How Stream Corridor Watershed Restoration Can Help
July 16, 2010
Watershed

Figure credit: Center for Inland Bays website.
Historical/Modern Impacts
Natural Streams and the Legacy of Water-Powered Mills

Robert C. Walter and Dorothy J. Merritts

Figure from 1868 Hundreds Map
Historical Impacts
Stream/floodplains were altered dramatically during the European settlement era.
Mill Dams
U.S. Census in Eastern US - ~60,000 mills in 1840

1840 US CENSUS OF WATER-POWERED MILLS FOR EASTERN USA

Average dam ht 2.4 m

Mill Dam Heights, Lancaster County, PA

Mean Dam Height = 2.4 m

Mills Per County

<table>
<thead>
<tr>
<th>Range</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 5</td>
<td></td>
</tr>
<tr>
<td>6 - 20</td>
<td></td>
</tr>
<tr>
<td>21 - 50</td>
<td></td>
</tr>
<tr>
<td>51 - 90</td>
<td></td>
</tr>
<tr>
<td>91 - 150</td>
<td></td>
</tr>
<tr>
<td>151 - 225</td>
<td></td>
</tr>
<tr>
<td>225 - 999</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>&gt;60,000</td>
</tr>
</tbody>
</table>

Figure credit: Franklin & Marshall College, Lancaster, PA.
Floodplain Sediment Analysis
F&M College collaboration:
- Radiocarbon dating of sediments
- Magnetic susceptibility
- Buried historic (wetland) floodplain
- Buried seed bank & carbon source

Floodplain Sediment Analysis
Historical Impacts

Indian Creek – Western Coastal Plain valley wide impacts

Dam In-place (upstream)

Dam Breach

Historic Dam Location

modern soil

historic soil gravel
Modern Impacts

Land development & urbanization
Grade Control Effects
Piedmont Region

Powder Mill Run - 56% Impervious Cover

Roland Run - 40% Impervious Cover
Grade Control Effects

Coastal Plain Region

Indian Creek - 24% Impervious Cover

Massey Branch - 2% Impervious Cover
Assessment of Pollution Load
## Stream Erosion: Measured vs. Predicted

<table>
<thead>
<tr>
<th>Creek (County or State)</th>
<th>Length of Stream Studied (feet)</th>
<th>Measured Erosion Rates (tons per year) for study area</th>
<th>Predicted “Problem” Area Erosion Rates* (tons per year) for study area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Codorus – East Branch</td>
<td>5,410</td>
<td>2,070</td>
<td>90 – 1,794</td>
</tr>
<tr>
<td>Codorus – South Branch Granary Rd.</td>
<td>2,200</td>
<td>2,900</td>
<td>56 – 1,122</td>
</tr>
<tr>
<td>Codorus – South Branch Phase I</td>
<td>1,770</td>
<td>1,083</td>
<td>15 - 304</td>
</tr>
<tr>
<td>Codorus – South Branch Phase II</td>
<td>2,050</td>
<td>500</td>
<td>15 - 298</td>
</tr>
<tr>
<td>Codorus – South Branch Phase III</td>
<td>4,170</td>
<td>2,180</td>
<td>33 - 654</td>
</tr>
<tr>
<td>Conewago</td>
<td>800</td>
<td>8,000</td>
<td>20 - 400</td>
</tr>
<tr>
<td>Cowanshannock – Reach 1</td>
<td>80</td>
<td>31</td>
<td>1 - 20</td>
</tr>
<tr>
<td>Cowanshannock – Reach 2</td>
<td>50</td>
<td>52</td>
<td>1 - 20</td>
</tr>
<tr>
<td>Crabby</td>
<td>400</td>
<td>1,444</td>
<td>4 - 80</td>
</tr>
<tr>
<td>Long Draught Branch</td>
<td>1,607</td>
<td>427</td>
<td>19 - 380</td>
</tr>
<tr>
<td>Octoraro – West Branch</td>
<td>1,650</td>
<td>1,200</td>
<td>4 - 84</td>
</tr>
<tr>
<td>Stewart Run</td>
<td>60,429</td>
<td>4,415 – 5,459</td>
<td>187 – 3,744</td>
</tr>
<tr>
<td>Santo Domingo</td>
<td>193</td>
<td>80</td>
<td>2 - 32</td>
</tr>
<tr>
<td>Spencer Run</td>
<td>16,250</td>
<td>3,200 – 3,900</td>
<td>133 – 2,666</td>
</tr>
<tr>
<td>Stony Run</td>
<td>1,392</td>
<td>912</td>
<td>12 - 238</td>
</tr>
<tr>
<td>Trout Run</td>
<td>50</td>
<td>20.5</td>
<td>1 - 20</td>
</tr>
</tbody>
</table>

*These values were calculated using lateral erosion rates of $1.0 \times 10^{-2}$ to $2.0 \times 10^{-1}$ meters/year as suggested by Evans et al, 2003.
## Typical Stream Bank Nutrients

