Resiliency and Stream Restoration

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What is Best for the Watershed?

- Resiliency for the Watershed in a Changing Climate
  - What is the desired outcome or level of protection for the watershed?
  - We shouldn’t promise things we can’t deliver
  - Public Interest ↑
- Resilient Stream Restoration Design
  - Discharge Scaling Q10 becomes Q2, etc.
  - Impacts of Flood Waves
  - Different Design Approach’s
    - Channel Shear vs. Floodplain Shear
  - Different Stability Considerations
    - Channel size versus material size
    - Floodplain stabilization limitations

What would we expect the effect on reach sediment loading to be in the absence of any restoration?

- Likely gradual increases in storms (not instantaneous)
- Lag time in both watershed and reach level responses – bed load vs. wash load
- Intensity and Duration Changes (typically use 6 or 24-hour event)
  - Microbursts more frequent
- Increases in Volume of Water
- Increases Rate of Depth/Velocity Change
- Existing Channel Adjustments
  - Widening
  - Deepen
- Additional Storage of Sediments in Channels and Floodplains
  - Likely Downstream Channel Fining and Upstream Incision (Gully Formation)
- Transitions between restored and existing stream reaches

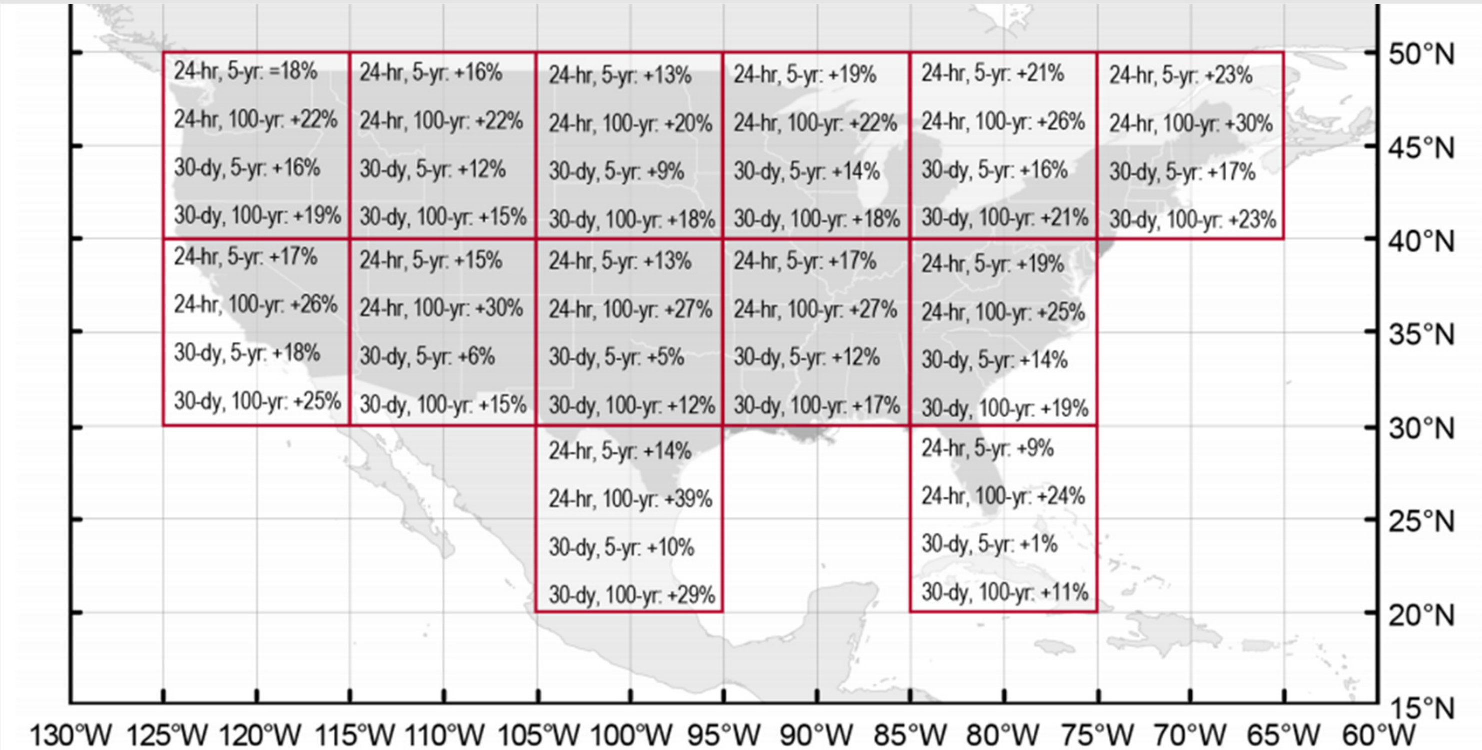


Figure 32. *Projected change in the 5-yr and 100-yr return period amounts for 24-hr and 30-day precipitation for 2070–2099 relative to 1976–2005 under the RCP8.5 emissions scenarios using the LOCA downscaled data.*

Floodplains Have Stored Lots of Sediment: Trimble, 1999

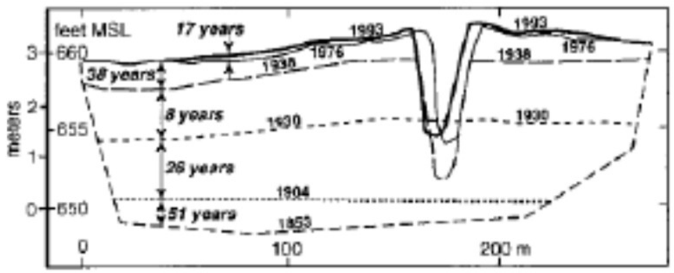
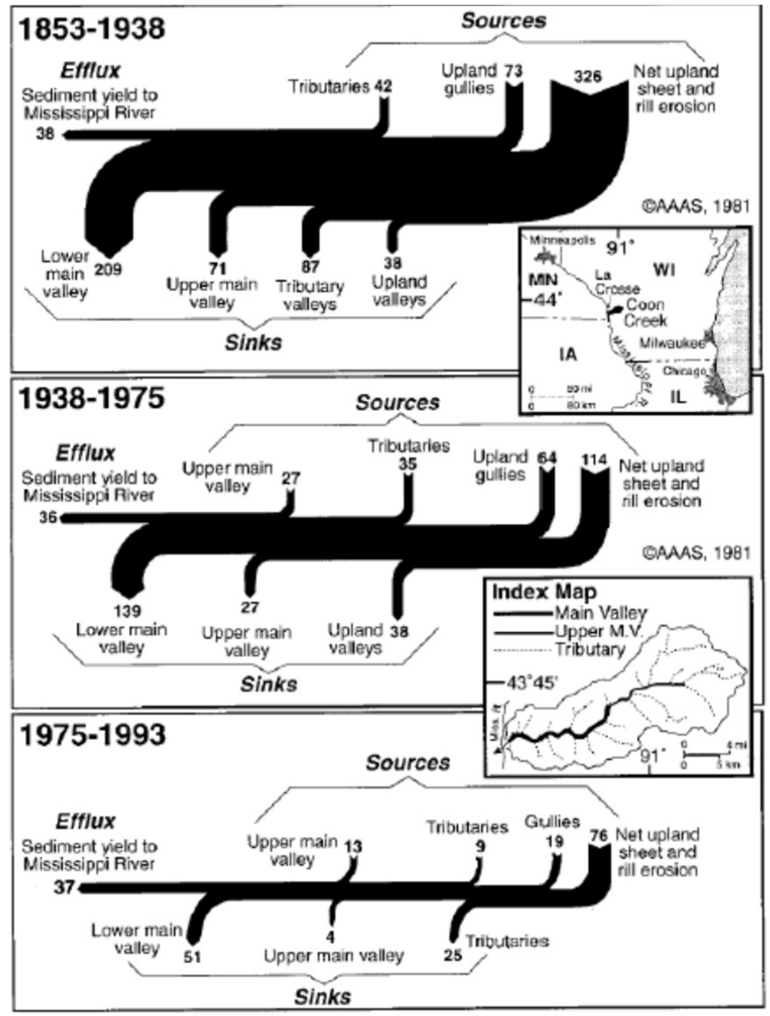


