The River Bathymetry Toolkit (RBT)

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Rocky Mountain Research Station, Boise, Idaho
Air, Water, and Aquatic Environments Program

RBT Goals

- Automate the interpretation of hydraulic geometry from high resolution DEMs
- Map aquatic habitat over a range of spatial scales
- Support some limited numerical flow modeling

Specific Objectives

- Freeware
- Include community design input
- Based on ArcGIS 9.3
- Maximum user flexibility

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RBT Approach and Methods

Input data

- High resolution undetrended raster
- Detrended raster
- Banks polygon (warning about “bankfull”)
- Centerline of channel

Derived products

- Cross-section “store”
- Gradient and Sinuosity
- Long Profile of any metrics
- HEC-RAS input data

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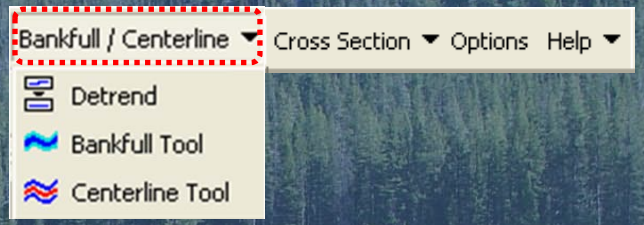
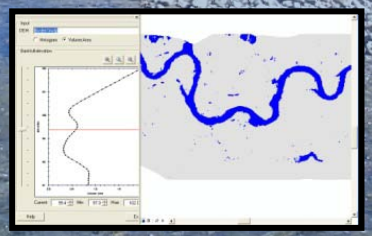
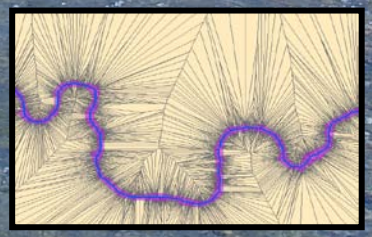
RBT Workflow

I. PRE-PROCESS INPUT DATA



INPUT	RBT TOOL	RBT PRODUCT
High Resolution DEM	DETREND TOOL	Banks, Thalweg and Centerline (geomorphic)
		Detrended DEM
Detrended DEM	BANKFULL TOOL	Banktop Polygon (elevation)
Banks and Thalweg	CENTERLINE TOOL	Centerline (Thiessen polygons)





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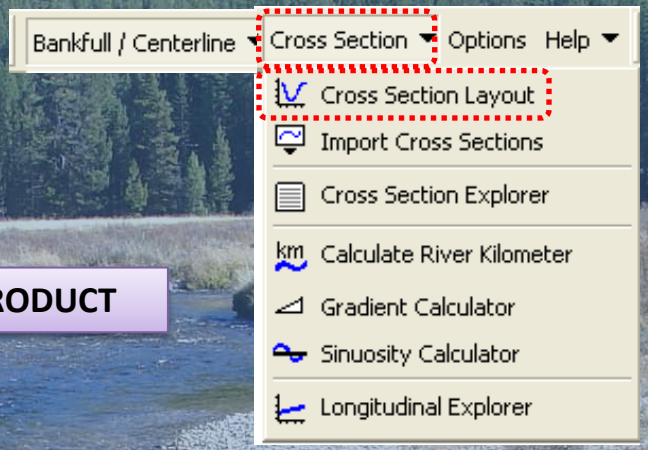
RBT Workflow

II. CREATE CROSS SECTIONS

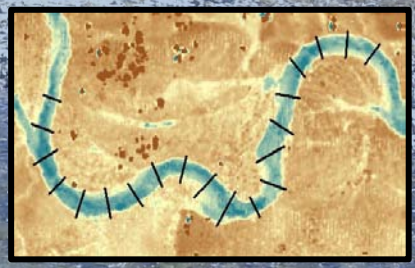


INPUT	RBT TOOL	RBT PRODUCT

Banktop & Centerline Shapefiles

High Resolution DEM

→ CROSS SECTION LAYOUT TOOL → Cross Section Shapefile



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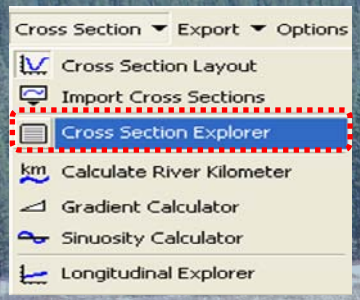
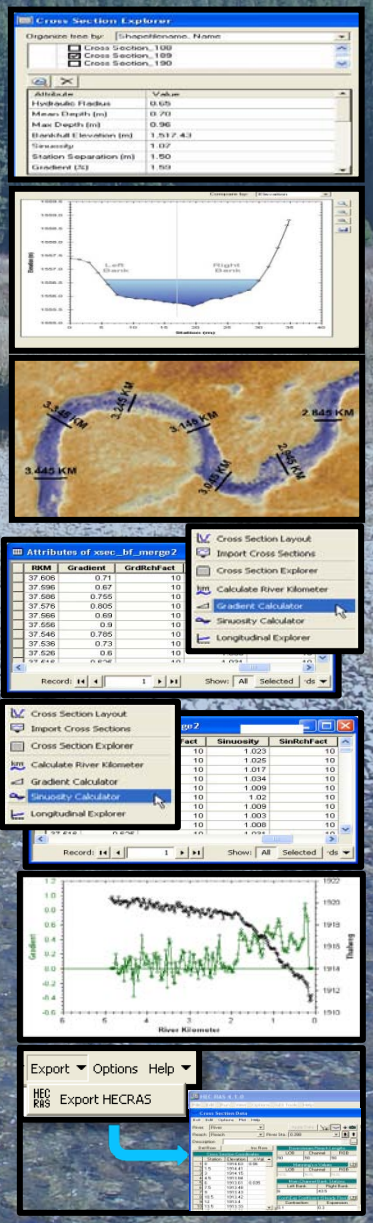
RBT Workflow

III. ACCESS RIVER ATTRIBUTES



INPUT	RBT TOOL	RBT PRODUCT
Cross Section Shapefile	CROSS SECTION EXPLORER	Metrics Table
		Cross Sections Display
	CALCULATE RIVER KM TOOL	Cross Section Distance
	GRADIENT CALCULATOR TOOL	Channel Gradient
	SINUOSITY CALCULATOR TOOL	Channel Sinuosity
	LONGITUDINAL EXPLORER TOOL	Attribute Profiles
	EXPORT TOOL	HEC-RAS Topography



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Current Status and Warnings

- This is research software
- Hydraulic geometry module is largely finished
- HEC-RAS interface is finished
- You are the first large beta testing group
- Be sure you have adequate high resolution DEMs
  - ❖ At least 5 pixels across a channel
  - ❖ Fix data errors before using RBT
    - ➢ Example: bridges mapped in airborne lidar data
    - ➢ Example: very low area on edge of raster
- Liability Disclaimer:

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Known Unresolved Issues in RBT

- Thalweg from connecting deepest points in cross sections isn't accurate
- Sometimes the cross sections are drawn facing upstream and sometimes downstream
- In a detrended DEM the layout of cross sections doesn't always proceed in the direction you specified; there is no downstream or upstream
- Program crashes if detrending is run multiple times. User must delete detrending workspace folder before rerunning detrending algorithm.

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RBT Development Team

- To report bugs and errors and request new features, contact:
  - Jim McKean (jmckean@fs.fed.us)
  - Dave Nagel (dnagel@fs.fed.us)
  - Philip Bailey (pbailey@essa.com)
- For help with existing RBT, contact:
  - Carolyn Bohn (cbohn@fs.fed.us, 208 373 4367)
- How is the RBT working for you? Please send comments and critiques to: Jim McKean (jmckean@fs.fed.us)
- Citation – If you use the RBT in work that results in a published manuscript, please cite as:

McKean, J., Nagel, D., Tonina, D., Bailey, P., Wright, C.W., Bohn, C., Nayegandhi, A., 2009. Remote sensing of channels and riparian zones with a narrow-beam aquatic-terrestrial lidar. Remote Sensing, *1*, 1065-1096; doi:10.3390/rs1041065

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Acknowledgements

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- NOAA & Bonneville Power Administration, ISEMP Project
- ESSA Technologies, Ltd.

