Multiple-Source Tracking
Investigating Sources of Pathogens, Nutrients, and Sediment in the South Fork Little River Basin, KY

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Outline of Talk

- Introduction
- Study Purpose, Scope, and Objectives
- The What’s and Why’s of...
  - Microbial-Source Tracking?
  - Sediment Fingerprinting?
  - Stable Isotopes?
- Study Approach
- Partnerships
Why a Water-Quality Study in this Basin?

- KDOV 303 (d) List of Impaired Waters

<table>
<thead>
<tr>
<th>Cause of Impairment</th>
<th>Cause of Impairment Group</th>
<th>Designated Use(s)</th>
<th>State TMDL Development Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fecal Coliform</td>
<td>Pathogens</td>
<td>Primary Contact Recreation Water</td>
<td>Completed (2009)</td>
</tr>
<tr>
<td>Nutrient/Eutrophication Biological Indicators</td>
<td>Nutrients</td>
<td>Warm Water Aquatic Habitat</td>
<td>TMDL needed</td>
</tr>
<tr>
<td>Other Cause</td>
<td>Other Cause</td>
<td>Warm Water Aquatic Habitat</td>
<td>TMDL needed</td>
</tr>
<tr>
<td>Sedimentation/Siltation</td>
<td>Sediment</td>
<td>Warm Water Aquatic Habitat</td>
<td>TMDL needed</td>
</tr>
</tbody>
</table>

- Concerns from basin stakeholders about the approved pathogen TMDL

- Encouragement from KDOV to basin stakeholders to develop a Watershed Plan
  - Contributing sources need to be identified and quantified to explore restoration options

- Involvement by basin stakeholders
  - Formed Little River WQ Consortium
WATER QUALITY

Physical Issues
Sediment, turbidity

Chemical Issues
Nutrients
- NH₃
- TKN
- NO₃
- TP
- orthoP

Biological Issues
Pathogens
(E. coli)

SF Little River @ Ft. Campbell Blvd
Scope and Objectives

Three-year study with **two years** of water-quality sampling

- Apply a multiple-source tracking approach to identify various source(s) of pathogens, nitrogen, and sediment
  - Microbial-source tracking for pathogen sources
  - Stable isotopes for characterizing nitrogen sources
  - Various tracers for potential sources of fine-grained suspended sediment

- **Study benefit:** Help guide placement of effective best management practices in the basin
WHAT IS MICROBIAL-SOURCE TRACKING (MST)?

• A technique used in diagnosing the sources of fecal contamination in water

Match microbes from a polluted site and an animal source to suggest the origin of the fecal pollution

USGS
WHY MICROBIAL-SOURCE TRACKING?

- SF Little River listed as impaired for Primary Contact Recreation use due to pathogens
- Remediation requires knowing the ‘source’ of the problem
- Science-based procedures are needed to assist in source identification
What are stable isotopes?

- **Isotope**: Elements with the same number of protons but varying numbers of neutrons.

- **Stable isotopes**
  - Not radioactive
  - Decay rate VERY slow
  - Same chemical properties but don’t have the same atomic mass
Why stable isotopes?

- Many different sources of nutrients have distinctive isotope ratios.
- Many different processes (e.g., denitrification, nitrification) change the isotope ratio of the reactants and products.
- In other words, different sources of nitrate often have distinctive isotope “fingerprints” that can provide a better understanding of the system than just chemical data alone.
What is Sediment-Source Fingerprinting?

Concept: Characterize potential fine-grained sediment sources in a watershed using a number of diagnostic physical and chemical properties (tracers)

Sediment Properties

- C
- O
- M
- P
- A
- R
- E

Source A
Source B
Source C
Source D
# Why Sediment Fingerprinting?

Leading Pollutants Impairing Assessed Rivers and Streams in Kentucky in 2010

<table>
<thead>
<tr>
<th>Cause of Impairment Group Name</th>
<th>Number of Causes of Impairment Reported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sediment</td>
<td>661</td>
</tr>
<tr>
<td>Nutrients</td>
<td>433</td>
</tr>
<tr>
<td>Pathogens</td>
<td>414</td>
</tr>
<tr>
<td>Salinity/Total Dissolved Solids/Chlorides/Sulfates</td>
<td>371</td>
</tr>
<tr>
<td>Organic Enrichment/Oxygen Depletion</td>
<td>223</td>
</tr>
<tr>
<td>Cause Unknown</td>
<td>170</td>
</tr>
<tr>
<td>Turbidity</td>
<td>99</td>
</tr>
</tbody>
</table>

[http://ofmpub.epa.gov/waters10/attains_index.control](http://ofmpub.epa.gov/waters10/attains_index.control)
Approach

1. Field data collection

2. Investigate nutrient (nitrate) sources using stable isotopes

3. Investigate pathogen source(s) using microbial-source tracking

4. Investigate sediment sources using sediment fingerprinting
Approach: Real-time Data

- **Real-time streamflow gages**
  - Three on SF Little River
  - Two on NF Little River
  - One on Little River mainstem near Cadiz

- **Continuous water-quality monitors**
  - Two real-time monitors (water temp., turbidity)
  - Two in-situ monitors (water temp., turbidity)
Approach: Routine water-quality sampling

- Monthly nutrient, stable isotope, and sediment sampling at 19 sites
- Collect water and sediment *E. coli* samples (May-October)
- Field parameters
  - Streamflow
  - Water Temperature
  - pH
  - Dissolved Oxygen
  - Conductance
  - Turbidity
Microbial-Source Tracking

- Collect *E. coli* samples from sampling sites during various hydrologic and seasonal conditions
- Collect fecal reference samples from each potential source group (human, canine, geese, dairy cattle, poultry)
Sediment Fingerprinting

- Collect sediment source samples from identified source areas (i.e. agriculture, forest) and from stream banks and bed
- Collect fine sediment samples from select stream sampling sites using passive samplers
- Samples analyzed for trace elements, carbon and nitrogen isotopes, and specific radionuclides (cesium, lead, etc.)

Passive sediment sampler
Why source-tracking studies?

- Tell us things about water resources that we didn’t know before
- Tell us things about water resources that contradict what we thought we knew before
- Increase the likelihood that any proposed remediation plans will be effective—because the correct source was identified
Partnerships

Little River Water-Quality Consortium

County Agriculture Development Boards
- Christian
- Trigg
- Todd

And many others
Thank You