Bacteria Contamination in Urban Water Monitoring using Multiple Analytical Tools

Laura Webb,
Regina Klepikow,
USEPA Region 7
Kansas City, KS
• Urban Stream Network
• Urban Lakes
• Real Time Telemetry Network

KCWATERS.org
EPA Region 7 Water Monitoring Team
Colilert©
Primary Tool for Bacteria Monitoring
Results

Urban Stream Sampling
Shoal Creek E. Coli

Year:
- 2007: 131.111 colonies/100mL
- 2008: 500 colonies/100mL
- 2009: 340 colonies/100mL
- 2010: 358.333 colonies/100mL
- 2011: 166.4 colonies/100mL
Turkey Creek E. Coli

![Graph showing e. Coli (MPN/100mL) from 2007 to 2011.](Image)

- 2007: 6000
- 2008: 5000
- 2009: 4000
- 2010: 3000
- 2011: 1000

- Year

- e. Coli (MPN/100mL)

- Turkey Creek E. Coli
Turkey Site 1

Blue River Site 1
• Caffeine
• ELISA by Abraxis
• Used as indicator of human waste influence

• Personal Care Products and Pharmaceuticals (PPCP)
• New SBSE GC/MS method (Twister©)
• BPA, TCEP, NPs, Coprostanol, Triclosan, Estrogens

New Tools in 2011
### 2011 Urban Streams

<table>
<thead>
<tr>
<th>Caffeine (ug/L)</th>
<th>TN (ug/L)</th>
<th>TP (ug/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.698</td>
<td>0.561</td>
<td>0.523</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>E. coli (MPN/ 100mL)</th>
<th>count of twister detection</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.523</td>
<td>0.849</td>
</tr>
</tbody>
</table>
Caffeine (μg/L)

Sampling site distance from WWTP discharge (m)

- Less than 5000 m: 1.06415
- More than 5000 m: 0.367625
- Upstream: 0.09
Coprostanol

- Formed by the degradation of cholesterol in higher animals and birds (carnivores)
- Used as a biomarker for human feces
- RL = 0.2 µg/L
- Range 0.03 to 0.84
- Found at 2 sites above the RL, the two most influenced by WWTP discharge
- Also found at two highly urbanized sites between RL and MDL
<table>
<thead>
<tr>
<th>Site Name</th>
<th>Positive Caffeine Concentration (µg/L)</th>
<th>PPCP count</th>
<th>E. coli (MPN/100 mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tomahawk 1</td>
<td>0.31</td>
<td>1</td>
<td>65</td>
</tr>
<tr>
<td>Tomahawk 2</td>
<td>0.28</td>
<td>0</td>
<td>126.7</td>
</tr>
<tr>
<td>Indian 3</td>
<td>0.36</td>
<td>2</td>
<td>410.6</td>
</tr>
<tr>
<td>Brush Creek 1</td>
<td>0.39</td>
<td>2</td>
<td>259.5</td>
</tr>
<tr>
<td>Brush Creek 2</td>
<td>0.35</td>
<td>3</td>
<td>435.2</td>
</tr>
<tr>
<td>Brush Creek 3</td>
<td>0.34</td>
<td>1</td>
<td>686.7</td>
</tr>
<tr>
<td>Shoal 1</td>
<td>0.26</td>
<td>1</td>
<td>273.2</td>
</tr>
<tr>
<td>Shoal 2</td>
<td>0.20</td>
<td>1</td>
<td>101.4</td>
</tr>
<tr>
<td>Line Creek 1</td>
<td>0.23</td>
<td>1</td>
<td>272.3</td>
</tr>
<tr>
<td>Jersey 2</td>
<td>0.36</td>
<td>0</td>
<td>613.1</td>
</tr>
<tr>
<td>Jersey 3</td>
<td>0.22</td>
<td>0</td>
<td>14.6</td>
</tr>
</tbody>
</table>

Sites without WWTP discharge
Results

Urban Lake Sampling
One-way ANOVA: E. Coli versus date

Individual 95% CIs For Mean Based on Pooled StDev

<table>
<thead>
<tr>
<th>Level</th>
<th>N</th>
<th>Mean</th>
<th>StDev</th>
</tr>
</thead>
<tbody>
<tr>
<td>06-15-2010</td>
<td>31</td>
<td>1447.9</td>
<td>961.1</td>
</tr>
<tr>
<td>08-25-2010</td>
<td>31</td>
<td>339.2</td>
<td>597.3</td>
</tr>
<tr>
<td>10-12-2010</td>
<td>31</td>
<td>766.2</td>
<td>914.8</td>
</tr>
<tr>
<td>06-01-2011</td>
<td>30</td>
<td>180.7</td>
<td>249.0</td>
</tr>
<tr>
<td>07-13-2011</td>
<td>29</td>
<td>1064.2</td>
<td>986.5</td>
</tr>
<tr>
<td>08-31-2011</td>
<td>29</td>
<td>78.6</td>
<td>131.3</td>
</tr>
</tbody>
</table>

Pooled StDev = 729.2

<table>
<thead>
<tr>
<th>48 Hour Rain Fall</th>
<th>North</th>
<th></th>
<th>East</th>
<th></th>
<th>South</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amount (in)</td>
<td>Hours prior</td>
<td>Amount (in)</td>
<td>Hours prior</td>
<td>Amount (in)</td>
<td>Hours prior</td>
</tr>
<tr>
<td>6/15/10</td>
<td>0.59</td>
<td>24-30</td>
<td>1.8</td>
<td>24-32</td>
<td>4.7</td>
<td>24-32</td>
</tr>
<tr>
<td>8/25/10</td>
<td>0</td>
<td></td>
<td>0</td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>10/12/10</td>
<td>.63</td>
<td>0-24</td>
<td>.47</td>
<td>12-24</td>
<td>.51</td>
<td>0-24</td>
</tr>
<tr>
<td>6/1/11</td>
<td>.16</td>
<td>24</td>
<td>.16</td>
<td>12-24</td>
<td>.08</td>
<td>24</td>
</tr>
<tr>
<td>7/13/11</td>
<td>.83</td>
<td>0-8</td>
<td>.98</td>
<td>6-8</td>
<td>.87</td>
<td>6-8</td>
</tr>
<tr>
<td>8/31/11</td>
<td>.04</td>
<td>18</td>
<td>0</td>
<td></td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
• Until we have a marker for geese...
• Could eliminate human and bovine with PCR – expensive and time consuming
• Could use caffeine ELISA or other chemical indicator
• Could change our PCR approach to do library source matching
Results
Real Time Telemetry Network
Real-Time Site
Good Correlation

$y = 206.72x + 100.57$

$R^2 = 0.8895$
Shoal Creek

\[ y = 70.688x - 1539.9 \]

\[ R^2 = 0.4389 \]

E Coli (MPN/100mL) vs Turbidity (NTU)

Not as good
PCR Results
Microbial Source Tracking
Method

- Collection and Filtering
- Extraction
- PCR Analysis
0 1 2 3 4 5 6 7 8 9
[382x385]10

log10 copies/100mL

Colilert - E.coli Log
qPCR - E.coli Log
qPCR - Entero Log
Human Marker
Next Steps

- Focus on high EC events
- Investigate the surprises
- Develop more markers
- Improve method
- Once we find the problem, work on fixing it!
- Questions???