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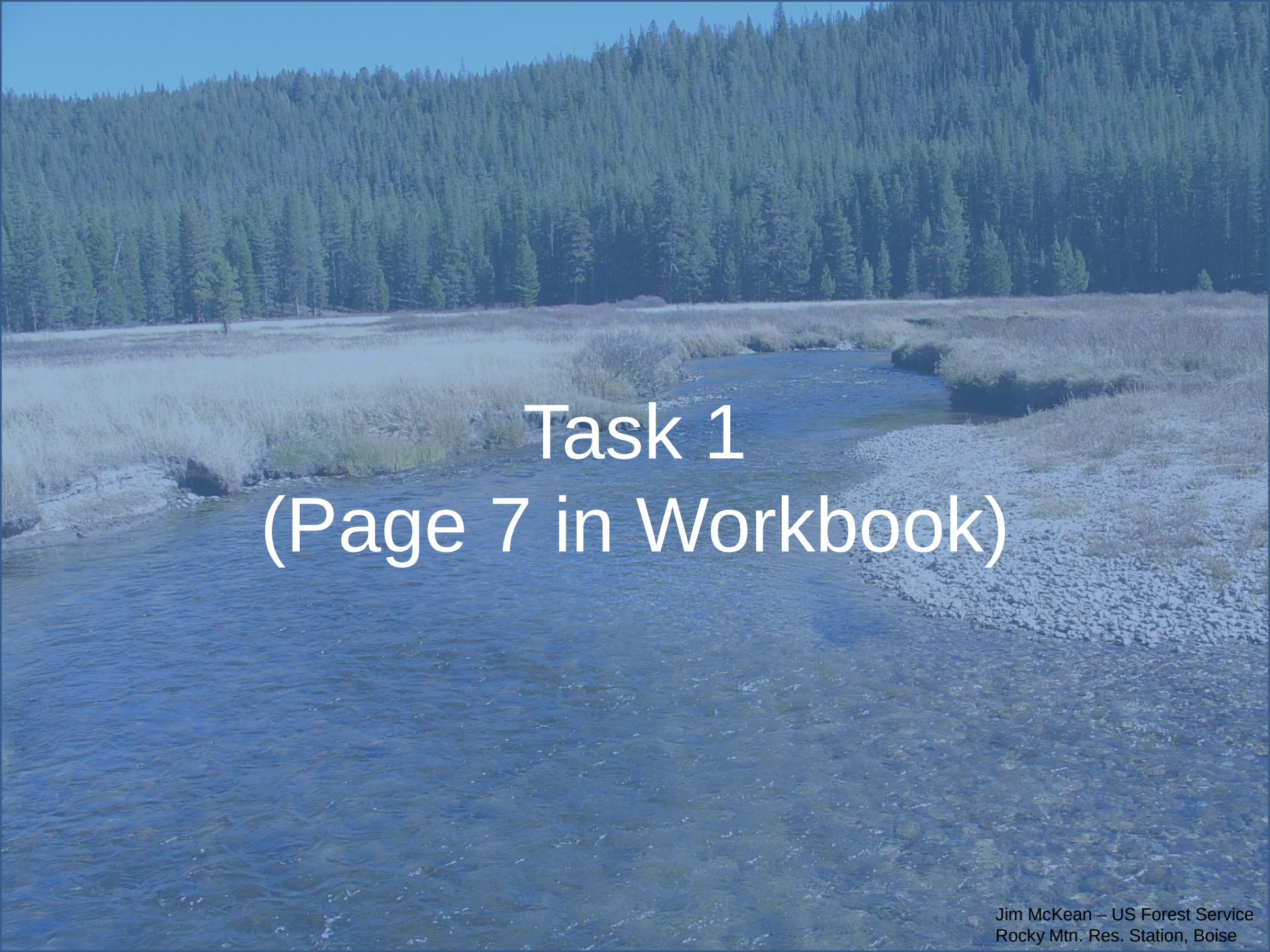

Task 1
(Page 7 in Workbook)

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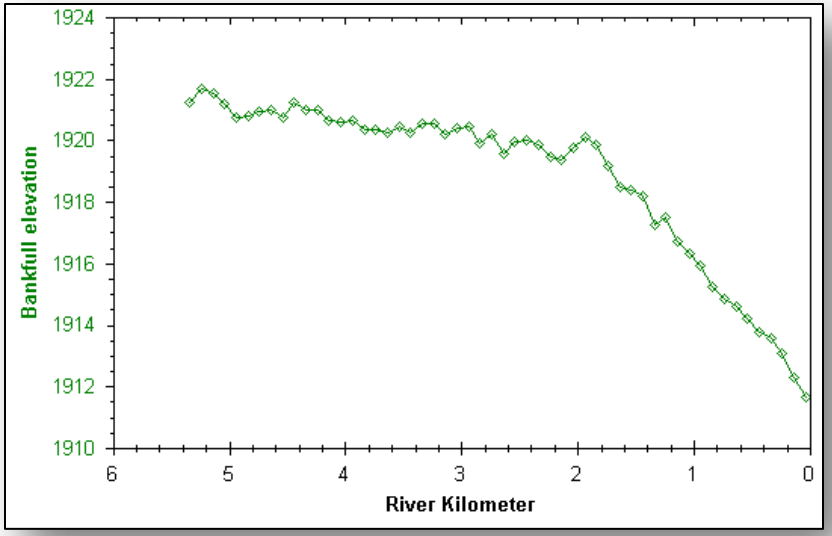
Task 2: Detrending in the RBT

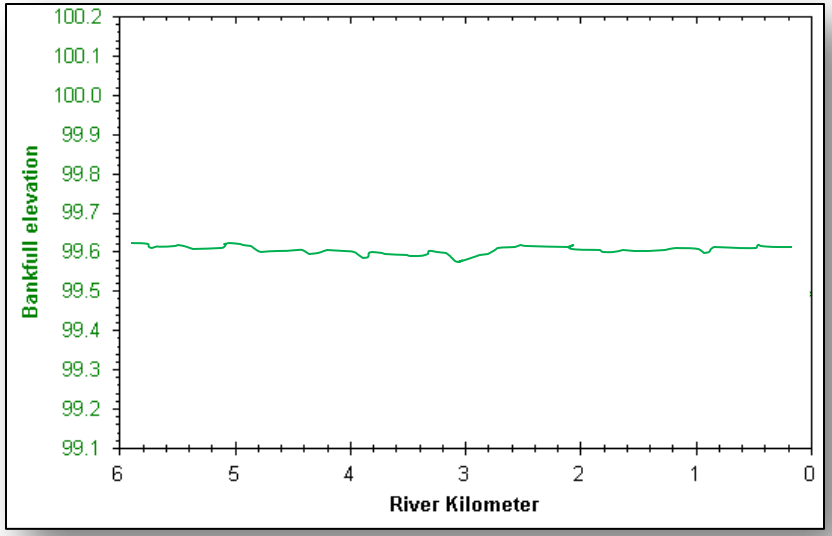
Objective: Remove the overall valley trend

Original DEM



Valley profile
1910 – 1924 m

Detrended DEM



Detrended profile
99.1 – 100.2 m

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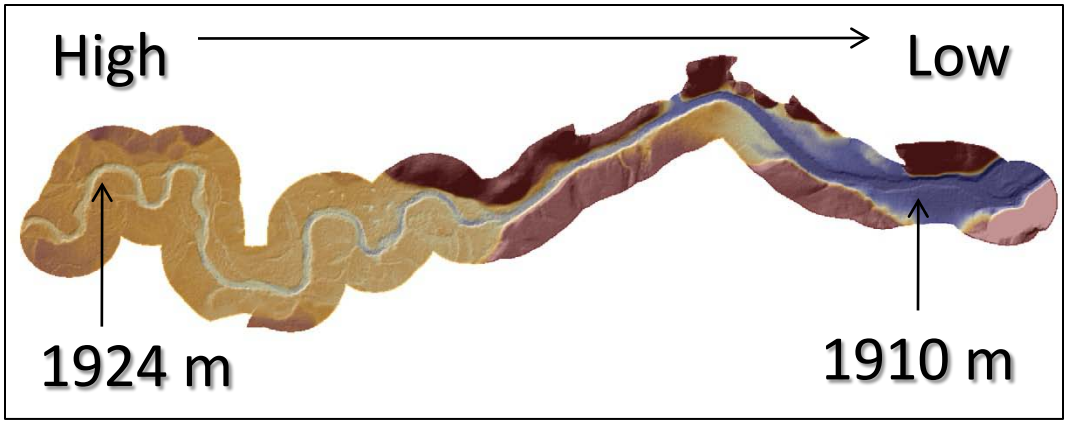
Detrending in the RBT

Purpose: Develop a surface with zero overall slope for analyzing in-stream characteristics

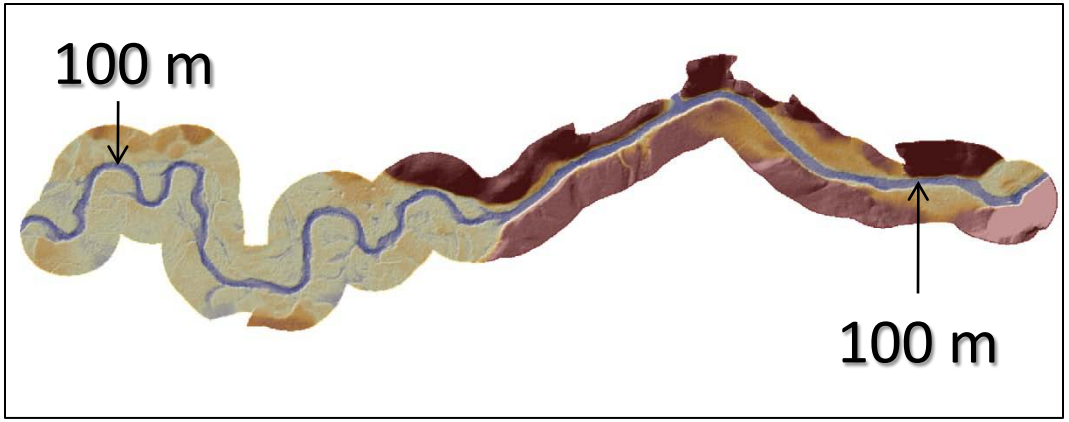


Original DEM

High to low elevation

Detrended

Equal elevation at water surface (100 m)



