Headwater Channel Restoration as a Tool to Aid in Red Spruce Restoration

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In cooperation with

Monongahela National Forest
Trout Unlimited
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Forest Hydrology

- Typically think of manipulating forests to influence hydrology

- Reverse approach: manipulate hydrology to promote red spruce restoration

Headwater Channels

Premise of this work:

Headwater channels are more well developed than they would be in the absence of disturbances (esp. historic disturbances in spruce ecosystems)
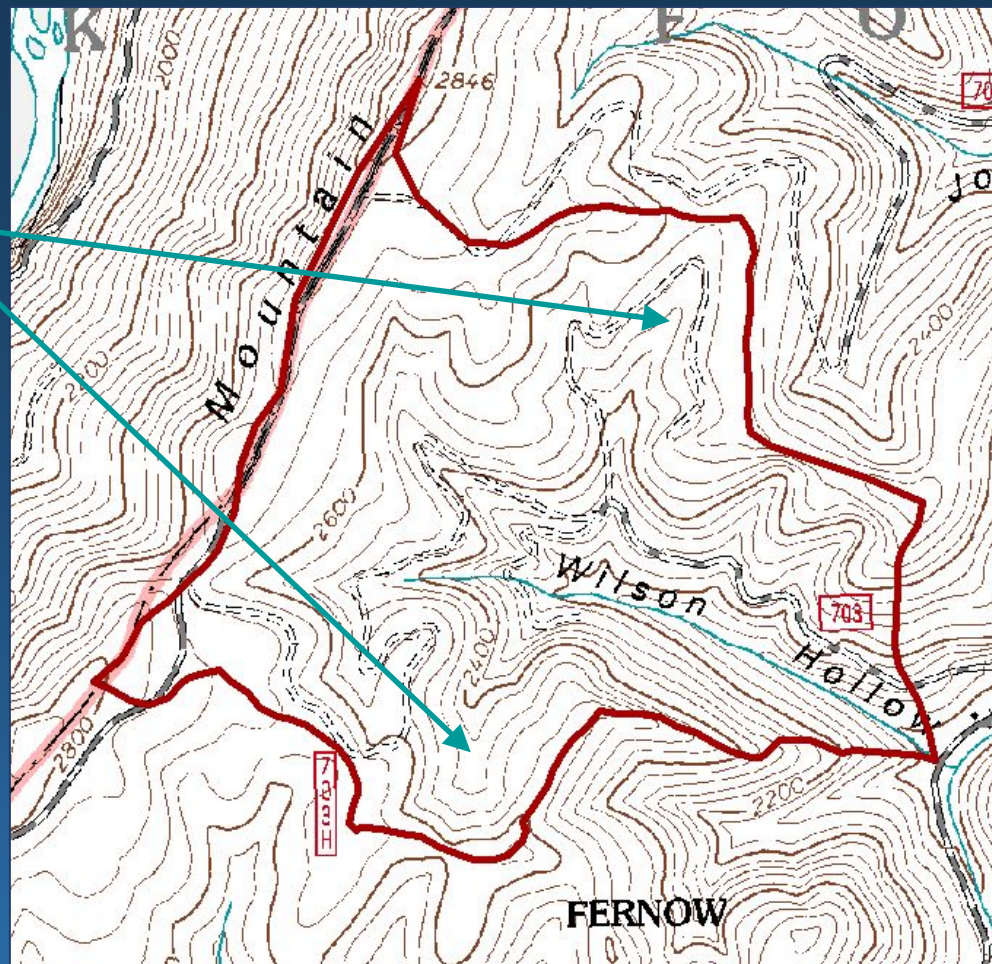
Well developed means
- wider
- deeper
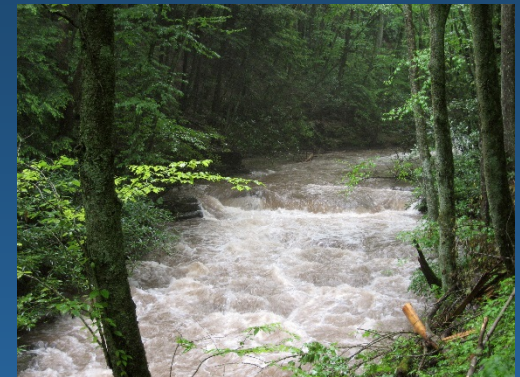- longer (head cuts)

