Innovations in Stream and Watershed Restoration

November 14-15, 2013 Spanish Fort, Alabama

Thank you sponsors: Hydro-Engineering Solutions, Southern Excavating, and Thompson Engineering, Inc.

Partners: City of Daphne, City of Foley, Alabama Cooperative Extension System, Auburn University, Mobile Bay National Estuary Program

Innovations in Stream and Watershed Restoration

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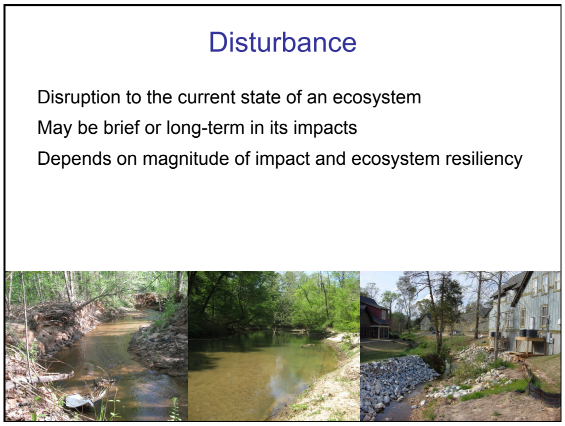
Schedule

I. Watershed Overview Stressors and Responses
II. Watershed Hydrology
III. Design Tools for Restoration
IV. Permits for Restoration
V. Vegetation for Restoration
VI. Field Tour of Projects
VII. Watershed Case Studies
VIII. Design Activity

Name That Disturbance

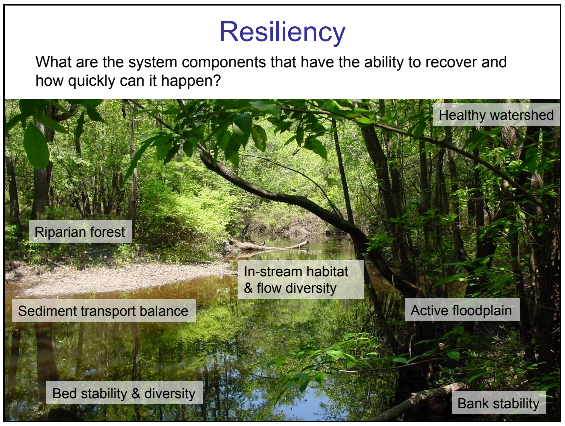


Disturbance

Disruption to the current state of an ecosystem

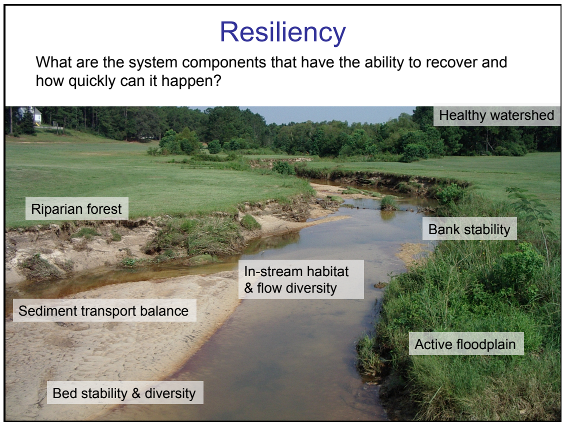
May be brief or long-term in its impacts

Depends on magnitude of impact and ecosystem resiliency



Resiliency

What are the system components that have the ability to recover and how quickly can it happen?