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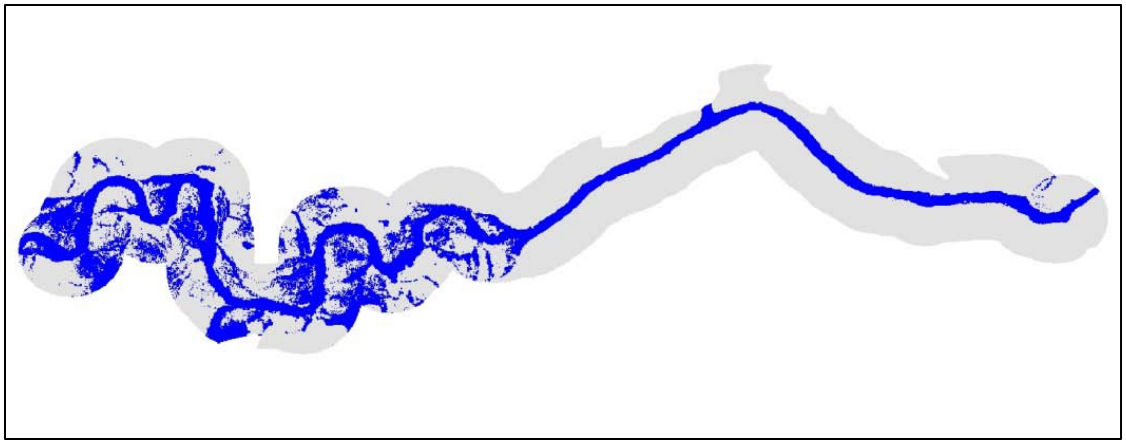
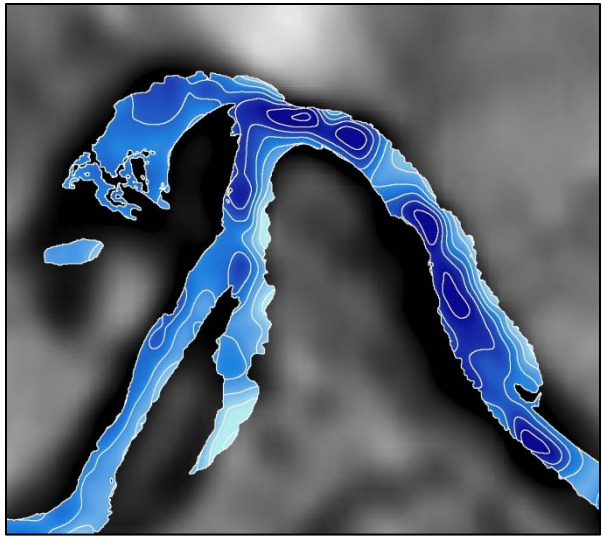
Detrending in the RBT

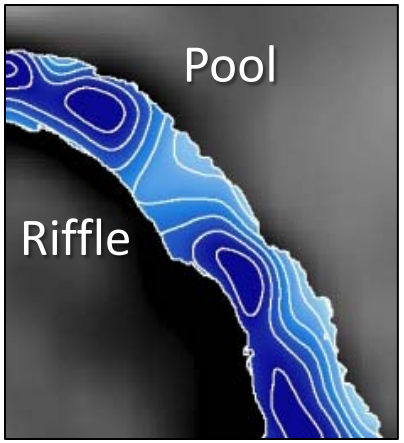
Allows interactive flooding





Depth mapping without flow modeling

Leading to habitat mapping



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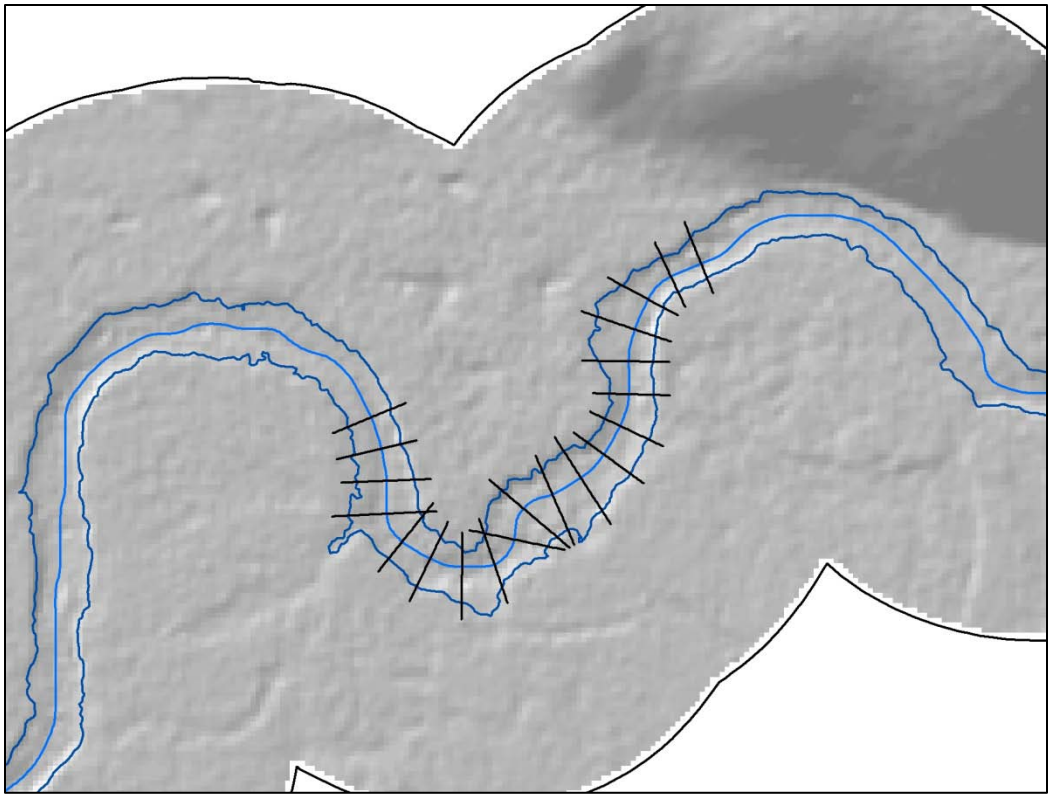
Detrending in the RBT

Necessary for generating a bankfull polygon and centerline, which are required for laying out cross sections



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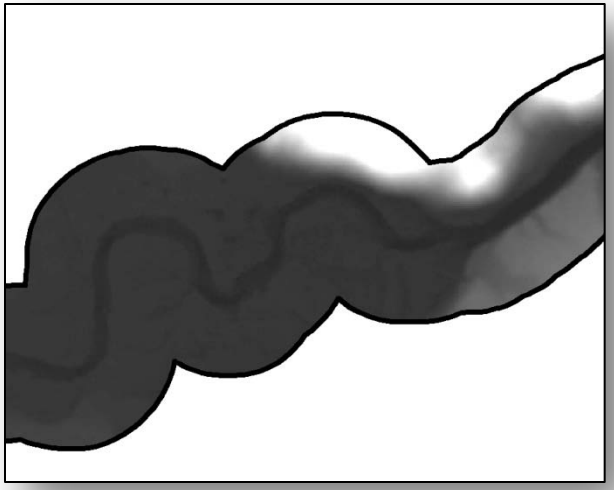
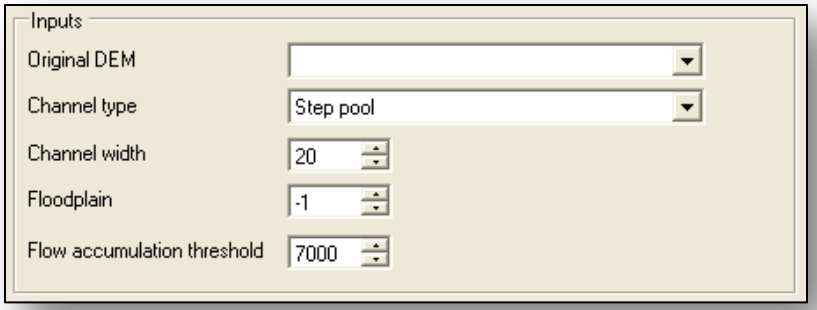
Data Requirements and Input Parameters



Requirements

- DEM clipped to stream corridor
- Elevation in meters
- Rectangular coordinate system



Input parameters

- Channel type
- Channel width
- Floodplain flood depth
- Flow accumulation threshold

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Input Parameters

- Channel type
  - Pool riffle, plain bed, step pool (0-1.5%, 1.5-3%, >3% slope)
  - Controls filter size
  - Higher gradient = smaller filter
- Channel width
  - General parameter for confining the channel near the thalweg
- Floodplain flood depth (meters)
  - Parameter for defining the extent for detrending the floodplain
  - Default -1, detrends channel only
- Flow accumulation threshold
  - Sets mainstem and tributary channel initiation