Fig. 2. A sediment sink. This is a cross-sectional profile in the lower main valley of Coon Creek showing succeeding, higher floodplain levels dated from 1853 to 1993. MSL, mean sea level. Such accretion accounts for most storage in the Coon Creek Basin. [Modified from (3)]



At what point do floodplains shift from sinks to sources?

How would the higher flows influence overall project design and feasibility (both channel and floodplain)?

Use Design Goals and Constraints to Establish Design Geometry and Iterate:

Hydrology

Cross-Section Geometry

Planform Alignment

Profile

Impact Tolerance

Test the Assumptions using Modeling

Transitioning to entirely 2-D Modeling

Lessons Learned from Previous Efforts

Floodplain Impacts

Develop Instream and Bank Measures

Materials

Stability

Habitat

Hydraulic Performance

Develop Riparian Vegetation Plan

Bioengineering

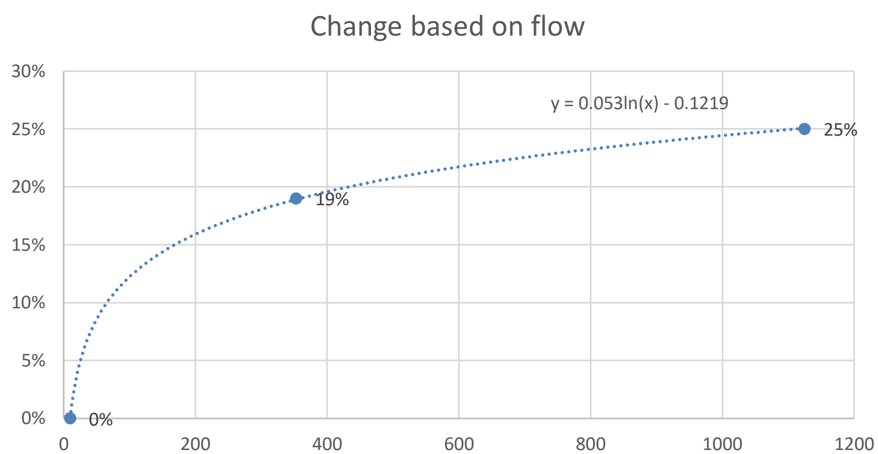
Seed Mixes

Trees/Shrubs

Matting

NNI Plan

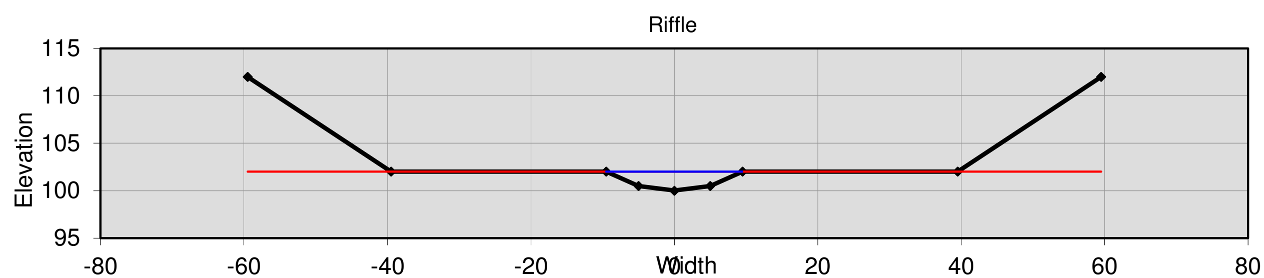
Sediment Transport Model
Example = 5 YR + 19% and 100YR + 25%



Unadjusted			Climate adjusted			Percent Change
Effective Discharge	**19-22**		**Effective Discharge**	**19-22**		
Results in Tons	**Annual**		**Results in Tons**			
Sand (<2)	324		Sand (<2)	332		2.75%
Gravel (2 - 6mm)	28		Gravel (2 - 6mm)	29		3.48%
Gravel (6+mm)	233		Gravel (6+mm)	252		8.20%
Total	585		Total	614		4.96%

Storm change

Baseflow	10	0%
5yr	353	19%
100yr	1125	25%



How would the higher flows influence overall project design and feasibility (both channel and floodplain)?