Headwater Channels

Headwater channels
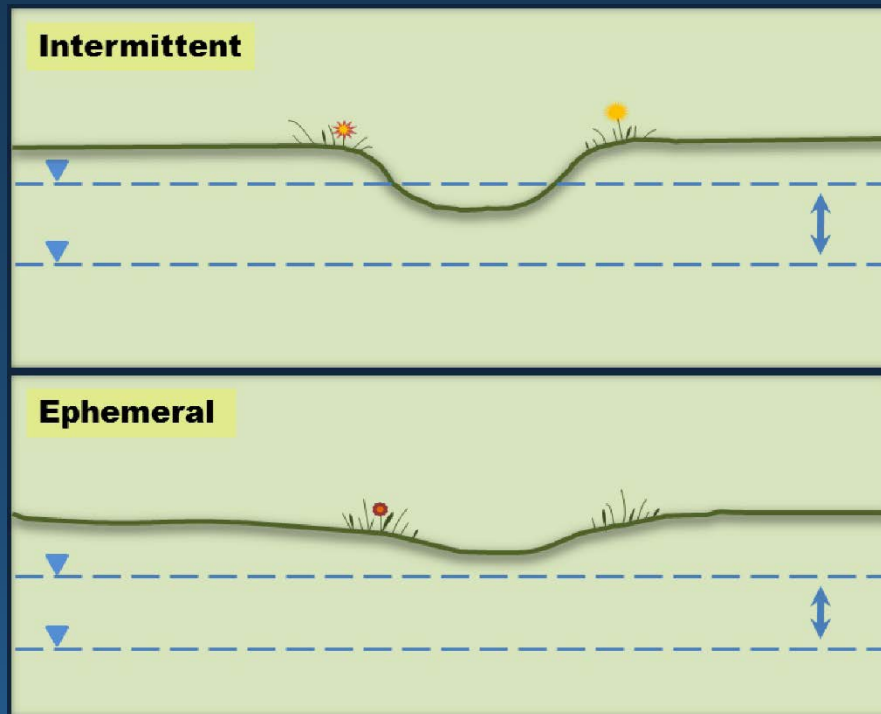
Headwater Channels

- Greater channel development or expression is the result of increased in-channel erosion, which is driven by the energy of water in the channel