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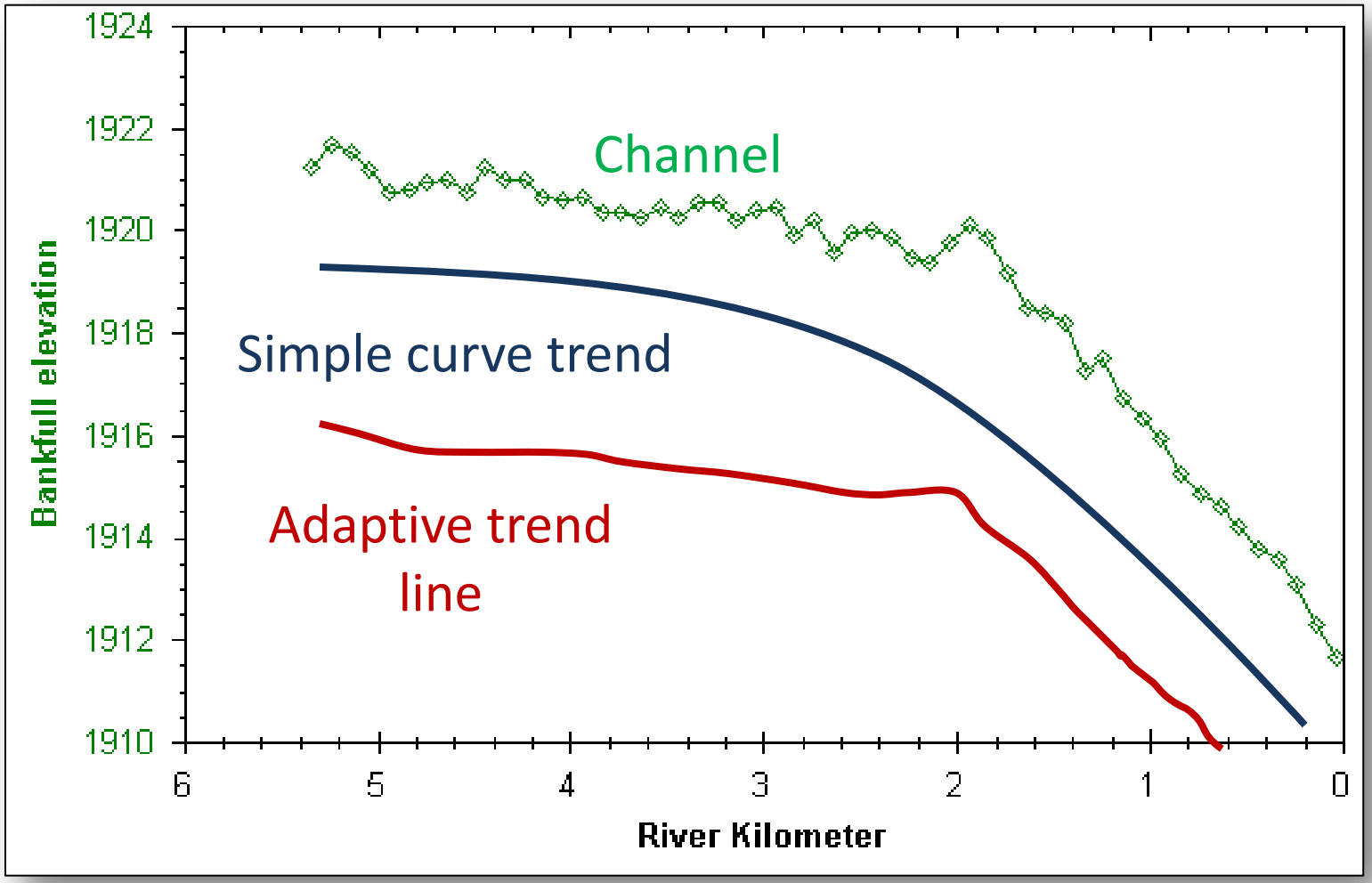
Representing the Trend

Algorithm is adaptive to preserve in-stream characteristics



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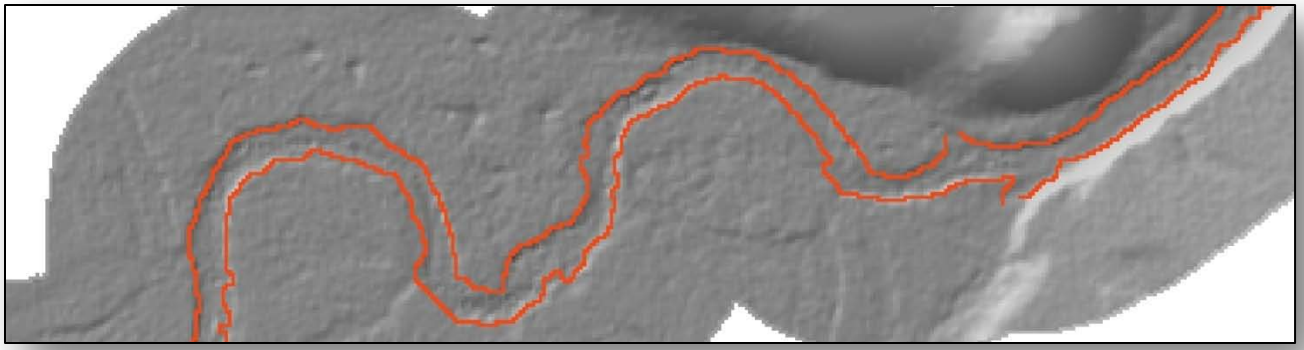
Detrending Process

Incorporates an adaptive method loosely patterned after techniques published by Wu et al., 2007 and Cobby et al., 2001

Uses the “top of bank” along the stream channel to represent the channel trend



Local thalweg elev + local mean depth = top of bank

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Detrending Process

Bank elevation is spread and smoothed to create the trend grid

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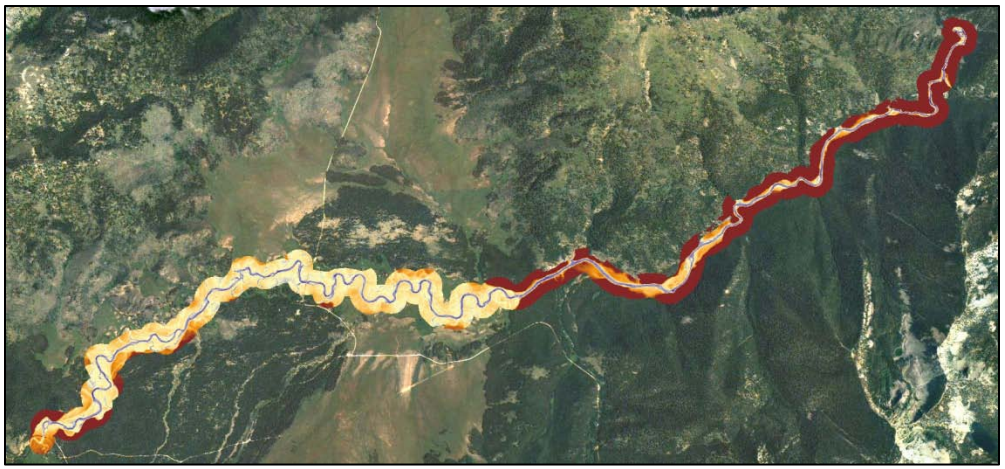
Detrending Process

Original DEM – trend grid + 100 = detrend grid

-

+ 100

=



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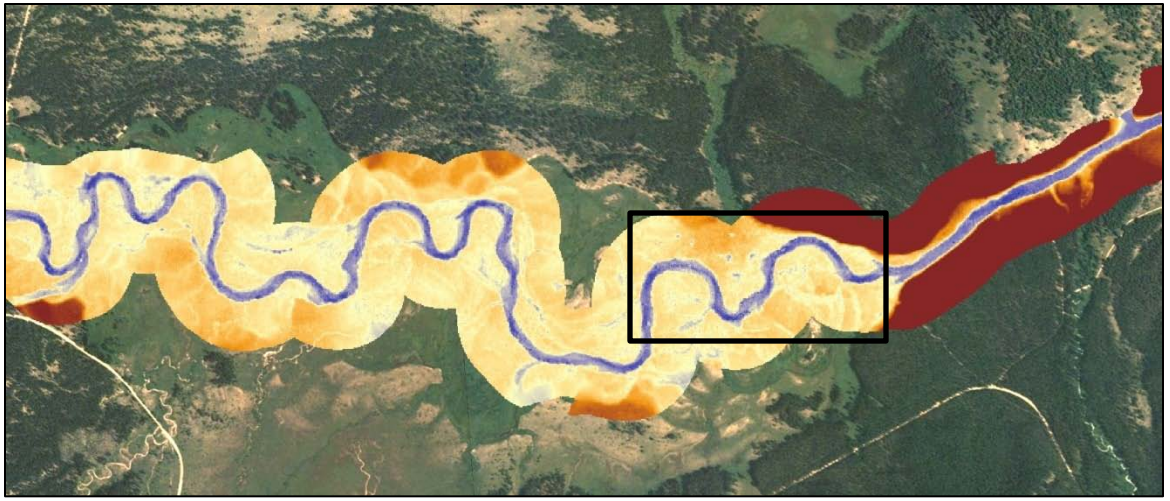
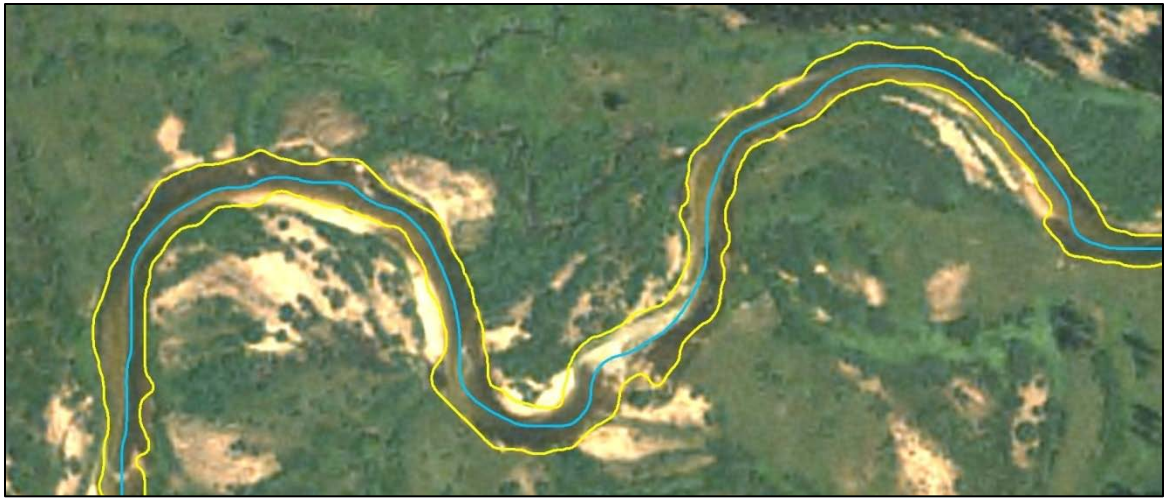
Detrending Output