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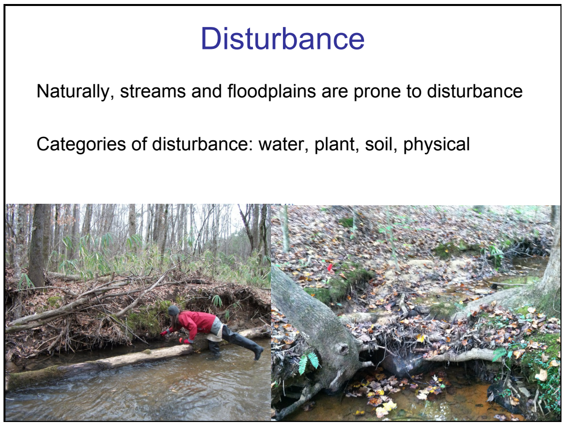
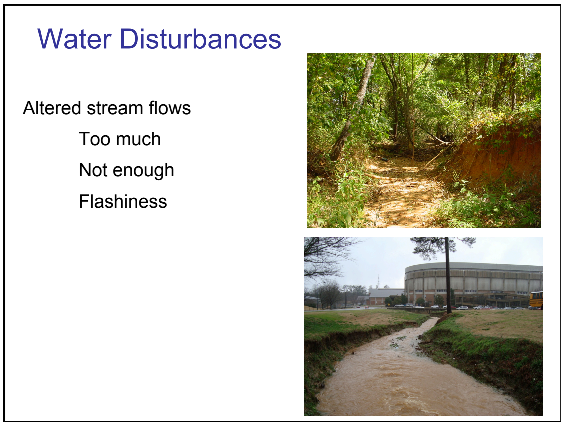


Disturbance

Naturally, streams and floodplains are prone to disturbance

Categories of disturbance: water, plant, soil, physical



Water Disturbances

Altered stream flows
- Too much
- Not enough
- Flashiness

Water Disturbances

Increased water temperatures

Decreased dissolved oxygen

Increased pathogens

Increased nutrients

Increased sediment

Increased toxins

Increased litter

Plant Disturbances

Competition with invasive, exotics

Herbivory

Soil moisture saturation or deficits

Soil Disturbances

Compaction

Loss of top soil

Aggradation

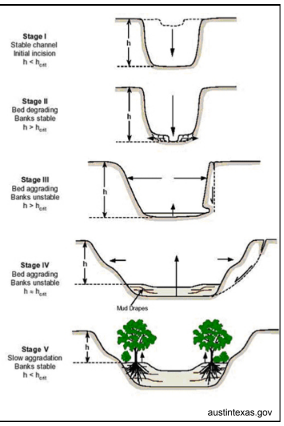
Altered biogeochemical cycling

Decreased infiltration rates

Root growth restriction

Anthrosols - soil class - human activities resulted in profound modification or burial of original soil horizons, through removal or disturbance of surface horizons, cuts and fills, secular additions of organic materials, long-continued irrigation, etc.

Physical Disturbances



Change in erosion and deposition patterns

- Changes in sediment supply
- Streamflow changes

Channel evolution (Schumm 1984)

austintexas.gov

Channel Stability – Stage I

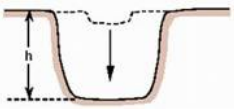
Stable stream channel

Erosion and deposition are ~ equal in stream reach

Erosion on outside of stream bends & deposition on inside

h < hc (height of banks is less than the critical bank height)

Stream banks support vegetation



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Channel Stability, Stage II

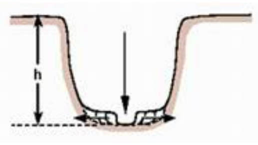
Channel evolution following increase in stream flow (Q) or stream slope (S)

Stream increases sediment discharge (Qs) or particle size (D50)

Greater sediment discharge leads to downcutting of streambed

Bank height becomes higher than the critical bank height (h > hc)

This stage characterized by degradation (loss of material).



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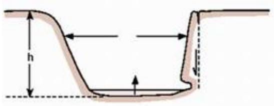
Channel Stability, Stage III

Banks begin to collapse.