Water does the work of erosion and the work of sediment transport
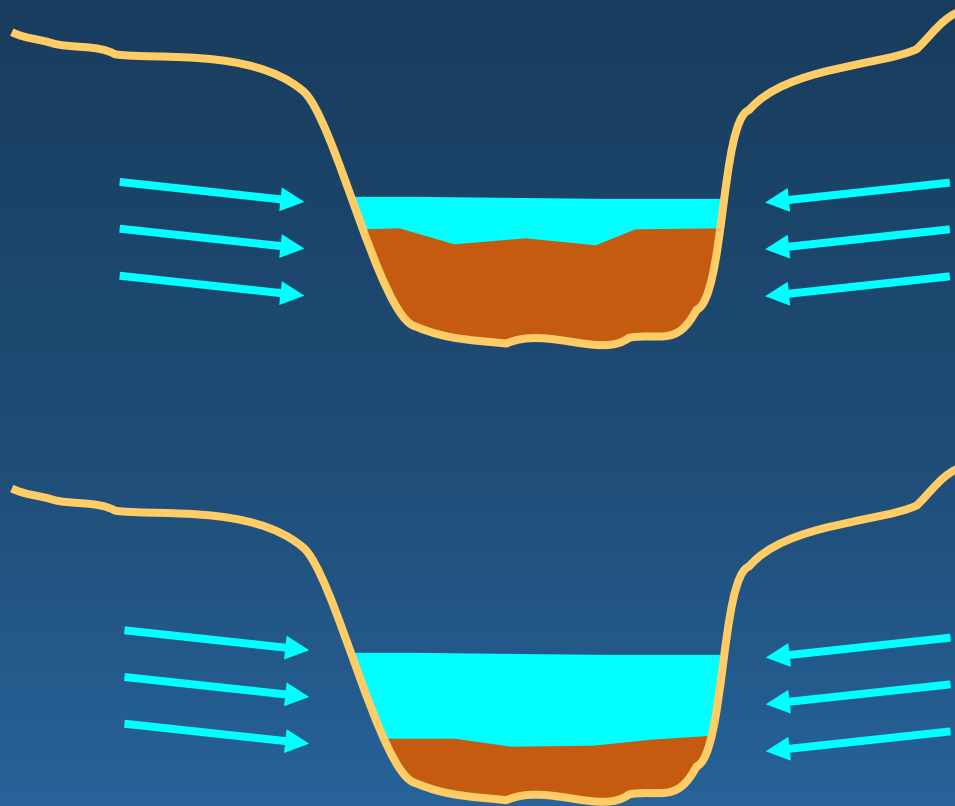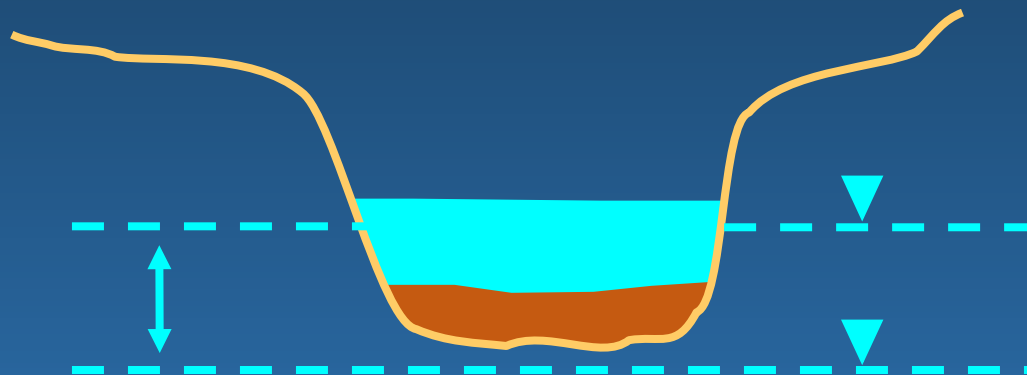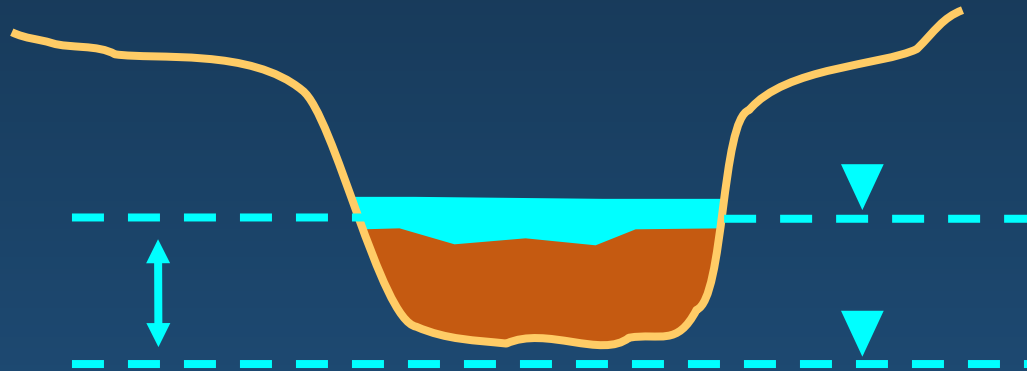
Headwater Channels

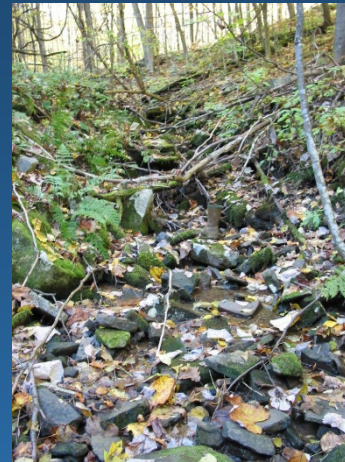Channel types

Headwater Channels

Headwater Channels

Headwater Channels

Interpretation of increased channel expression is that headwater channels have shifted from areas of sediment storage to sediment sources