Detrended grid



Banks and centerline



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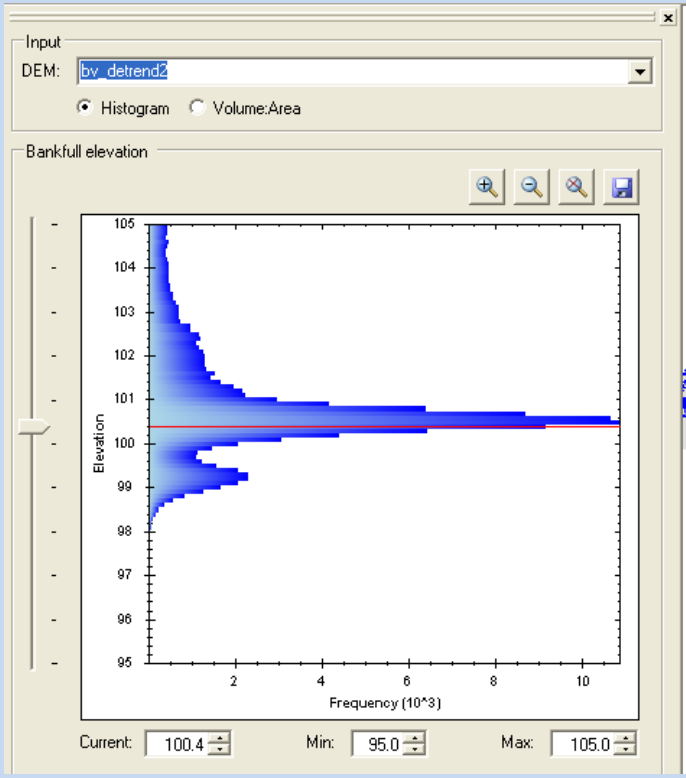
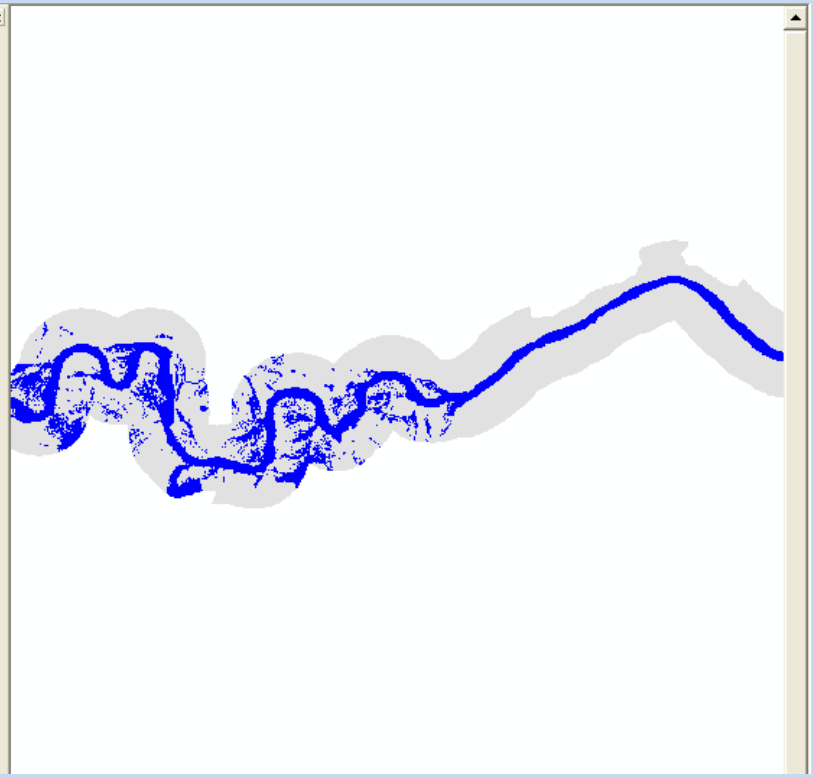
Task 3: Methods to Define “Bankfull” or Any Other Stage

- Morphologic
  - ❖ Elevation histogram
  - ❖ Stream DEM calculation (V/A)
  - ❖ Raster Flooding

- Field Measurement
- Flow Modeling
- Hand digitizing
  (e.g., orthophotos)





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- Morphologic
  - ❖ Elevation histogram
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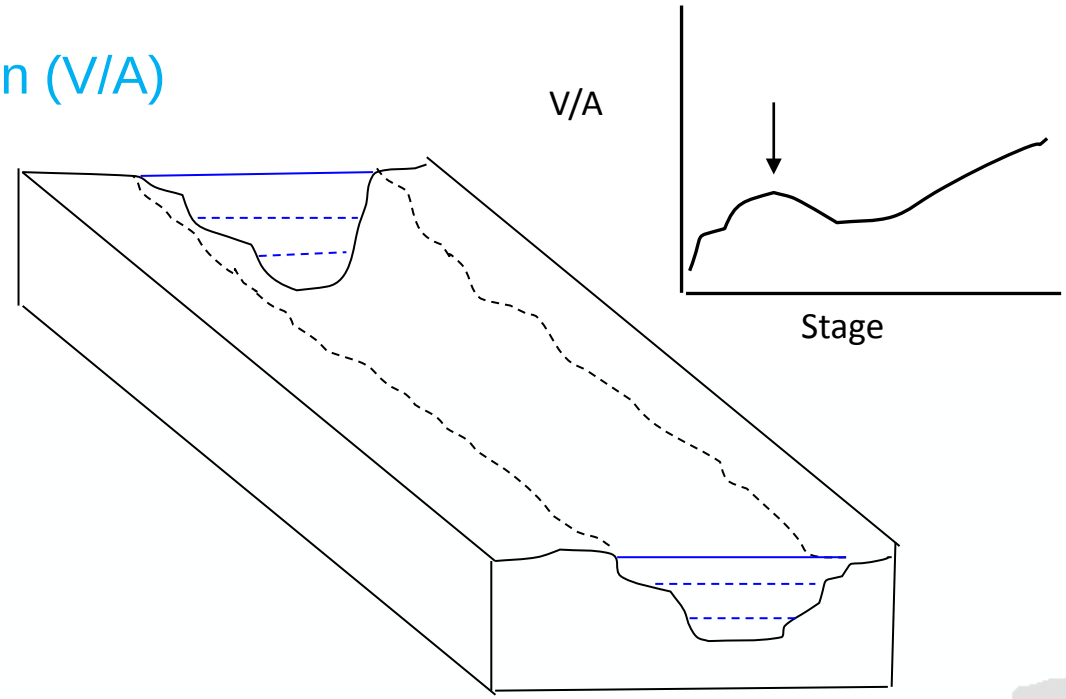