- Increased Public Awareness of Flood Risk Requires Clear Communication
- Backwater Scenarios from DS Infrastructure
  - Localized Flooding
  - Reduction of Stress, Velocity and Settlement of Sediment
- Adjacent Infrastructure
  - More frequently impacted (manholes, sewer lines, roadways, buildings, etc.)
- FEMA – Legal Property Issues, Likely Increase in Litigation
- Factor of Safety – Hydrology, Stability Computations, etc.
- Alluvial, Threshold, and Valley Restoration Strategies have space limitations
- Additional Gully Formation and Damage to Outfalls connecting uplands to streams
- Landscaping Changes – Drought and Extreme Flood variability – Diversity of Species (TU Study)
- Stormwater Infrastructure/Retrofits
- Design with Time of Concentration and Floodplain Storage as Driver? Hydromodification?

What are the prospects for floodplain reconnection? - Methods

Figure 2. Floodplain Restoration by Raising the Stream Bed (Courtesy: Joe Berg, Biohabitats)

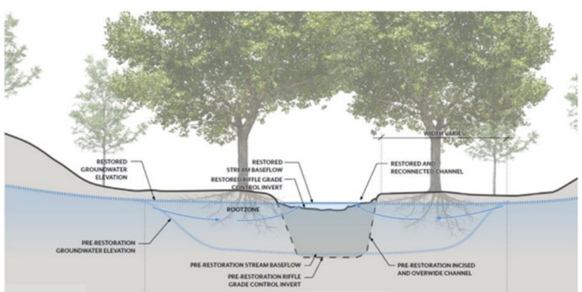
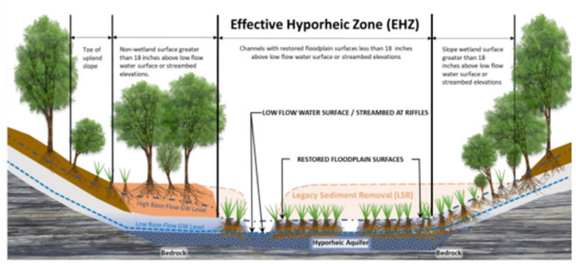
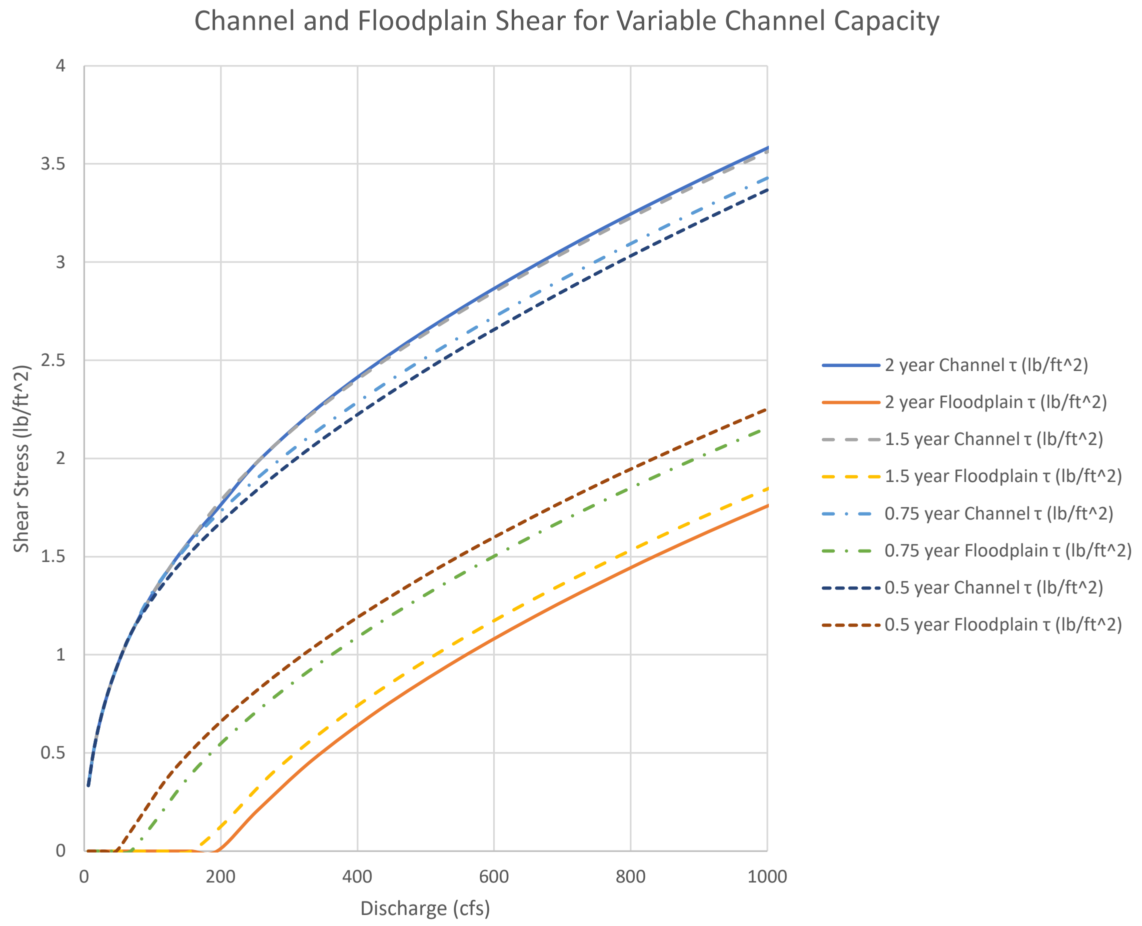