Link to Forest Restoration

If we can reverse channel development, especially down cutting and head cutting, we can reduce the amount of water that becomes surface flow during storm and melt events (ephemerals and intermittents) and during base flow (intermittents) and keep it in the headwater soils (or keep more of it there longer)

Link to Red Spruce Restoration

- Red spruce require cool, moist soils; with climate change, increased above-ground temperatures will increasingly stress red spruce stands

- Increased soil moisture storage will directly provide the moisture that spruce require and reduce soil temperatures which may reduce overall stress

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Channel Restoration

How do we make the shift from channels as areas of sediment sources to sediment storage?

Energy controls erosion processes, so reduce available energy by:

- Reducing volume of streamflow
- Reducing the velocity of streamflow

Channel Restoration

- Reducing volume by aggrading the stream channel - building up the elevation of the channel bed through sediment deposition

- Reduce the velocity to allow aggradation by increasing channel roughness (frictional loss of energy)

Channel Restoration

How do we make channel aggradation happen?

How do we increase channel roughness?

Simplest and cheapest way – add wood to channels

Channel Restoration

We know that adding wood to perennial channels can influence energy and sediment deposition

Channel Restoration

Gully plugging works by similar processes – providing friction, using check dams to pool water and allow deposition, etc.

Concept is the same, so the approach of adding wood should work for headwater channels

Channel Restoration Using Wood

Methodology for Headwater Proof of Concept
(East Fork Upper Greenbrier River Watershed, MNF)

- Piles
- Random placement

Channel Restoration Using Wood

- Non-engineered design

- Use available wood

- Limit prescriptions as much as possible to increase "user friendliness" of the approach and to maximize appeal of approach to private land owners

Affirmation of Proof of Concept

Structure-from-motion

- Image analysis technique that builds 3-D structure from 2-D photo arrays
- Employ GIS to identify changes in volume or area changes within an area of interest from repeated measurements

Structure-from-Motion

- 3 photographed segments per headwater tributary (upper, middle, lower)
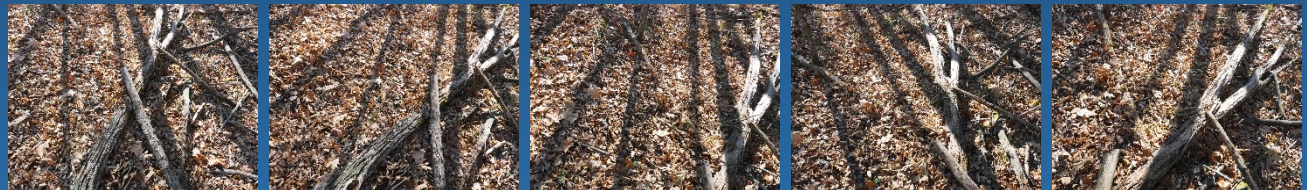- Segment corners are outside of channel boundaries, but are "permanent"