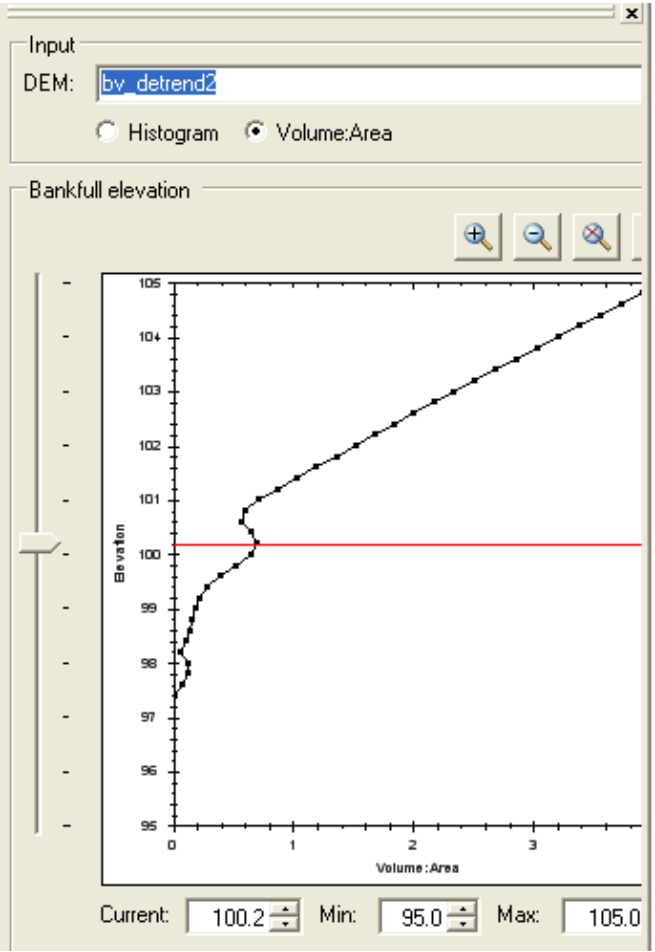

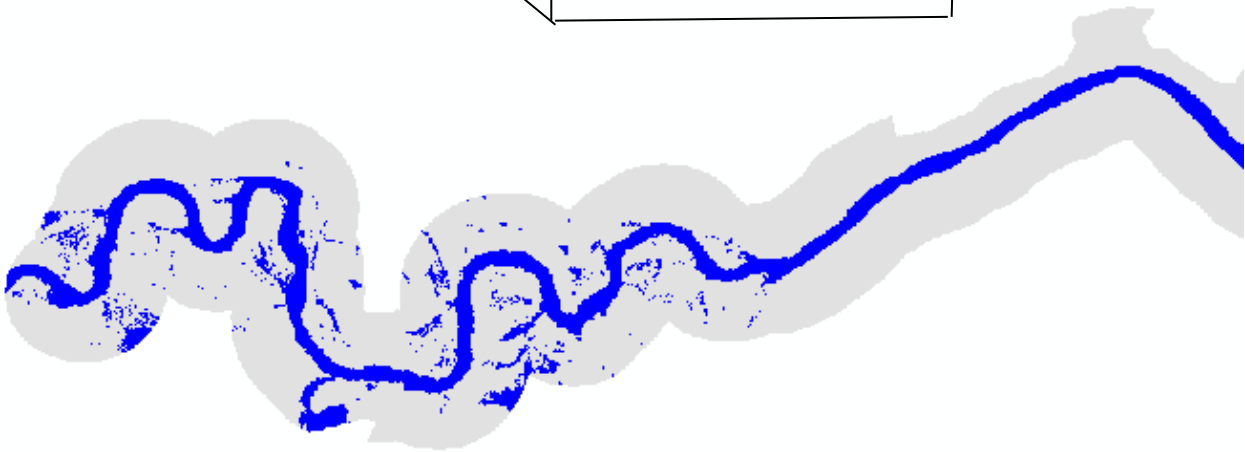

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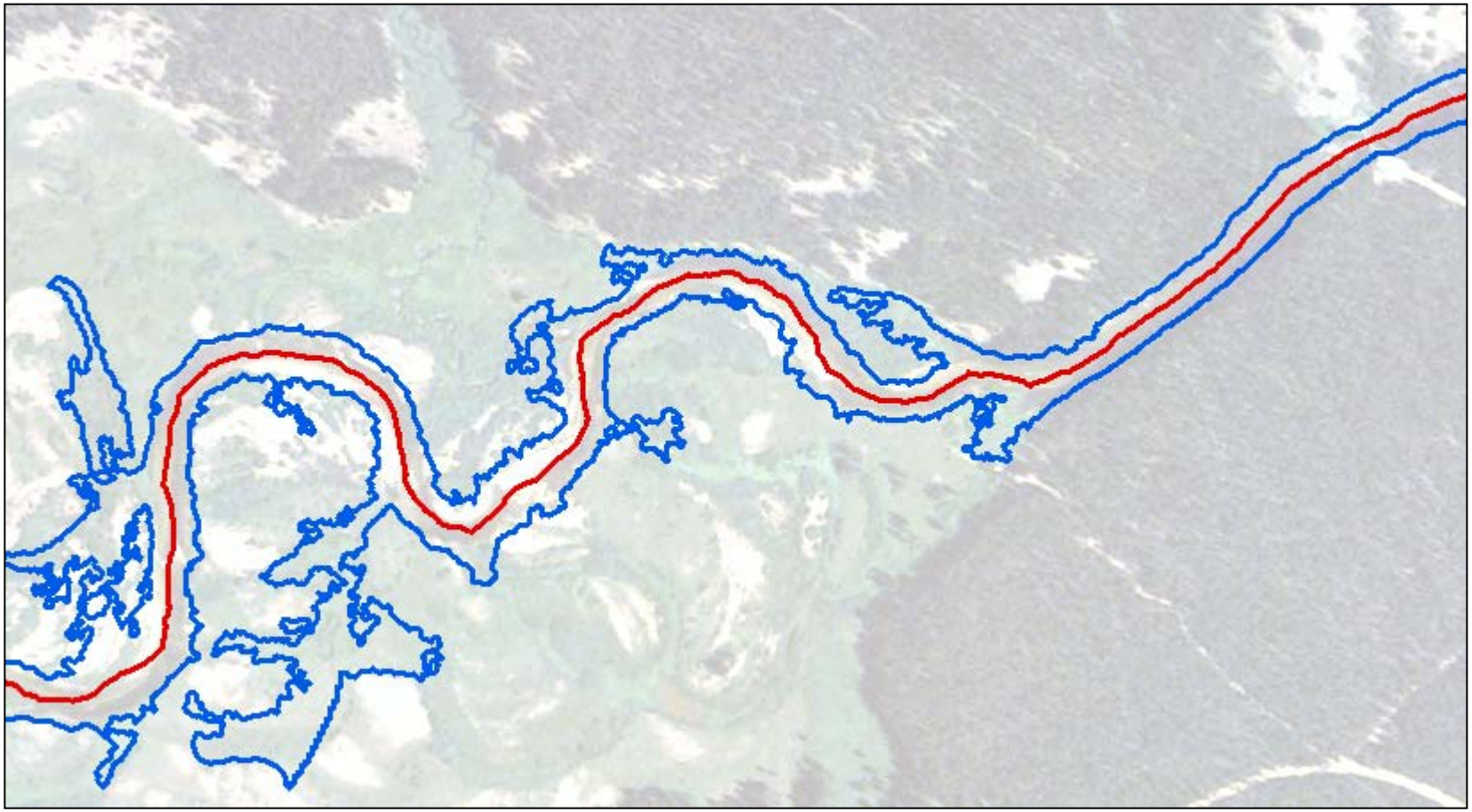
Centerline algorithm

- Significantly influences accuracy of the channel metrics
- Equal (shortest) distance from both banks
- Unique for each banks polygon



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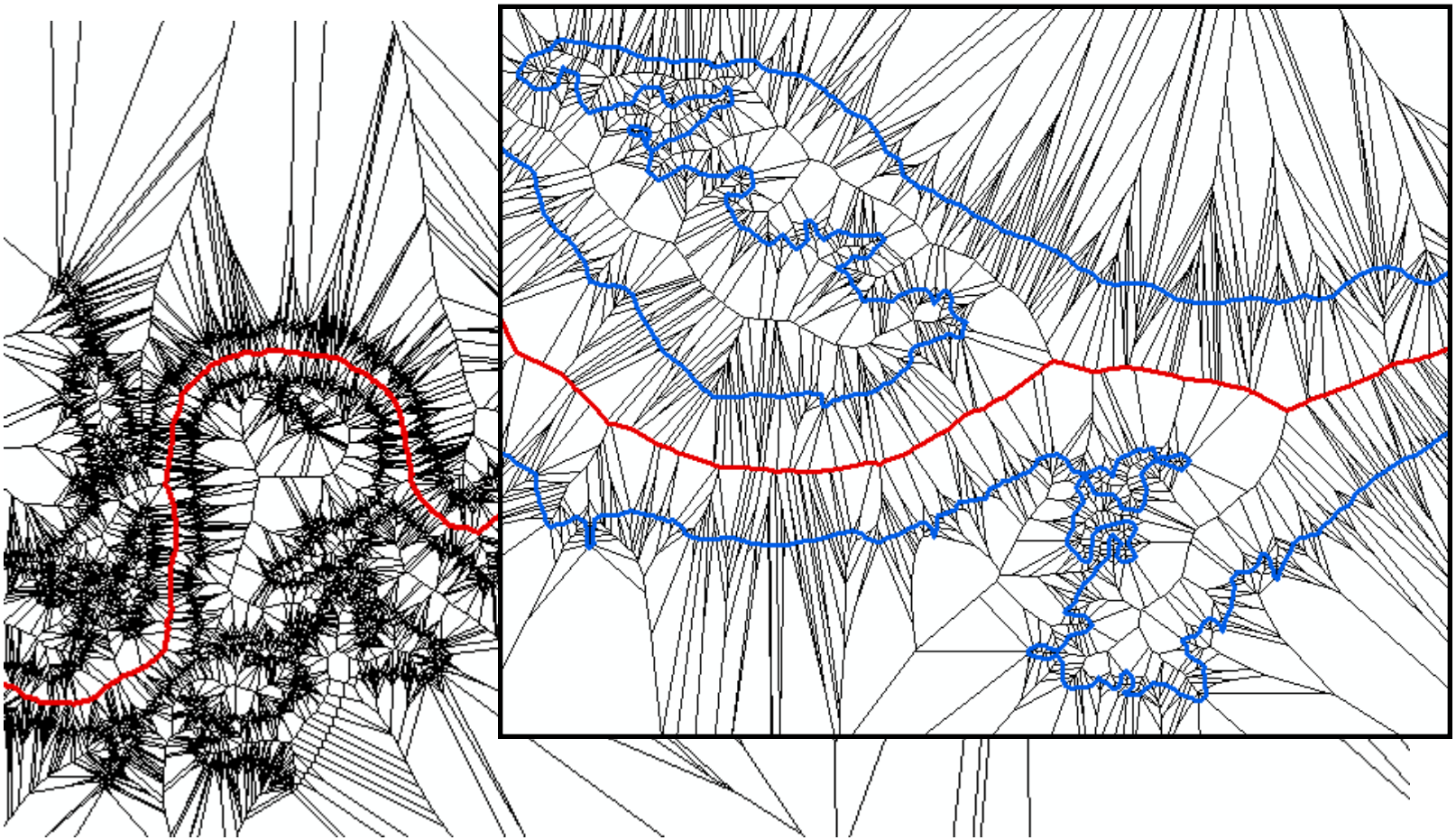
Centerline algorithm

- Uses Thiessen polygons
- Divides banks using Thalweg
- Find lines that are equal distance from banks



