Treatment of Pathogen and Pollutants in the Wolf Creek Watershed

Kristopher D. Barnswell, Ph.D
Daryl F. Dwyer, Ph.D

Department of Environmental Sciences
University of Toledo
Lake Erie Center
What is going on in Wolf Creek Watershed?

[Map showing Wolf Creek Watershed with locations marked]
Berger Ditch is the primary pathway

- Transport of nutrients
  - Agricultural fields
- Transport of heavy metals
  - Surface runoff
- Transport of bacteria
  - Agricultural fields
  - Septic tanks
  - Animals
Purpose for research by University of Toledo

- Determine the levels of bacteria and nutrients from Wolf Creek Watershed to Maumee Bay
- Data will be used to design the wetlands

Maumee Bay State Park
Wetland Functions and Values

- **Ecosystem values**
  - Flood mitigation
  - Erosion control
  - Water quality protection
  - Productivity
  - Aesthetics
  - Recreational

- **Population values**
  - Habitat
  - Diversity

*Not all wetlands perform all functions, nor do they perform all functions equally well*
**Constructed “Treatment” Wetlands**

**Surface flow**
- May require high acreage
- Regulate water depth and residence time
- Increase aquatic diversity
- Restore native habitat

**Subsurface flow**
- May require low acreage
- Increased contact time with soil
- Less likely to have odor or mosquitoes
- Restore native habitat
## Performance by Constructed Wetlands

<table>
<thead>
<tr>
<th>Wetland type</th>
<th>Material</th>
<th>Removal Efficiency (%)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsurface flow</td>
<td>Wastewater</td>
<td>Bacteria (&gt;97)</td>
<td>Rivera et al. 1995</td>
</tr>
<tr>
<td></td>
<td>Wastewater</td>
<td>Bacteria (96-99)</td>
<td>Decamp and Warren 2000</td>
</tr>
<tr>
<td></td>
<td>Wastewater</td>
<td>Bacteria (23-39)</td>
<td>Hench et al. 2003</td>
</tr>
<tr>
<td></td>
<td>Wastewater</td>
<td>Bacteria (95-99)</td>
<td>Molleda et al. 2008</td>
</tr>
<tr>
<td></td>
<td>Wastewater</td>
<td>Bacteria (72)</td>
<td>Reinoso et al. 2008</td>
</tr>
<tr>
<td>Surface flow</td>
<td>River water</td>
<td>Phosphorus (53-92)</td>
<td>Mitsch et al. 1995</td>
</tr>
<tr>
<td></td>
<td>River water</td>
<td>Phosphorus (56-59)</td>
<td>Nairn and Mitsch 2000</td>
</tr>
<tr>
<td></td>
<td>Stream water</td>
<td>Phosphorus (21-44)</td>
<td>Braskerud 2002</td>
</tr>
<tr>
<td></td>
<td>Agricultural runoff</td>
<td>Phosphorus (59)</td>
<td>Lu et al. 2009</td>
</tr>
</tbody>
</table>
Designing a Constructed Wetland
Parameters measured

- **Velocity** = speed of water
- **Discharge** = volume of water per time
- **E. coli** = bacteria indicator for fecal contamination
- **Suspended solids** = particles in water
- **Total phosphorus** = dissolved and particulate phosphorus
Seasonal trends
Effect of discharge on densities of *E. coli*
Effect of discharge on *E. coli* loadings
## Berger Ditch loadings from July 2007 to July 2008

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Annual</th>
<th>Winter</th>
<th>Spring</th>
<th>Summer</th>
<th>Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>E. coli</em> (CFU)</td>
<td>$9.19 \times 10^{14}$</td>
<td>$1.66 \times 10^{14}$</td>
<td>$1.96 \times 10^{13}$</td>
<td>$6.9 \times 10^{14}$</td>
<td>$4.18 \times 10^{13}$</td>
</tr>
</tbody>
</table>

**FACTS**

- One *E. coli* cell is 2 μm in length = 0.000002 meters
- Total length of *E. coli* cells = 1,143,323 miles
- Circumference of earth = 24,902 miles

*E. coli* cells would circle the earth more than 46 times!

*National Center for Water Quality Research, Heidelberg University*
### Berger Ditch loadings from July 2007 to July 2008

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Annual</th>
<th>Winter</th>
<th>Spring</th>
<th>Summer</th>
<th>Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suspended solids (metric tons)</td>
<td>4747.52</td>
<td>2702.57</td>
<td>580.31</td>
<td>838.23</td>
<td>646.41</td>
</tr>
<tr>
<td>Total phosphorus (metric tons)</td>
<td>20.23</td>
<td>10.38</td>
<td>1.37</td>
<td>5.81</td>
<td>2.67</td>
</tr>
</tbody>
</table>

### Maumee River loadings from April to June 2010*

- Watershed greater 6,000 mi²
- Suspended solids 377,000 metric tons = **MUDDY WATER**
- Total phosphorus 925 metric tons = **ALGAL BLOOMS**

*National Center for Water Quality Research, Heidelberg University*
Relationships between tested parameters in the summer

Reduce *E. coli* and phosphorus by removing suspended solids!
Summary

- **Seasonal variation**
  - *E. coli* highest in summer
  - Total phosphorus highest in winter
  - Suspended solids highest in fall and winter

- **Strong relationships**
  - *E. coli* and total phosphorus to suspended solids

- **Rate of discharge**
  - No effect on densities of *E. coli*
  - Strongly effect loadings of *E. coli*
Current Research

- Development of a predictive model
  - Forecast water quality conditions
  - Ohio Nowcast system
- Evaluation of rapid methods
  - Enumerate densities of *E. coli*
- Application of biosolids to agricultural fields
  - Tillage vs. no tillage
  - Capping drainage tile

Funding provided by USDA grant 2009-5377