Investigating sources of bacterial contamination in Boise Creek

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The Problem:

- Washington water quality standards limit fecal coliform bacteria
  - geometric mean 100 cfu×100mL⁻¹
  - and no more than 10% > 200 cfu×100mL⁻¹
- Boise Creek is the biggest contributor of FC to the entire Puyallup TMDL study area
- 92% reduction - dry season (July-October)
- 67% reduction - wet season (November-June)
Are brown trout native to Boise Creek?
The Challenge

• WQ standard *DOES NOT* inform problem resolution
  – FC exist in the gut of warm blooded animals
  – High numbers can warn of dangerous conditions
• Find an approach that *DOES* inform a resolution
  – Spatial and temporal sampling
  – Organisms that discriminate between human and animal sources
2011 Biological parameters

- Fecal coliform bacteria
- *E. coli*
- *Bacteroides spp.*
- *Rhodococcus coprophillius*
- *Bifidobacteria spp.*
FC and E. coli Results by sampling site and period
Comparing FC to E.coli
# 2011 Boise MST Hits

<table>
<thead>
<tr>
<th>Site</th>
<th>Rhodo</th>
<th>Bifido</th>
<th>Fecals</th>
<th>E.Coli</th>
<th>Bacteroides</th>
<th>Rhodo</th>
<th>Fecals</th>
<th>E.Coli</th>
<th>Bacteroides</th>
<th>Bifido</th>
<th>Fecals</th>
<th>E.Coli</th>
<th>Bacteroides</th>
</tr>
</thead>
</table>
| 1    |       | 30     |        |        |            |       | 550    | 1300   |            |        | 440    | 750    | 841        | 1        
| 2    |       |        | 679    |        |            | 475   | 280    | 740    | 457        | 5      | 470    | 480    | 1208       |  
| 3    | 5     | 90     |        |        |            | 679   | 1600   | 2200   | 1086       | 5      | 800    | 960    | 2888       |  
| 4    | 110   | 2049   |        | 550    | 770    987 | 560   | 680    | 5005   |            | 5      | 670    | 1000   | 7820       |  
| 5    |       |        | 110    | 2049   |        | 679   | 560    | 680    | 5005       | 5      | 670    | 1000   | 7820       |  
| 6    |       |        | 110    | 2049   |        | 679   | 560    | 680    | 5005       | 5      | 670    | 1000   | 7820       |  
| 7    |       |        | 110    | 2049   |        | 679   | 560    | 680    | 5005       | 5      | 670    | 1000   | 7820       |  
| 8    |       |        | 110    | 2049   |        | 679   | 560    | 680    | 5005       | 5      | 670    | 1000   | 7820       |  
| 9    |       |        | 110    | 2049   |        | 679   | 560    | 680    | 5005       | 5      | 670    | 1000   | 7820       |  
| 10   |       |        | 110    | 2049   |        | 679   | 560    | 680    | 5005       | 5      | 670    | 1000   | 7820       |  
| 11   |       |        | 110    | 2049   |        | 679   | 560    | 680    | 5005       | 5      | 670    | 1000   | 7820       |  
| 12   |       |        | 110    | 2049   |        | 679   | 560    | 680    | 5005       | 5      | 670    | 1000   | 7820       |  

**14-Apr** | **17-Jun** | **13-Jul** | **5-Oct**
2012 – What did we learn from last year?

• Expanded sampling site distribution
  – Needed to find baseline values

• Changed temporal nature of sampling
  – 3 straight days sampled in the morning and in the afternoon

• Employed some new / adapted methods
  – Molecular methods for human-specific Bacteroides
  – Found a marker for Ruminant Bacteroidales (RB)
  – Molecular method for Rhodococcus
2012 Biological parameters

- Fecal coliform bacteria
- *E. coli*
- *Bacteroides spp.*
- *Ruminant Bacteroidales* (RB)
- *Rhodococcus coprophillus*
- *Bifidobacteria spp.*
Escherichia coli
Fecal Coliform
Bacteroides
Escherichia coli
Fecal Coliform
Bacteroides
BSE_7TRIBDITCH

Organisms

CFU

6 Aug AM  6 Aug PM  7 Aug AM  7 Aug PM  8 Aug AM  8 Aug PM

Escherichia coli  Fecal Coliform  Bacteroides
BSE_11TRAILERPKDITCH

- **Organisms**
  - Escherichia coli
  - Fecal Coliform
  - Bacteroides

- **Graph Details**
  - X-axis: 6 Aug AM, 6 Aug PM, 7 Aug AM, 7 Aug PM, 8 Aug AM, 8 Aug PM
  - Y-axis: 10,000, 1,000, 100, 10, 1

- **Map Features**
  - Locations labeled with numbers (1 to 20)
  - Color-coded markers for different organisms
BSE_12ENUMCLAWDITCH

Organisms

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<tr>
<th>CFU</th>
<th>6 Aug AM</th>
<th>6 Aug PM</th>
<th>7 Aug AM</th>
<th>7 Aug PM</th>
<th>8 Aug AM</th>
<th>8 Aug PM</th>
</tr>
</thead>
<tbody>
<tr>
<td>RB</td>
<td>1</td>
<td></td>
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</tbody>
</table>

Escherichia coli  
Fecal Coliform  
Bacteroides
BSE_16_284THAVESE

Organisms

CFU

Escherichia coli  Fecal Coliform  Bacteroides

6 Aug AM  6 Aug PM  7 Aug AM  7 Aug PM  8 Aug AM  8 Aug PM

RB RB RB RB RB
Escherichia coli
Fecal Coliform
Bacteroides
What do we know now?

• Sampling period biased results toward human sources
• We have found some sections of stream with definite sources
  – 15 to 14 (96% increase in average FC conc.)
  – Above 19 (16, 17, 18, 20 all essentially baseline – and all on different tributaries)
  – 11 and 12 (13 mostly in compliance with State WQ Std.)
  – 1, 2, 6, 7, 8, 9 (all still problems)
What do we know now?

- Still working to understand new molecular approaches.
- Ruminant Bacteroidales results give us more to think about.
  - *When* and *Where* do positive results indicate domestic animals?
  - Elk and deer?
  - How does this inform the spatio-temporal aspects of our sampling?
King County Science,
KC Stormwater Services,
King County Ag,
King Conservation District,
King County DDES (DPER),
Seattle-King County Health Department,
Wash State Ag Landowner