Implications of Channelization and Sedimentation on Bottomland Hardwood Ecosystems

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Hydrology

- Single most important factor affecting wetland function
- Influence plant structure, composition, invert communities and wildlife

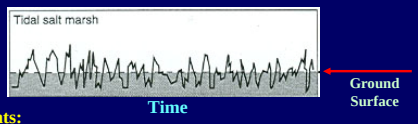
Hydroperiod

- Seasonal pattern of water level in a wetland
- Defines the rise and fall of a wetlands surface and subsurface water levels

Wetland Hydroperiod

Seasonal pattern of water level in a wetland.

Hydrologic Signature → **Hydrograph**



Depth

Time

Ground Surface

3 Components:

1) **Flood duration:** (6 COE Zones) **Average or total amount of time standing water exists during a flood event.**

2) **Flood frequency:** **Average number of times a wetland has standing water per year.**

3) **Flood depth:** **Depth of aboveground standing water.**

Hydroperiod Variability

- General patterns over long-term but highly unpredictable within and among years
- Natural variability is essential to maintain system productivity

Flood Pulse Concept

- Lateral connectivity of a river and its floodplain is critical for productivity of river, forests, and its organisms
- Life-cycles of floodplain plants and animals and many floodplain functions (e.g., sediment retention) are linked to flooding patterns

Dynamic Hydrology of Hardwood Bottomlands

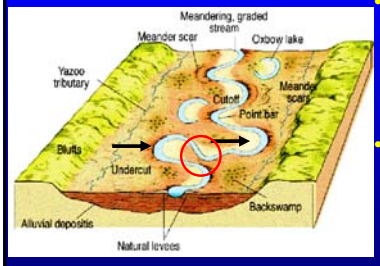
Day 1

Day 5

Natural hydroperiod is characterized by stochastic and ephemeral flooding events

Unaltered Systems

Geomorphology



- Floodplains are formed from the erosion and deposition of sediment
- Patterns and rates of erosion and deposition are critical forces affecting wildlife and fish habitat

Where is natural scouring and deposition occurring?

Sedimentation

- Provides sediment retention, improves water quality, replenishes nutrients, and creates new areas for colonization by wetland plants

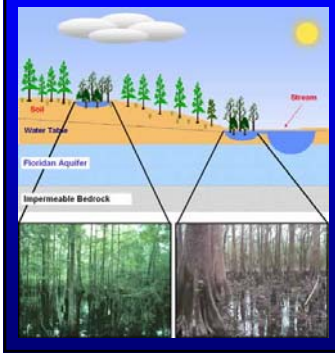
Point bar deposition – within stream channel

- creates ridge and swale topography
- temporary storage of sediment

Vertical Accretion – deposition in the floodplain

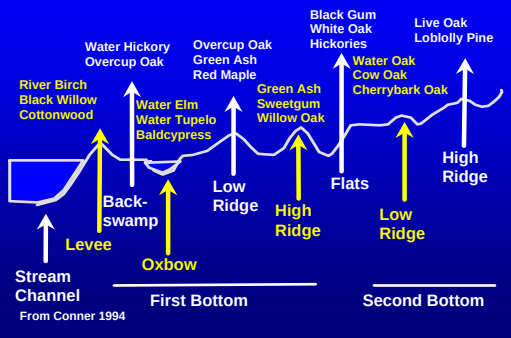
- results from overbank flooding
- forms the primary floodplain soils
- rates and textures are highly variable

Overbank Sedimentation



- Deposition rates typically <1 cm/yr
- Most deposition occurs near the stream channel
- Depressional areas can also receive high rates of deposition

Geomorphology and Vegetation



From Conner 1994

Activities Impacting Wetlands

- Dams
- Highways
- Irrigation
- Levees
- Oilfield Canals
- **Channelization**

Reasons for Channelization

- Mainly for agricultural purpose to remove water from land for cultivation

Channelization

- Straightens, shortens, and steepens stream channels
- Increases stream velocity and stream power
- Facilitates transport of sand to the river system
- Impacts hydrology and geomorphology

