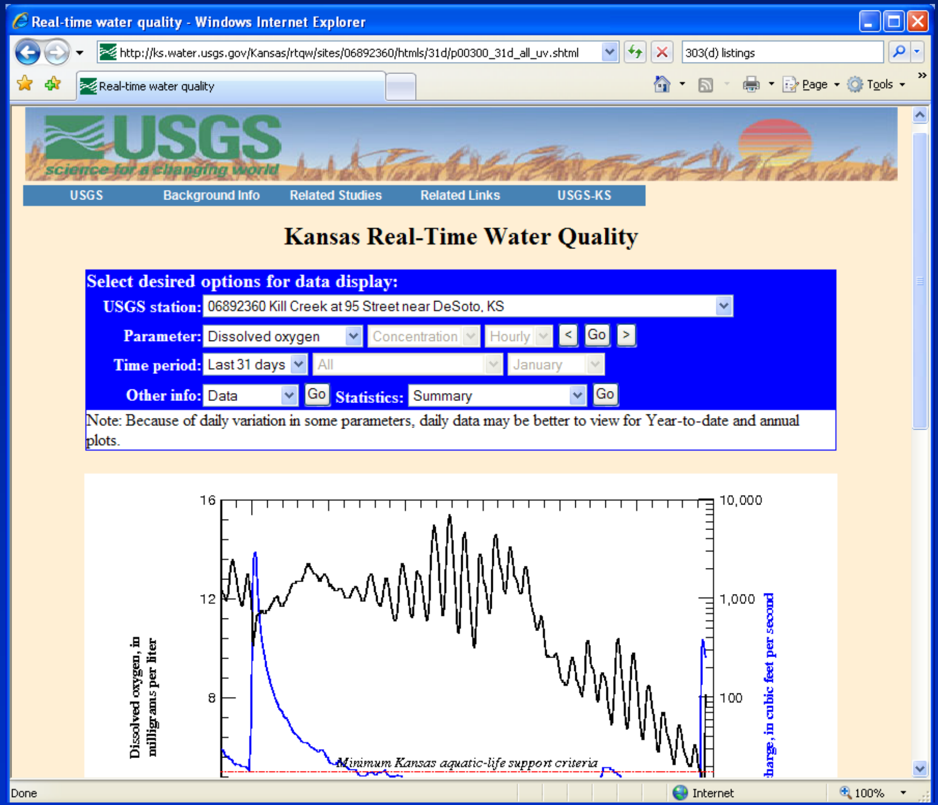
For more information

http://ks.water.usgs.gov/Kansas/studies/qw/joco

http://ks.water.usgs.gov/Kansas/rtqw/





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