Effects of Agricultural Management, Land Use, and Watershed Scale on *E. coli* Concentrations in Runoff and Streamflow

R.D. Harmel, R. Karthikeyan, T. Gentry, R. Srinivasan
USDA-ARS, Texas A&M, Texas AgriLife Research

Texas Watershed Coordinator Roundtable
July 27, 2011

Improving Life through Science and Technology.
Different Scales and Land Uses

- Field
  - Grazed pasture
  - Cultivated
  - Cultivated & grazed
- Small watershed
  - Mixed rural
  - Mixed rural with dairies, irrigated fields, WWTP
- River basin
  - Mixed rural with dairies, WWTPs, small communities
## Sampling Sites

<table>
<thead>
<tr>
<th>Site</th>
<th>Scale</th>
<th>Land Use</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>Field</td>
<td>Grazed pasture</td>
<td>0.4 ha</td>
</tr>
<tr>
<td>P2</td>
<td>Field</td>
<td>Grazed pasture</td>
<td>0.3 ha</td>
</tr>
<tr>
<td>SS1</td>
<td>Field</td>
<td>Cultivated</td>
<td>0.9 ha</td>
</tr>
<tr>
<td>SS2</td>
<td>Field</td>
<td>Cultivated</td>
<td>0.9 ha</td>
</tr>
<tr>
<td>SS3</td>
<td>Field</td>
<td>Cultivated</td>
<td>1.2 ha</td>
</tr>
<tr>
<td>M</td>
<td>Field</td>
<td>Cultivated (80%), Grazed pasture (20%)</td>
<td>18.1 ha</td>
</tr>
<tr>
<td>Mustang Creek</td>
<td>Small watershed</td>
<td>Mixed rural</td>
<td>14.7 km² (MC1)</td>
</tr>
<tr>
<td>(MC1, MC2)</td>
<td></td>
<td></td>
<td>55.1 km² (MC2)</td>
</tr>
<tr>
<td>Resley Creek</td>
<td>Small watershed</td>
<td>Mixed rural with dairies, irrigated fields, WWTP</td>
<td>57.6 km² (RC1)</td>
</tr>
<tr>
<td>(RC1, RC2, RC3)</td>
<td></td>
<td></td>
<td>128.9 km² (RC2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>217.5 km² (RC3)</td>
</tr>
<tr>
<td>Leon River</td>
<td>River basin</td>
<td>Mixed rural with dairies, WWTPs, small communities</td>
<td>5200 km² (LR1)</td>
</tr>
<tr>
<td>(LR1, LR2)</td>
<td></td>
<td></td>
<td>6070 km² (LR2)</td>
</tr>
</tbody>
</table>
Sampling & Analysis

- Types of water samples
  - Edge-of-field runoff (field-scale)
  - Stream (small watershed & river basin)
    - ~ Every 2 wks & runoff events
- Samples collected 2005 to 2009
- *E. coli* enumerated using m-ColiBlue24°
## Samples Collected

<table>
<thead>
<tr>
<th>Site</th>
<th>Scale</th>
<th>Land Use</th>
<th>No. of Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>Field</td>
<td>Grazed pasture</td>
<td>11</td>
</tr>
<tr>
<td>P2</td>
<td>Field</td>
<td>Grazed pasture</td>
<td>12</td>
</tr>
<tr>
<td>SS1</td>
<td>Field</td>
<td>Cultivated</td>
<td>15</td>
</tr>
<tr>
<td>SS2</td>
<td>Field</td>
<td>Cultivated</td>
<td>15</td>
</tr>
<tr>
<td>SS3</td>
<td>Field</td>
<td>Cultivated</td>
<td>16</td>
</tr>
<tr>
<td>M</td>
<td>Field</td>
<td>Cultivated (80%), Grazed pasture (20%)</td>
<td>14</td>
</tr>
<tr>
<td>Mustang Creek (MC1, MC2)</td>
<td>Small watershed</td>
<td>Mixed rural</td>
<td>127</td>
</tr>
<tr>
<td>Resley Creek (RC1, RC2, RC3)</td>
<td>Small watershed</td>
<td>Mixed rural with dairies, irrigated fields, WWTP</td>
<td>74</td>
</tr>
<tr>
<td>Leon River (LR1, LR2)</td>
<td>River basin</td>
<td>Mixed rural with dairies, WWTPs, small communities</td>
<td>172</td>
</tr>
</tbody>
</table>
Land Use Effects on *E. coli* Levels: Field-Scale

![Box plot showing the distribution of E. coli levels across different land use types.](image)

- **Cultivated**: 300 a
- **Cultivated with grazed pasture**: 1060 b
- **Grazed pasture**: 2465 b
Land Use Effects on *E. coli* Levels: Small Watershed-Scale

![Box plot showing *E. coli* levels in different land use contexts.](image)

- **Resley All**
  - MC1: 63 b
  - MC2: 200 a
  - RC1: 114 a
  - RC2: 245 a
  - RC3: 520 a

- **Mustang All**
  - MC1: 114 a
  - MC2: 245 a

Current standard for *E. coli* (cfu per 100 mL) is shown as a grey line at 1000.
Watershed Scale Effects on *E. coli* Levels

- **Field**: 680 a
- **Small watershed**: 120 b
- **River basin**: 30 c
Conclusions

- Grazed fields had higher levels of *E. coli* in edge-of-field runoff samples than did cultivated fields.
- No significant difference in *E. coli* levels due to land use at the small watershed-scale.
- *E. coli* levels decreased as watershed scale increased.
  - Consideration of watershed scale in water quality standards?
For More Details:

Questions?

Daren Harmel
USDA-ARS
808 E. Blackland Rd.
Temple, TX 76502
Phone: (254) 770-6521
Email: daren.harmel@ars.usda.gov

Terry Gentry
Texas A&M University
2474 TAMU
College Station, TX 77843
Phone: (979) 845-5323
Email: tgentry@ag.tamu.edu