Stream channel becomes progressively wider

Stream banks are still higher than the critical bank height

This stage also characterized by degradation



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Channel Stability, Stage IV

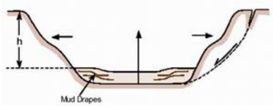
Stage III erosion & bank collapse add sediment which cannot all be removed by stream

Through this accumulation of sediment, weak riffle-pool bed features begin to form

Stream bank height begins to stabilize to critical height

Stream channel may shift among different channels within main channel

This stage characterized by aggradation



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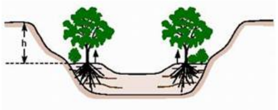
Channel Stability, Stage V

Channel evolution is complete

Channel is stable at a lower elevation

Banks are lower than the critical bank height

Terraces may be visible - remnants of the original floodplain



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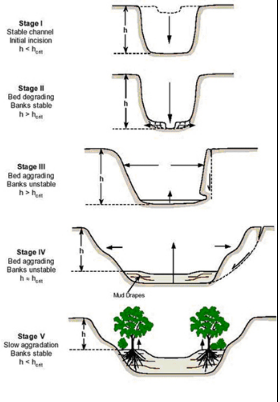
Channel Stability

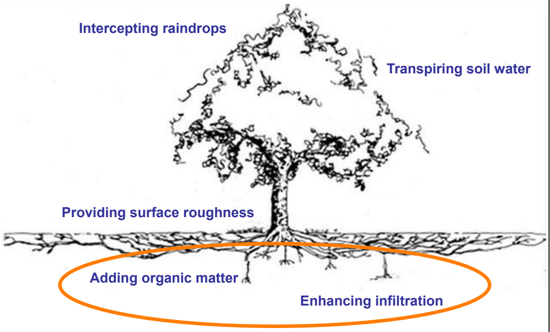
Soil erodibility is inversely proportional to resistance of soil to erosion.

How can we increase resistance to erosion?

The importance of vegetation



Plants reduce soil erosion



www.boroondara.vic.gov.au

Gyssels et al., 2005

Roots

Roots grow with adequate oxygen and moisture

Most active roots in top 1 m of soil

Majority of roots in top 10-30 cm

Roots grow most of year, not in cold temps or saturated soils

Root Functions

Absorption of water and minerals from soils

Storage of nutrients produced by the leaves

Anchor

Roots Influence Soil Erosion

Soil aggregate stability:

Roots 'glue' soil particles with root secretions, increase organic matter and biological activity

Soils.usda.gov

Infiltration capacity:

Roots create macropores that increase soil infiltration, decreases bulk density, reduce surface runoff

soilandwater.bee.cornell.edu

Roots Influence Soil Erosion

Soil is strong in compression, but weak in tension

Plant roots are weak in compression, but strong in tension

Combined, soil-root matrix produces reinforced earth much stronger than soil or roots separately (Simon and Collison 2001)

Roots Influence Soil Erosion

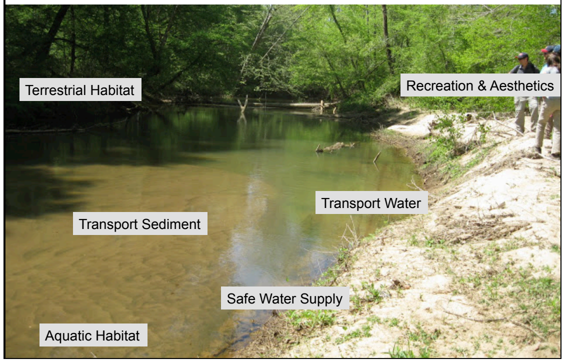
Diversity is important: Type and Species

- Small roots have more strength per unit area than large
- But, small roots lack sufficient area to increase soil strength – large roots provide most reinforcement (Simon and Collison 2001)

- Switch grass has strong root strength (high root area ratio)
- River birch and sycamore had stronger root strength than black willow or sweet gum (Simon and Collison 2002)

Limit to roots ability to resist

Water + Plant + Soil + Physical Disturbances =
Loss of Stream Functions



The Gain of Functions

Stream and Floodplain Re-evolution
- Floodplain connectivity
- Water quality
- Channel morphology
- Channel structures
- Native plant community