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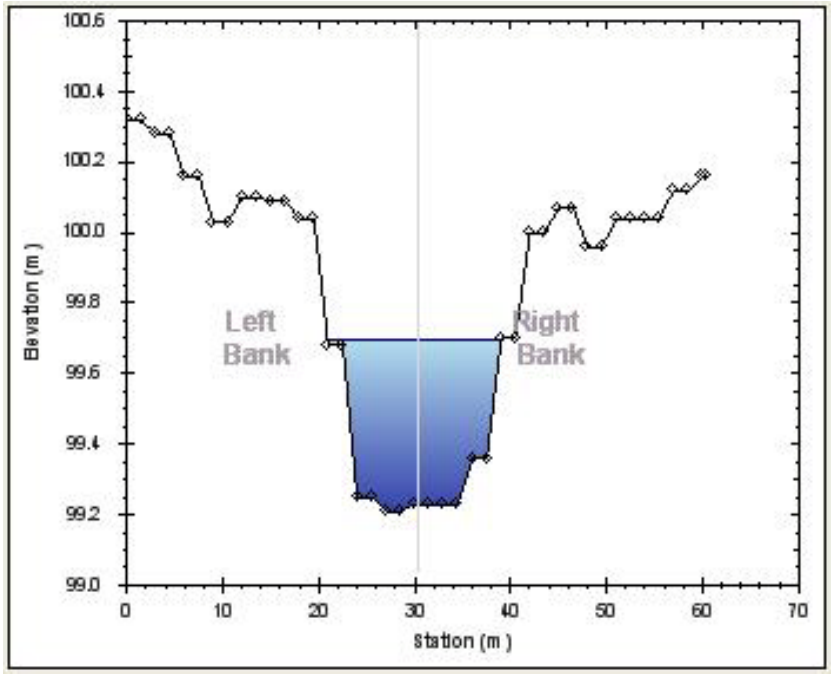
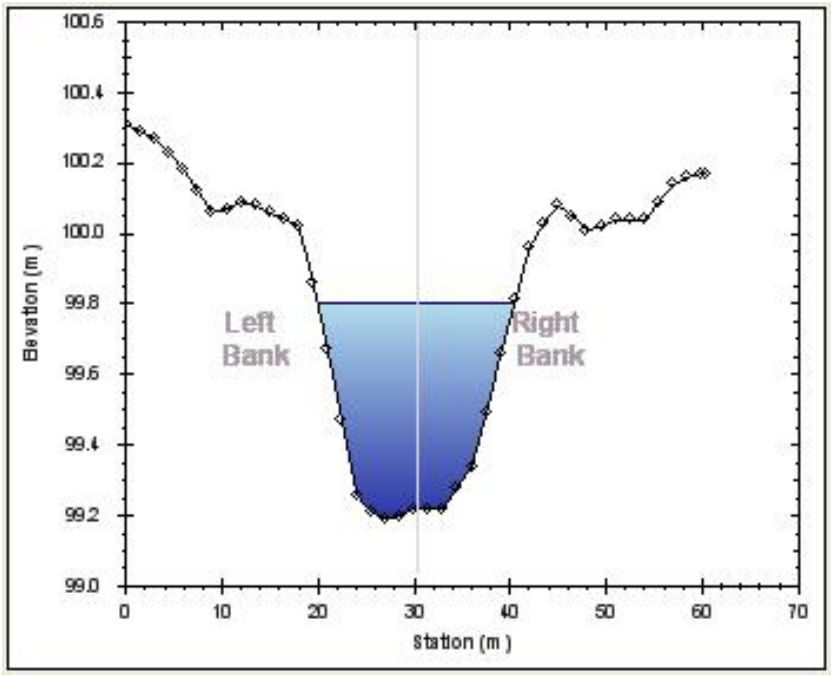
Bilinear Interpolation of Cross Sections





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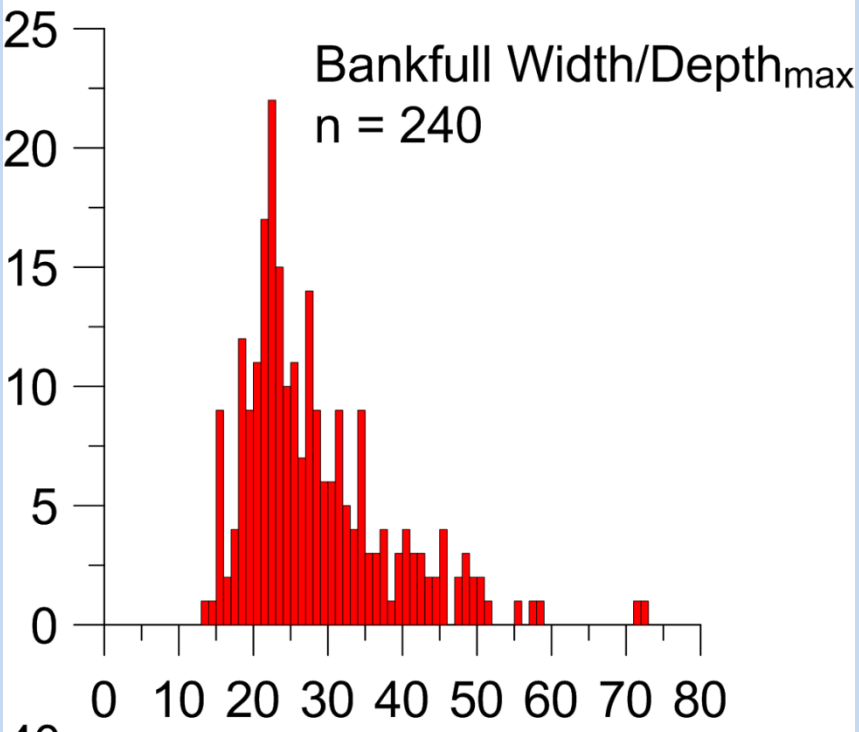
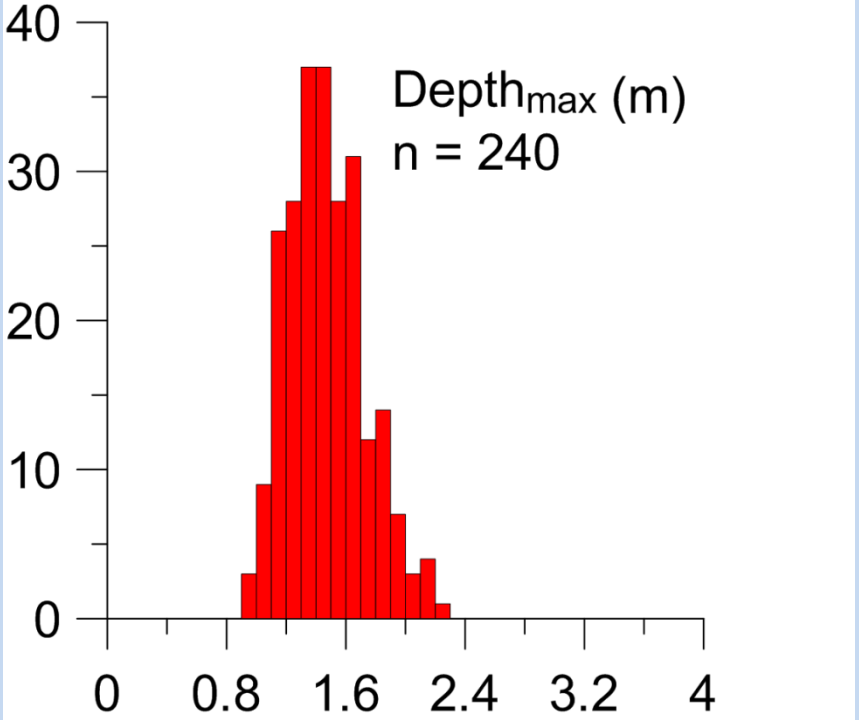
Task 6: Cross Section Explorer





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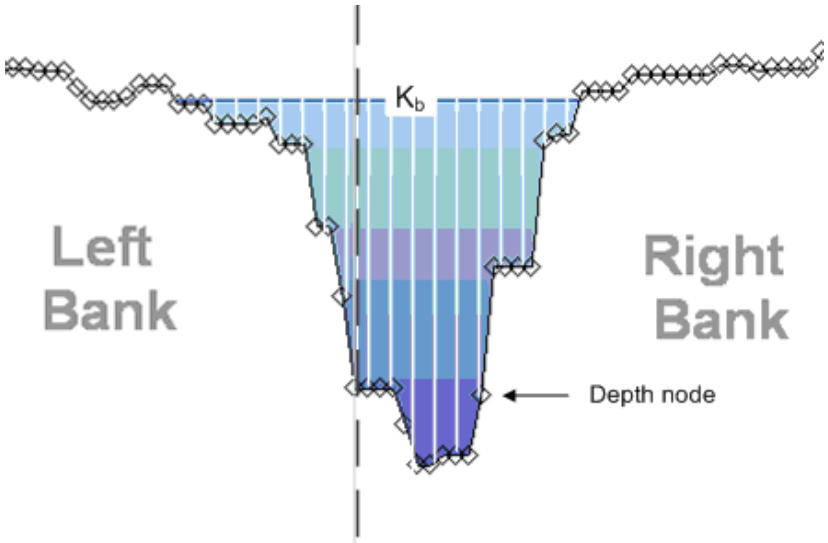
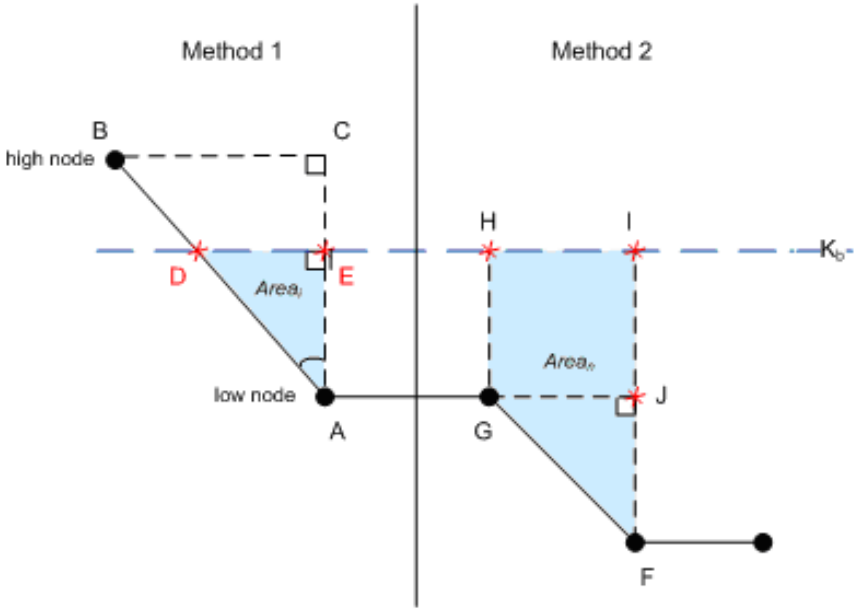
Bankfull Area