Hydrologic Impacts

- Alters timing, depth, duration, and frequency of flooding
- Disconnects rivers from the floodplain
- Can cause excessive ponding at confluences

Geomorphic Impacts

- Excessive sediment deposition, increased overbank flooding, increased water table, degrade bottomland systems

Hatchie River

- Headwaters are in Upper East Gulf of Mexico Coastal Plain
- Drains into MS River
- Longest unchannelized stretch of river in LMAV

Hatchie River

- Supports 100 species of fish, 250 species of birds, 50 species of mammals, 35 species of mussels, and numerous herps
- Globally rare Hatchie River burrowing crayfish
- TNC "Last Great Place" list

http://www.hatchie.com/index.html

BLH Forests

- Structurally diverse
- Highly productive
- Important timber resource and provides important wildlife and fisheries habitat

Economic Value

- Over $3.6 billion generated by timber industry in West TN in 1997
- BLH are an important component of regional and state economy

BLH Losses

System Alterations

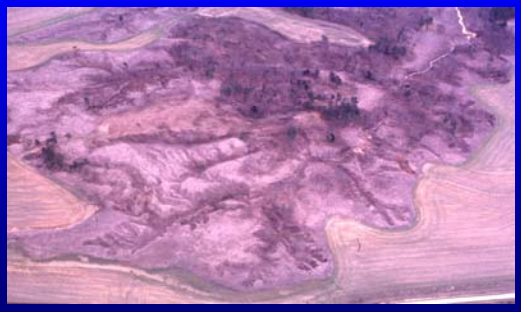
- Extensive channelization of over 90% of the tributaries
- Altered hydrology caused rapid geomorphic adjustment

Root of the Problem

- Geology – Source of the sand
- Past and Present Land Use – expose the sand

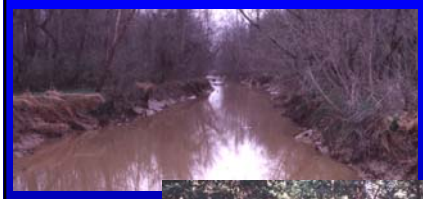
Thin Fertile Loess Layer with Underlying Sand