Structure-from-Motion

- Series of overlapping photographs covering the entire segment

- 100-200 photographs per segment
- "Aerial" view

Structure-from-Motion

Agisoft Photoscan software used for all image processing and creation of digital elevation model (DEM)
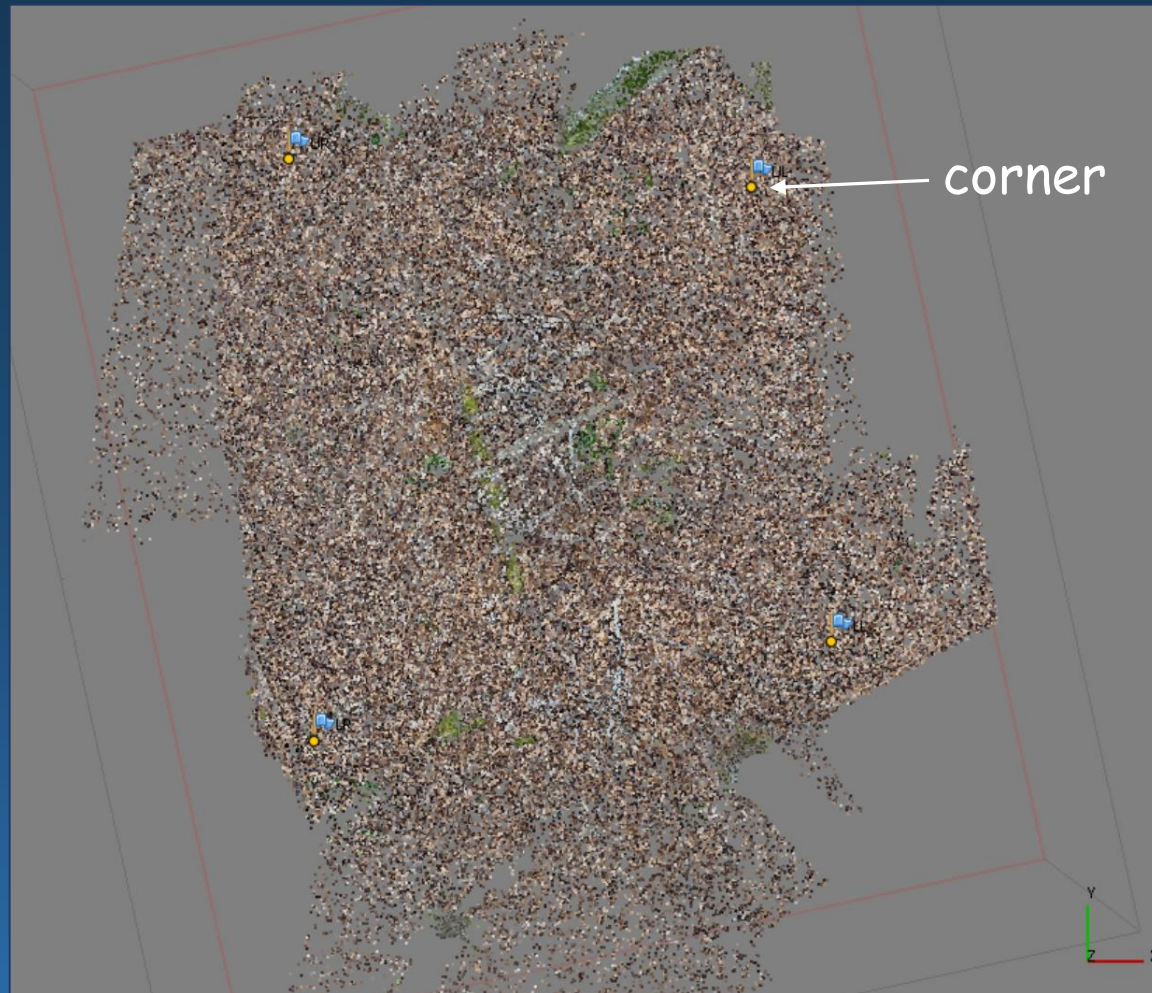
Data processing steps (simplified):

1. Designate corners in all photos
2. Align photos → sparse point cloud
3. Build dense point cloud
4. Build and export DEM
5. Build orthomosaic of all photos