February 2008

2008 May

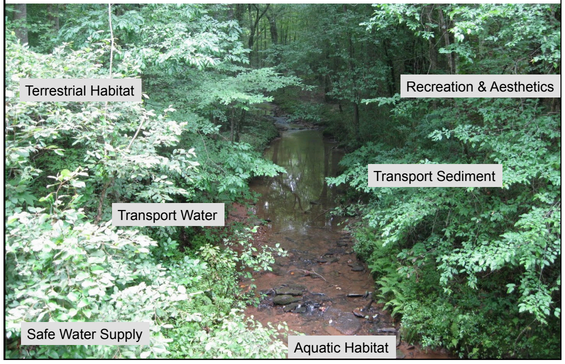
2009 June

2011 July

2013 November

2013 November

Water + Plant + Soil + Physical Restoration = Gain of Stream Functions



What are the watershed benefits?

Floodplains as BMPs

Southern forested wetlands - documented pollutant transformation

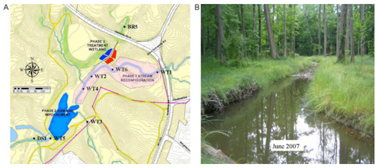
P sediment deposition: 1.6 to 36.0 kg ha-1 yr-1

P adsorption: 130 to 199 kg ha-1 yr-1

Denitrification of NO3-N: 0.5 to 350 kg ha-1 yr-1

Walbridge, M.R. and B.G. Lockaby. 1994. Effects of forest management on biogeochemical functions in southern forested wetlands. Wetlands (14)1 pp 10-17.

Duke, NC



($NO_2^- + NO_3^-$) –N loads reduced by 64%

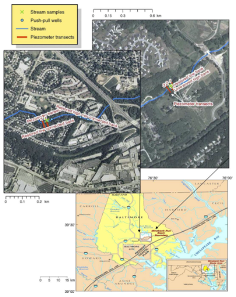
P loads were reduced by 28%

600m stream / floodplain restoration, 1.6 ha storm water reservoir/ wetland complex & 0.5 ha surface flow treatment wetland

Richardson, C.J., N. Flanagan, M.Ho, and J.Pahl, Integrated stream and wetland restoration: A watershed approach to improved water quality on the landscape, Ecological Engineering, vol. 37 (2011), pp. 25-39.

Baltimore, MD

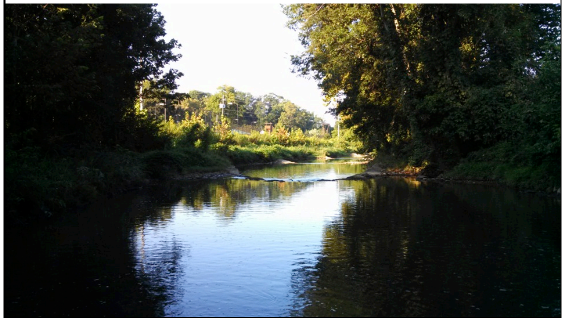
Riparian areas with low, hydrologically ‘‘connected’’ streambanks designed to promote flooding & dissipation of erosive force for storm water management had substantially higher rates of denitrification than restored high ‘‘nonconnected’’ banks and both unrestored low and high banks



Kaushal SS, Groffman PM, Mayer PM, Striz E, Gold AJ. 2008. Effects of stream restoration on denitrification in an urbanizing watershed. Ecological Applications, 18(3), pp. 789–804.

Next …

Engineering components to address disturbance



Floodplains as BMPs?

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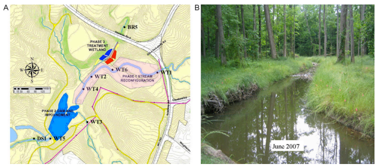

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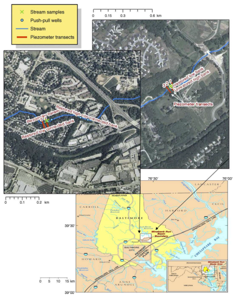

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