Gully Erosion

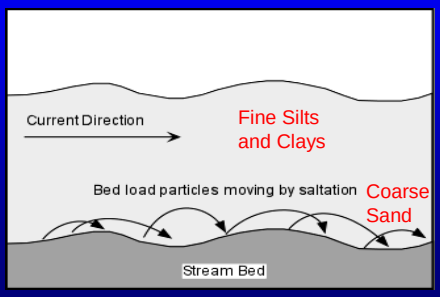


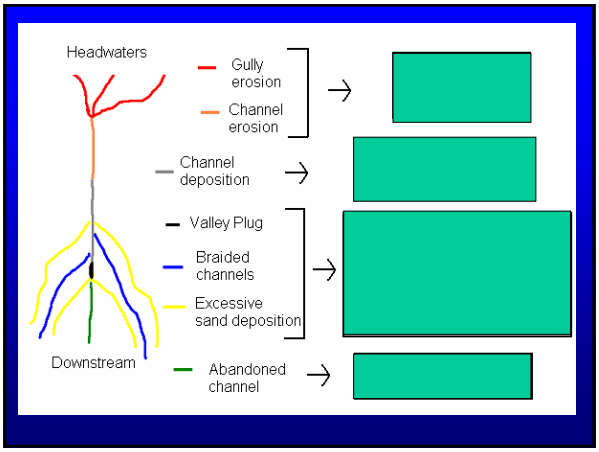
Channel Erosion

Jeffers Creek



Bed Load Transport

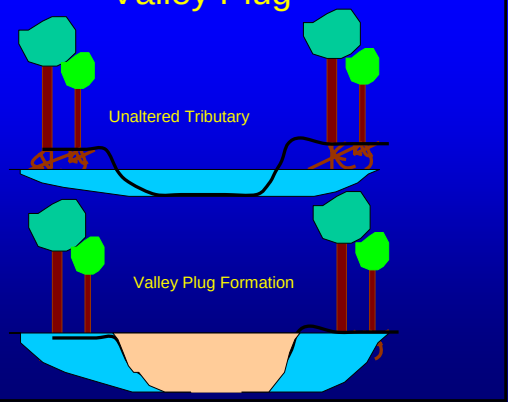




Valley Plugs

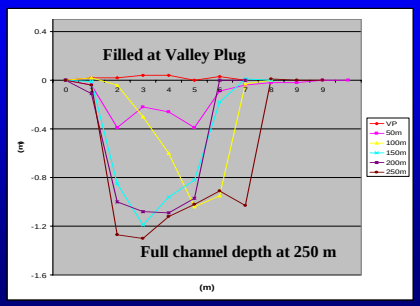
- Occur where sediment (sand) laden waters slow in velocity
- Debris jams and intersections of tributaries and rivers are common locations
- Completely plugs the channel
- During subsequent flows, the plug enlarges upstream as additional sand is deposited

Valley Plug



Bear Creek Channel Profile

Distance upstream from VP and Channel Depth

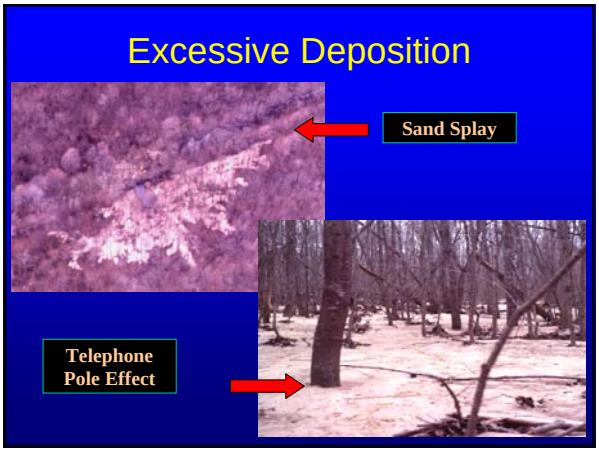


Possible Impacts

Hickory Creek – valley plug

- Increases in the water table height
- Shift in floodplain plant species composition
- Homogenizes aquatic habitats
- Alters flood frequency


Overbank
Flooding


Excessive Deposition
Sand Splay
Telephone
Pole Effect


Sanding of Timber
• Kills standing timber
• Alters tree species composition
• Buries productive soils

Ponding of Timber

- Increased water table and accelerated natural levee development encourage permanent ponding of timber

Abandoned Channel

- Reduced flooding and sedimentation leading to a shift in species composition

Shoal Sites

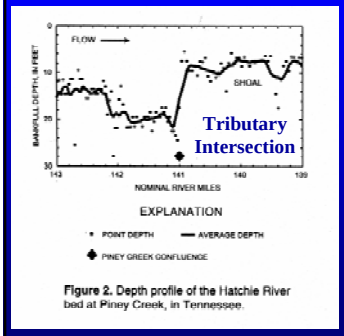
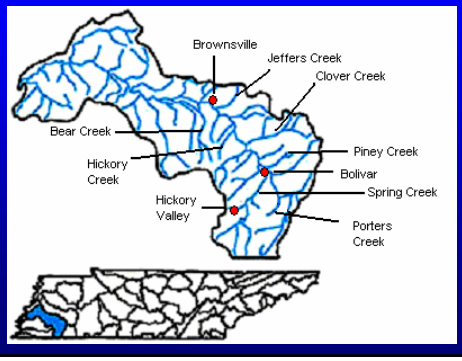


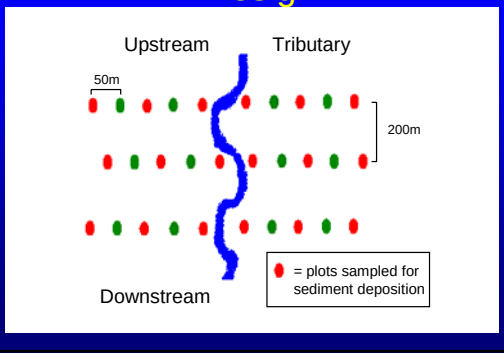
Figure 2. Depth profile of the Hatchie River bed at Piney Creek, in Tennessee.