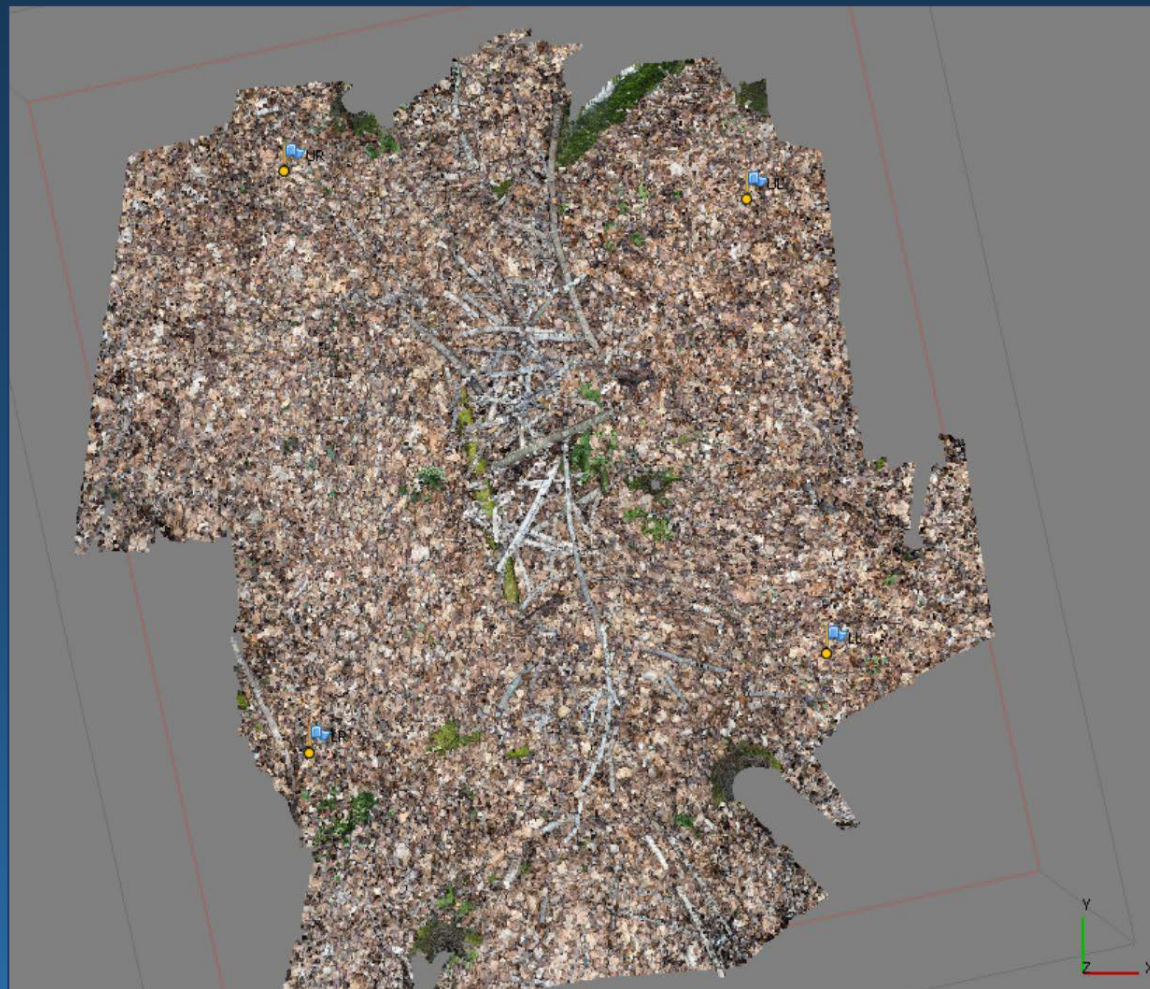All steps include quality checks and adjustment of settings as needed
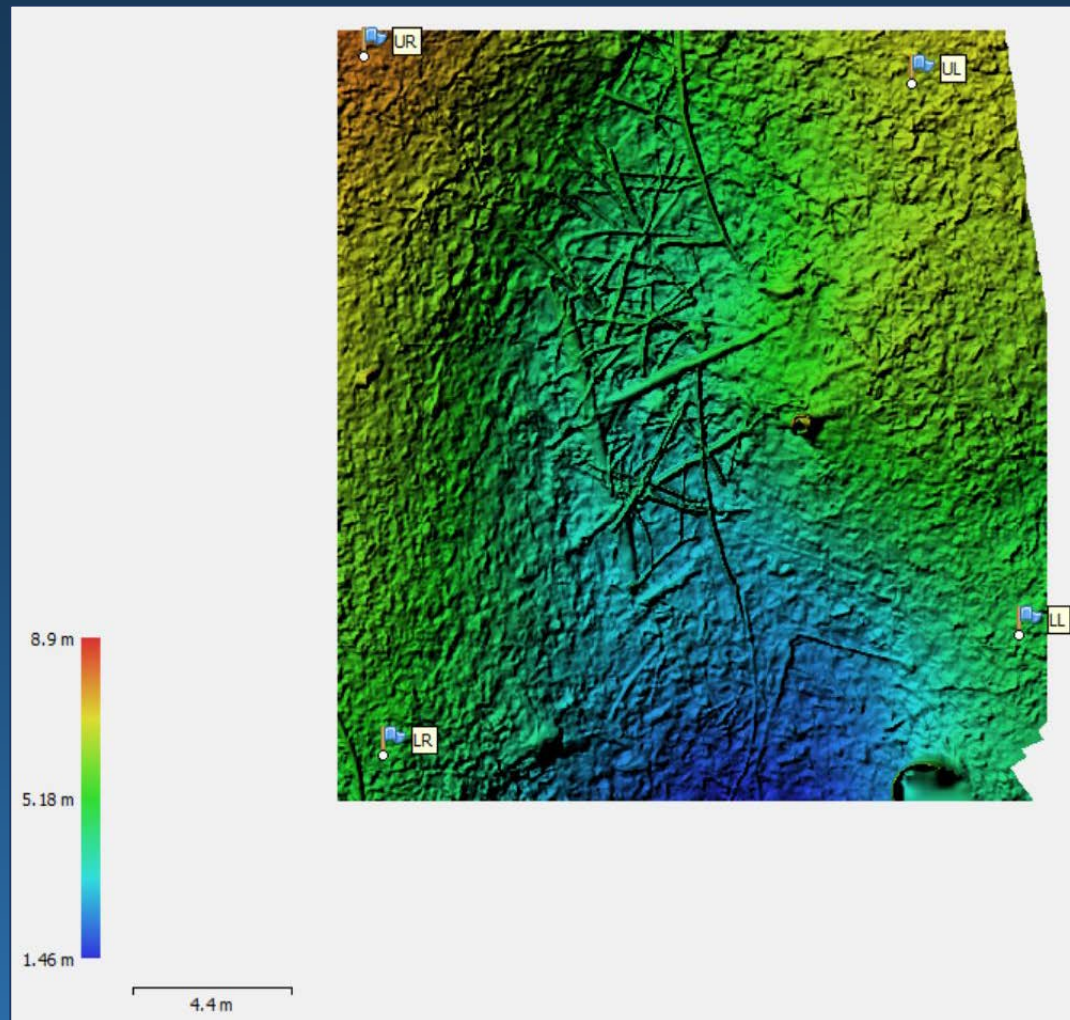
Structure-from-Motion