Measured nutrient content in eroding stream banks

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Long Draught Branch Gaithersburg, MD</td>
<td>0.62 to 0.79 (311 to 394)</td>
<td>0.012 to 0.028 (6 to 14)</td>
<td>1.20 to 2.21 (600 to 1100)</td>
<td>0.006 to 0.016 (3.2 to 8.1)</td>
<td>0.002 to 0.007 (1.23 to 3.47)</td>
</tr>
<tr>
<td>Santo Domingo Creek Lititz, PA</td>
<td>0.93 to 1.88 (463.9 to 936.9)</td>
<td>0.020 to 0.168 (10 to 84)</td>
<td>2.81 to 6.62 (1400 to 3300)</td>
<td>0.005 to 0.067 (2.7 to 33.5)</td>
<td>0.006 to 0.57 (2.8 to 28.2)</td>
</tr>
<tr>
<td>Big Spring Run Willow Street, PA</td>
<td>0.87 (434.4)</td>
<td>0.028 to 0.044 (14 to 22)</td>
<td>1.40 to 2.00 (700 to 1000)</td>
<td>0.007 to 0.012 (3.5 to 6.1)</td>
<td>0.006 to 0.048 (2.9 to 23.8)</td>
</tr>
<tr>
<td>Stony Run Baltimore, MD</td>
<td>0.30 to 0.54 (150 to 270)</td>
<td>Not Measured</td>
<td>0.13 to 0.18 (65 to 92)</td>
<td>Not Measured</td>
<td>Not Measured</td>
</tr>
<tr>
<td>Lititz Run Lititz, PA</td>
<td>0.99 to 2.45 (491.9 to 1222.2)</td>
<td>Not Measured</td>
<td>3.01 to 6.82 (1500 to 3400)</td>
<td>0.007 to 0.046 (3.7 to 23.1)</td>
<td>0.023 to 0.053 (11.7 to 26.2)</td>
</tr>
<tr>
<td>Conoy Creek Elizabethtown, PA</td>
<td>0.39 to 0.96 (196.3 to 479.1)</td>
<td>0.050 to 0.068 (25 to 34)</td>
<td>0.80 to 3.21 (400 to 1600)</td>
<td>0.002 to 0.005 (0.9 to 2.3)</td>
<td>0.002 to 0.013 (1.08 to 6.54)</td>
</tr>
</tbody>
</table>
Stormwater Benefits to Restoration
Potential Restoration Solutions

Channel armoring to store modern sediment

Re-build/patch dams to store modern sediment

Remove modern sediment to re-create riparian wetland floodplain
Quantifiable Stormwater Benefits

Benefits from Floodplain Restoration

- Peak Discharge Reduction
- Runoff Volume Reduction
- Water Quality Improvement
Peak Discharge Reduction

- Modern sediment removal yields increased flood storage
- Peak discharge reduction
  - Project specific variation
  - Extent of flood storage increase
  - Existing/proposed controls (culverts, bridges, pinch points)
  - Valley slope
- Quantification of flood flow attenuation
  - Discharge vs. area rating curves developed from HEC-RAS
  - Reach routing analysis using TR-20
Peak Discharge Reduction
Runoff Volume Reduction

- Remove low permeability modern sediment infill
- Expose organic-rich historic soil, if possible
- Increased wetted surface area for frequent flood flows
- Create densely vegetated floodplain
- Yields increased soil permeability
- Yields increased evapotranspiration

Quantification methods

- Measure improved infiltration rate
- Area x Improved infiltration Rate x Storm Duration (similar to Filter Strip BMP)
Water Quality Improvement

- Plant filtration of TSS and nutrient uptake
- Adjacent land runoff filters though riparian wetland floodplain
- Stormwater outfalls flow to floodplain, not directly to stream
- Increased frequency of stream flow access to floodplain yields greater filtration of all watershed flood flows
- Eliminates unstable channels - source of sediment & nutrients
Other Restoration Benefits

- Riparian wetland creation or enhancement
- Reconnection to buried wetland seed and carbon source
- Improve aquatic habitat functions and diversity
- Remove/reduce invasive species
Case Studies
Bee Branch Stream Bank Restoration
Bee Branch Stream Bank Restoration
Blackbird Creek Stream Restoration
Methods to Target Restoration Sites
Watershed Assessments

Inland Bays Watershed

- Unchannelized Streams
- Ditches/Channelized Streams
- Water
- All Wetlands

Figure credit: Wetland Condition of the Inland Bays Watershed Report – Volume 1.
Example Projects
Lititz Run Restoration
Stream relocation and riparian wetland creation

Construct 2004

May 2008
Lititz Run
Pre-restoration Conditions
Saucon Creek Restoration
Stream relocation and riparian wetland creation
Constructed 2008

October 2009
Saucon Creek
Pre-restoration Conditions
Upper Stony Run Restoration
Urban stream relocation/stabilization and floodplain attachment

Constructed 2006
Upper Stony Run
Pre-restoration Conditions
Questions?