- Shoal sites may be impacted in similar ways as valley plug sites but to a lesser extent
- Channel filling influences overbank flooding and the water table
- Crevasse splays cause excessive deposition in the floodplain

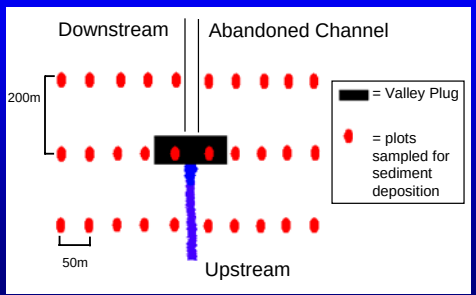
Location of Study Streams



Control Study Site Sampling Design



Valley Plug Study Site Sampling Design



Feldspar Clay Sediment Pads

Excessive Sand Deposition

Early Spring

Fall

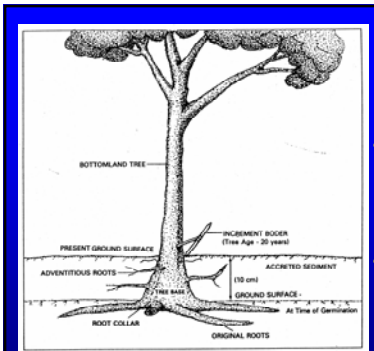


Figure 3. Generalized "buried" bottomland tree. As an example, excavation to original roots shows, at least, 10 cm of deposition since germination. Tree-ring analysis indicates tree is 20 years old. Therefore, the sedimentation rate, in the vicinity of the tree is approximately 0.5 cm/yr.

- Dendrogeomorphic approach to measure sedimentation
- Provides a long-term average of sedimentation

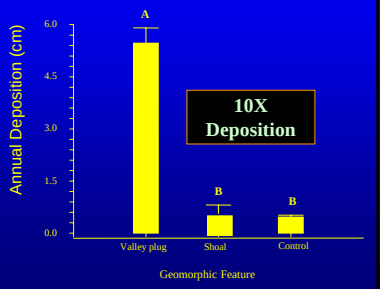
Relate age with depth to root collar (tree base)

Mean Annual Deposition 2002-2004

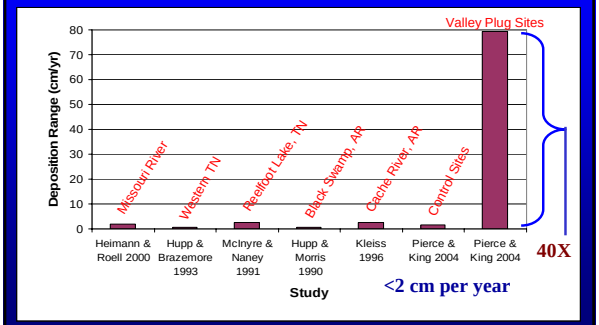
Valley Plug Sites (4):
- Mean = 5.46 cm/yr
- SE = 0.44

Shoal Sites (2):
- Mean = 0.57
- SE = 0.24

Control Sites (4):
- Mean = 0.46 cm/yr
- SE = .05

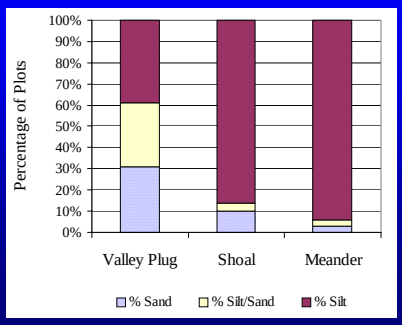


Maximum Annual Sediment Deposition Rates (cm/yr)

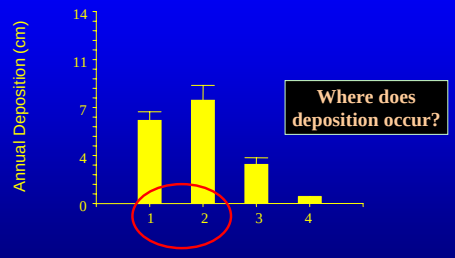


Deposition Texture Types

Larger Sediment at VP and Shoals!