Sparse
cloud

corner

Structure-from-Motion

Dense
cloud

Structure-from-Motion

DEM

Structure-from-Motion
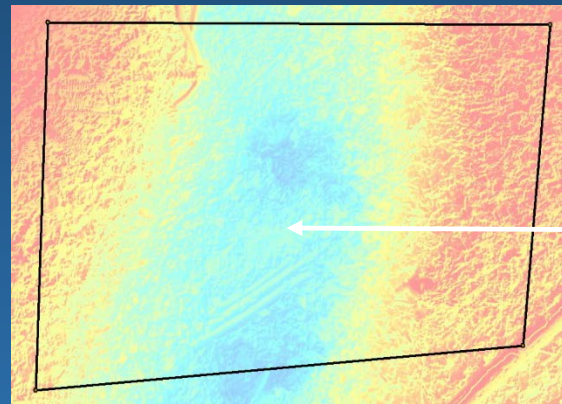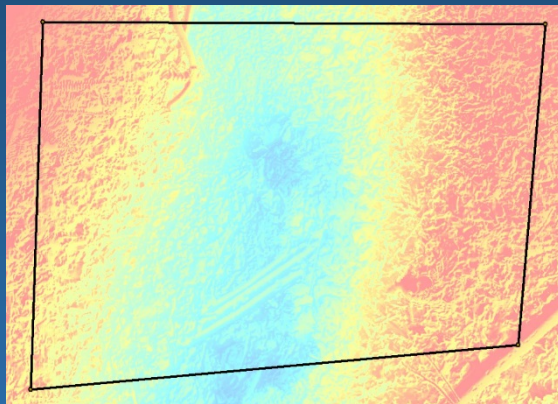
Sensitivity test – manually added sediment to channel

Before   After

added sediment

less of darker blues

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Additional Data Collection

- Physical landscape variables
- Physical characteristics of placed wood
- Subsequent additions of wood

- If concept is affirmed, examination of magnitude and spatial extent of soil moisture changes

Current Status

- First year of field measurements
- Shooting for ~20 tributaries
- 24-48 hours to process a single segment

Questions?