Wenger et al. (2009). “Twenty-six key research questions in urban stream ecology: an assessment of the state of the science”.

- Identified “critical unanswered questions in urban stream ecology”
- Focus was on research needed to help generate healthier urban streams
- Solicited input from many leading experts in the field using a variety of mechanisms
Urban stream syndrome: Characterized by streams that are “simultaneously affected by multiple sources, resulting in multiple, co-occurring and interacting stressors”

Source: US EPA
Fig. 1. Conceptual model of urban impacts on streams. Arrows show selected major pathways, but many important pathways are omitted for readability. For example, piped/filled channels affect virtually all other stressors but most of these linkages are not shown. All water-quality variables (grouped within dashed lines in center) are treated as a group for purposes of linkages to instream stressor sources; all stream ecosystem variables (grouped within dashed lines at right) are likewise treated as a group. Pathways among the stream ecosystem variables are not shown for readability. EI – effective impervious, mgt. – management, regs. – regulations.
CADDIS: Causal Analysis/ Diagnosis Decision Information system

• Designed to aid in causal assessments for aquatic systems
• Provides a systematic methodology for identifying ecosystem responses, stressors and sources
• What applications could CADDIS have for stream restoration?
Steps for managing streams with incomplete knowledge on urban stream ecology

• Identify the desired stream ecosystem state
• Identify major stressors or stressor sources and select appropriate management actions
• Identify appropriate monitoring indicators and monitor adaptively

Question: Should these steps be applied to river restoration more broadly (in urban and rural areas)? Will these steps be necessary as our knowledge about urban stream ecology becomes more complete?
IS URBAN STREAM RESTORATION WORTH IT? Kenney et al. (2012)

• How to measure “is it worth it?”
• $/foot
• Structure, N removal, recreation

• The net benefit of stream restoration could be expressed as the aesthetic and recreational benefits plus the avoided costs of the next best alternatives for achieving water quality and infrastructure goals, minus the cost of restoration. This would assume that the goals would be achieved by the least costly alternative means if restoration is not implemented.
Procedure for Quantifying the Nitrogen Benefits of Stream Restoration
Cost per foot for different BPMs

<table>
<thead>
<tr>
<th>BMP b</th>
<th>Stream Restoration Without Land Costs [$/ft]</th>
<th>Stream Restoration With Land Costs [$/ft]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry extended detention pond</td>
<td>40</td>
<td>99</td>
</tr>
<tr>
<td>Wet extended detention pond</td>
<td>30</td>
<td>90</td>
</tr>
<tr>
<td>Wetland</td>
<td>40</td>
<td>94</td>
</tr>
<tr>
<td>Infiltration basin</td>
<td>73</td>
<td>279</td>
</tr>
<tr>
<td>Riparian buffer</td>
<td>45</td>
<td>67</td>
</tr>
</tbody>
</table>
Willing to pay

FIGURE 3. WTP Survey Responses for High and Dry with Trees and Low and Wet with Meadow for Both Stony Run and Baltimore City. Stony Run respondents had a higher WTP, however, these respondents represented only 1% of Baltimore City households.
Comparison of Value (bars) and Cost (horizontal lines)
Case Study: Portland, Oregon

Direct interventions:
• Wetland enhancement projects
• Habitat enhancement projects
• Watershed revegetation program
• Installation of rain gardens and other Low Impact Development projects
• [http://www.portlandoregon.gov/article/315581](http://www.portlandoregon.gov/article/315581) (from 1:30)
Case Study: Portland, Oregon

Incentive programs:
- “Treebate” Program
- Community watershed stewardship program (offers grants up to $10,000)
- Green Street Steward program
- Private property retrofit program
Example: Detroit Water and Sewerage Department Wastewater Master Plan DWSD Project No. CS-1314

• "Daylighting is the act of removing streams from underground pipes and culverts, restoring some of the form and function of historic streams."


Figure 3. USGS Map of Greydale Area. Drainage area tributary to Greydale is shown by the outline.
daylighting projects can:

- relieve choke points and flooding problems caused by under-capacity culverts;
- increase hydraulic capacity over that provided by a culvert, by recreating a floodplain;
- reduce runoff velocities—thus helping prevent erosion—as a result of a natural channel meandering and the roughness of the stream bottom and banks;
- replace deteriorating culverts with an open drainage system that can be more easily monitored and repaired;
- cost less, or only marginally more, than replacing a culvert;
- divert urban runoff from combined sewer systems before it mixes with sewage, reducing combined sewer overflows and burdens on treatment plants;
- (emphasis added) improve water quality by exposing water to air, sunlight, vegetation and soil, all of which help transform, bind up, or otherwise neutralize pollutants;
- recreate aquatic habitat and improve fish passage;
- recreate valuable riparian habitat and corridors for wildlife movement;...
- “beautify neighborhoods, perhaps serving as a focal point of a new park or neighborhood revitalization project; . . ."
- “reconnect people to nature through the look, feel, and smell of open water and riparian vegetation;” pages IV and V of the report.
Goals

• 1. Replace deteriorated culverts - in some cases it was less expensive
• 2. Divert urban runoff and reduce wastewater flows
• 3. Increase recreational opportunities
• 4. Provide education about the area, history, stream
• 5. Promote development and increase property values.
Conclusions

• The restoration of an urban stream would also reduce the wet weather flows to the wastewater plant.

• Adding a wetland to the restored urban stream would improve water quality in the receiving streams and help reduce the peak flows to the river.

• Redevelopment of an area provides the opportunity to include stream restoration in the construction.
Potential group activity

• Develop a conceptual diagram that elucidates various restoration activities (management actions), the particular stressors these activities would target, and potential responses. Think broadly, and consider both social and ecological stressors and responses.
Questions

• What is a “healthy urban stream”?

• In what areas have we made significant progress towards addressing the 26 key research questions identified by Wenger et al.?

• Wenger et al. point out that their research questions may be biased due to the majority of contributors being from the U.S. How do you think their questions may have differed if there was greater representation from the developing world?

• Wenger et al. suggest that there has been too much focus in urban stream restoration on structural approaches rather than process-based approaches. How can we implement process-based approaches (restoring natural flow, reestablishing floodplain wetlands, etc.) while protecting pre-existing development?
More Questions

• Do you think Kenney et al. should have also quantified the aesthetic/recreational benefits of BMPs? How do you think those benefits might compare to the restoration project?

• How do you quantify non monetary benefits of urban stream restoration?

• How do you think the water quality/ infrastructure benefits may vary between the various restoration scenarios presented in the contingent valuation survey done by Kenney et al.?

• Do you think Kenney et al. answered their question- is urban stream restoration worth it? Is that the right question to be asking?

• Can a cost benefit model be the best way to determine if a restoration project is “worth it”? 