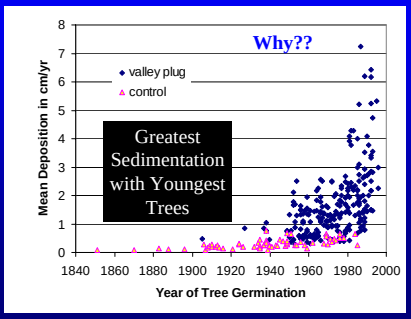


Deposition at Valley Plugs by Location

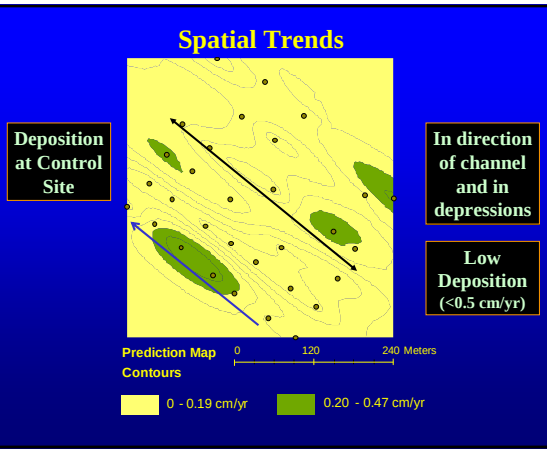


1 = upstream of vp, 2 = at vp, 3 = downstream of vp, 4 = control

Dendrogeomorphic Analysis



Spatial Trends



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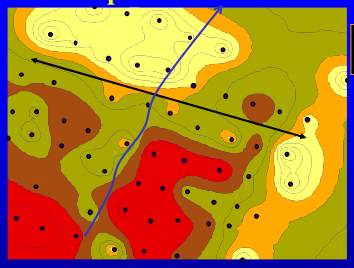


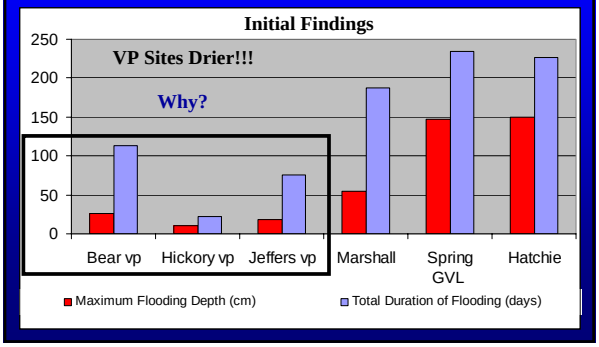
Summary

- Deposition is 10 times greater at valley plug sites than at control and shoal sites
- Significant differences in deposition types among soil types
- Valley plugs are progressing upstream, impacting new areas
- Valley plugs change the spatial dynamics of sedimentation

Future Work

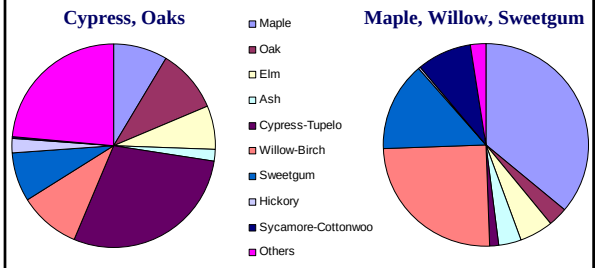
- Investigate linkages between excessive sedimentation and changes in surface and subsurface hydrological regimes
- Determine implications of excessive sedimentation, surface and subsurface hydrology on succession of BLH forests

Maximum Flood Depth and Total Duration of Flooding



Abundance of Tree Species

Control Site | **Initial Findings** | Valley Plug Site



Differences in Species Evenness!

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Questions?

Photograph by Byron Jorjorian