Figure 1. Floodplain Restoration Using Legacy Sediment Removal (Courtesy: Jeff Hartranft, PA DEP and Art Parola, University of Louisville)



- Two Generally Understood Options –
  - Raise the Channel and Lower the Floodplain
- Two Alternative Strategies
  - Hydraulic Modification (Roughness and Natural Modification via Beaver) and Offline Floodplain Wetlands
- Should we look to modify our floodplain reconnection strategies to create additional storage or modify hydrographs?

Example Channel Capacity Evaluation



What are the prospects for floodplain reconnection? - Challenges

- Public Perception – Seek consensus on tree takes? Address off-site drainage issues?
- FEMA
- Cost and Carbon Offsets
- Width Limitations – Property Rights, Infrastructure
- Natural Resource and Tree Impacts
- Not every floodplain is a sponge or underlain with basal gravels – more Geotech investigations
  - Soil treatments and amendments
- Compaction during construction
- Mobilization of Floodplain Sediments
- Trash Accumulation
- Vegetation Re-Establishment
  - Buoyancy/Drag Force
  - NNI
  - Desiccation/Watering
  - Predation
  - Microtopography
  - Groundwater Alteration

Would projects, including LSR projects, need for more armoring?

- Depends on Hydraulic Control, Floodplain Width and Drainage Area
- At Crossings and Infrastructure
- Current Projects Bury Riprap in Areas of High Floodplain Stresses
  - Armor floodplain or channel or both?
  - What do you do if you can’t meet your shear stress tolerances?
- Need more understanding of vegetation dynamics

What are the implications on project longevity and possible sediment/nutrient remobilization?

- Maintenance and Monitoring
- Think about in terms of Existing versus Proposed
- Sources versus sinks
- Locations of Infrastructure
- Vegetative Community Changes
  - Plant Stress
  - Hydrologic Regimes
  - Soil Conditions
- No one size fits all






Thank You!!