Shoreline and Shallow Conference: Challenges and Successes
March 11, 2015
Kellogg Center, MSU
Benefits for Natural Lake Shoreline

- Bank Erosion
- Habitat for various life stages and time of year
- Improved water quality
- Privacy
- Reduced maintenance
- Cost
How do we get the point that our Stream Restoration/Habitat Improvement/Stabilization projects results in projects that look like this....
...instead of this?
What should our Goal be?

Addressing impairments?

Maximizing function of systems?
How do we evaluate the Health of a Stream and its watershed?

Riverine Components

(Instream Flow Council)
Water Quality

(US EPA)
Knife River After a Rain Storm

(Photo courtesy of St. Paul Pioneer Press)
Hydrology

The study of water. Hydrology generally focuses on the distribution of water and interaction with the land surface and underlying soils and rocks.
Natural systems were built and are maintained by different magnitudes of discharge occurring over time and space.  

(Hill et al. 1991)
Fluvial Geomorphology

"... the branch of science that studies the landforms associated with river channels and the processes that form them." (Kellerhals and Church 1989)
Pattern (plan view)

- Riffle S
- Pool S

Dimension (cross-section)

- Wave Length
- Radius of Curvature
- General Stream Bed Slope
- Meander Belt Width

Profile

- Floodplain
- Point Bar
- Bankfull
Dimension, Pattern, Profile, & Floodprone Width
Yield 4 ratios used for stream reach classification

1. Entrenchment Ratio = \(\frac{\text{Flood-Prone Width}}{\text{Bankfull Width}}\)

2. W/D ratio = \(\frac{\text{Width}_{\text{bkf}}}{\text{Depth}_{\text{mean}}}\)

3. Sinuosity = \(\frac{\text{Channel Length}}{\text{Valley Length}}\)

4. Slope = \(\frac{\text{Elevation difference}}{\text{Channel length}}\)

All of these ratios define how a stream and its valley handle the energy of flowing water, sediment, and debris.
Meandering reduces the slope (steepness) of a stream (or road)
If you watch melting snow pack in driveway, you can see the same channel types forming.
Pattern and Profile are Intimately Linked

Plan and Profile Diagrams of a Longitudinal Profile

Pattern

Profile
Comparison of “designed” channel dimensions and pattern with a natural channel.

\[ \tau = \gamma DS \]

where:
- \( \gamma \) is the specific weight of the fluid,
- \( D \) is the mean depth, and
- \( S \) is the water surface slope.
Ditches are designed to transport water more quickly.

But ditches are inefficient at transporting sediment.

Natural, meandered channels are the most efficient at transporting both water and sediment.
Stream Stability

“How ability of a stream to transport the water & sediment of its watershed in such a manner as to maintain its dimension, pattern, and profile, over time, without either aggrading or degrading.”

Rosgen and Silvey, 1996
This is not what we mean by a “stable” channel!
Connectivity
Lateral Connectivity
Longitudinal Connectivity
Biology
Habitat

- Depth
- Velocity
- Substrate – bottom material
- Cover – hiding
- Avoid being eaten
- Eat others (ambush)
So how are we doing with Stream Restorations?

Or
Whitewater River, MN

Goals:
1. Stop erosion, sedimentation
2. Provide trout habitat
Further study of stream condition could have produced longer term fix to restore stream stability.

Riffle = flat

Indication of Unstable Channel

Pool = steep
Bluff Stabilization

What techniques to use when stabilization is all that is needed?
Pennsylvania
Have we addressed the Cause?

Are we fixing the System or a Symptom?
“Detroit Rip-Rap”

“And they made good riprap. Unlike dirt or rock or concrete, which could be carried away during a flood, these big, heavy cars usually stayed put. It helped that the cars were almost always reinforced by thick steel cables that passed through the bodies.

......The Ridiculous Root Wad

(Rosgen)
Rock River, Southwest Minnesota

Luther Aadland
Toe-Wood Sod Mats with Woody Debris: Cross-Section View of Existing vs. Proposed
Crow River
2012
Toe Wood

Rip Rap
<table>
<thead>
<tr>
<th></th>
<th>Toe Wood</th>
<th>Rip Rap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>$183,000</td>
<td>$2,400,000</td>
</tr>
<tr>
<td>Cost per lineal foot</td>
<td>$266</td>
<td>$4,800 per lineal foot</td>
</tr>
<tr>
<td>Cost per ft²</td>
<td>$22 per ft²</td>
<td>$96 per ft²</td>
</tr>
<tr>
<td>Construction</td>
<td>6 weeks to construct</td>
<td>29 weeks construction</td>
</tr>
<tr>
<td>Habitat</td>
<td>Good fish habitat</td>
<td>Poor habitat</td>
</tr>
</tbody>
</table>
Downstream

Erosion at start and end of project

Upstream
At bankfull flow

No sign of erosion
Sequential Phases: There are eight phases associated with the stream restoration.

- **Phase I:** Restoration Goal/Objectives - *Define specific restoration objectives associated with physical, biological and/or chemical process.*

- **Phase II:** Regional and Local relations - *Develop regional and localized specific information on geomorphologic characterization, hydrology and hydraulics.*

- **Phase III:** Watershed/River Assessment – *Conduct a watershed/river assessment to determine river potential, current state and the nature, magnitude, direction, duration and consequences of change.*

- **Phase IV:** Change overall management (Passive restoration) – *Consider passive restoration recommendations based on land use change prior to considering mechanical restoration.*

- **Phase V:** Stream Restoration/Natural Channel Design – *Initiate natural channel design with subsequent analytical testing of hydraulic and sediment transport (competence and capacity) relations.*

- **Phase VI:** Design Stabilization and Fisheries Enhancement Structures – *Select and design stabilization/enhancement/vegetative establishment measures and materials to maintain dimension, pattern and profile to meet stated objectives.*

- **Phase VII:** Implementation – *Implement the proposed design and stabilization measures involving layout, water quality control and construction staging.*

- **Phase VIII:** Monitoring and Maintenance Plan – *Design a plan for effectiveness, validation and implementation monitoring to ensure stated objectives is met, prediction methods are appropriate and construction is implemented as designed.*
Michigan's Natural Channel Design Review Checklist Reference Document

DRAFT

Prepared By:

DEQ

Michigan Department of Environmental Quality, Water Resources Division

May 2014

Based on the "Natural Channel Design Review Checklist" developed by Baker Engineering NY Inc. and U.S. Fish and Wildlife Services for the U.S. Environmental Protection Agency, January 2008.
Make sure structures are compatible with the river to maintain processes.
The answers are often confused amidst the complexity of natural systems as well as social, financial and political constraints.
Learn to read the land (river),
and when you do
I have no fear
of what you will do with it

indeed,
I am excited
about what you will do for it

Aldo Leopold, 1949,
A Sand County Almanac