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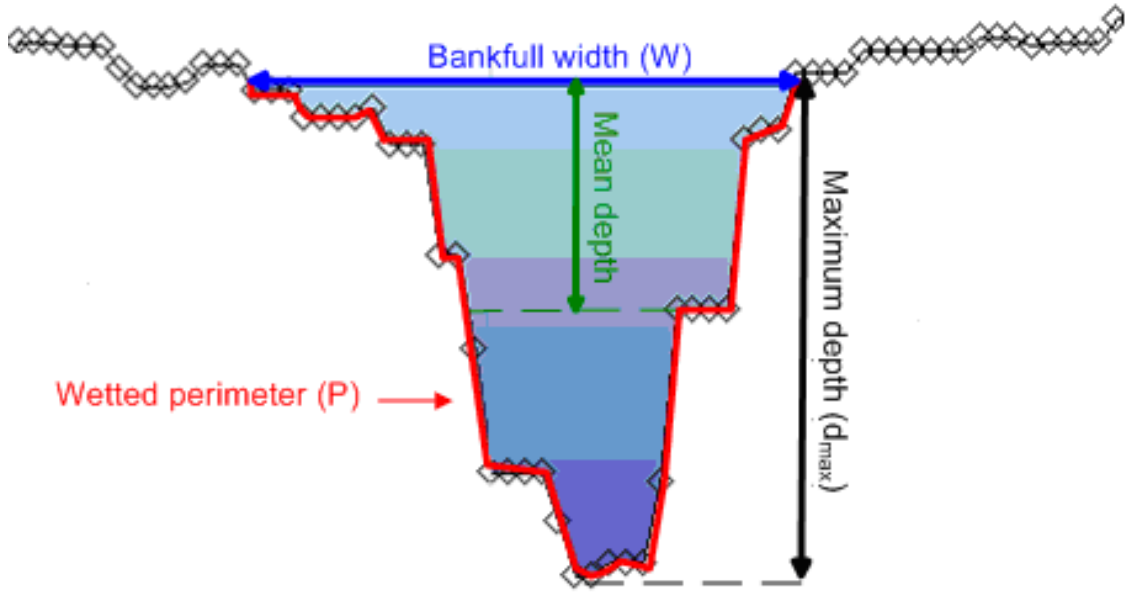
Width, Depths and Wetted Perimeter



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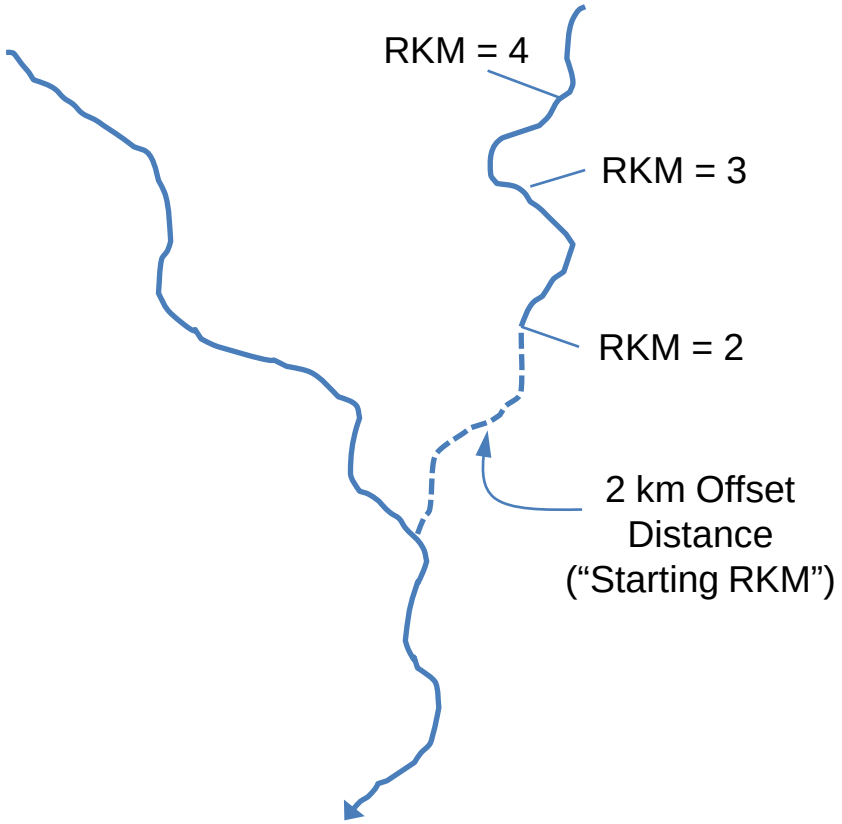
Task 8: Long Profiles

River Km Offset Starting Point



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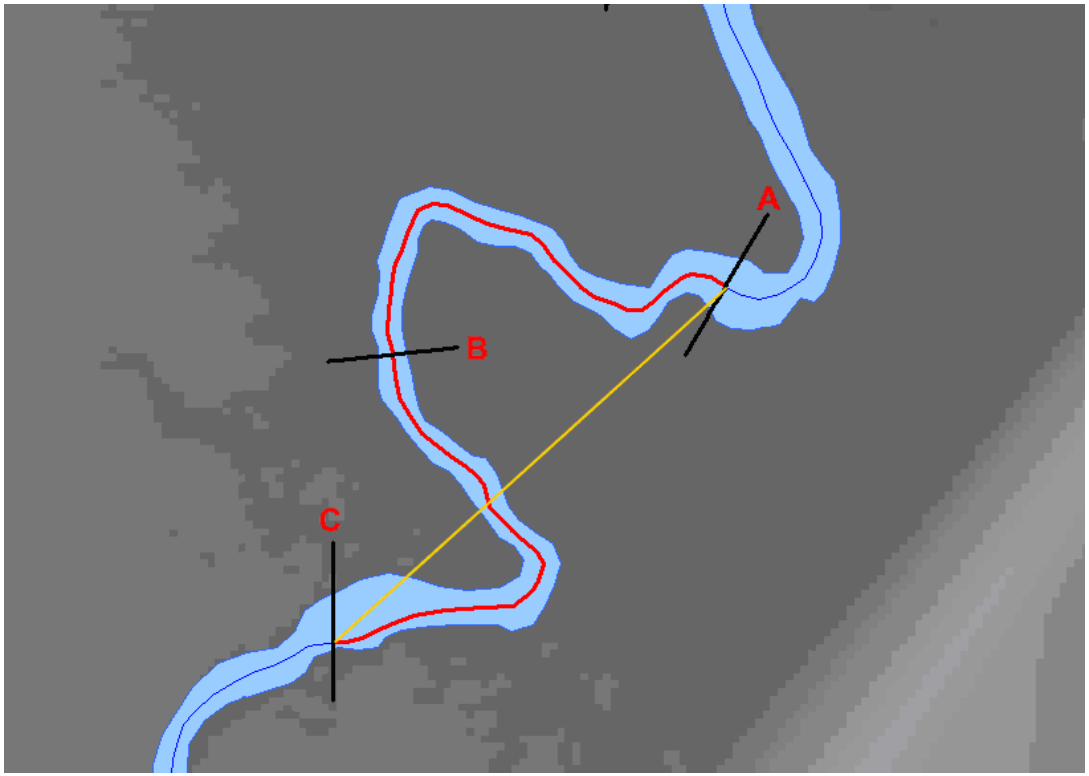
Task 9: Sinuosity



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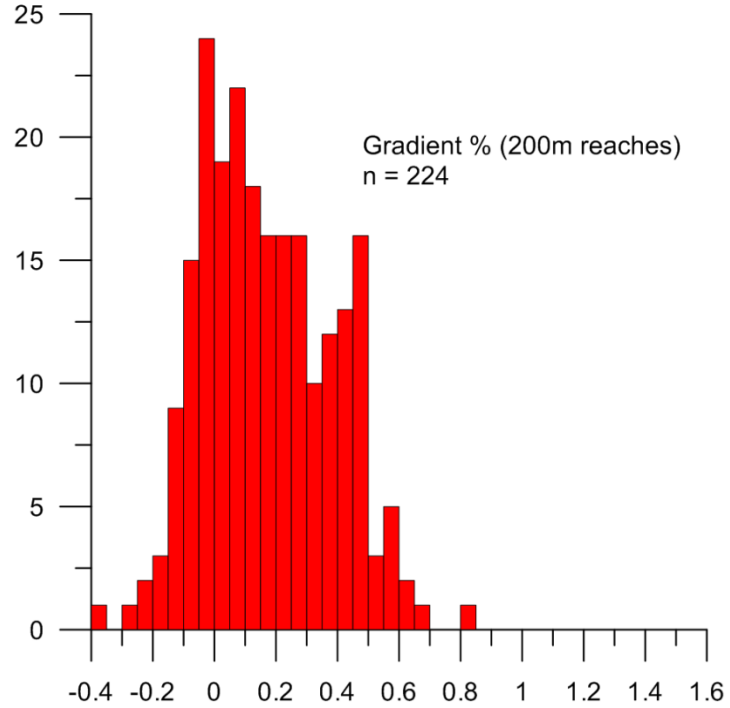

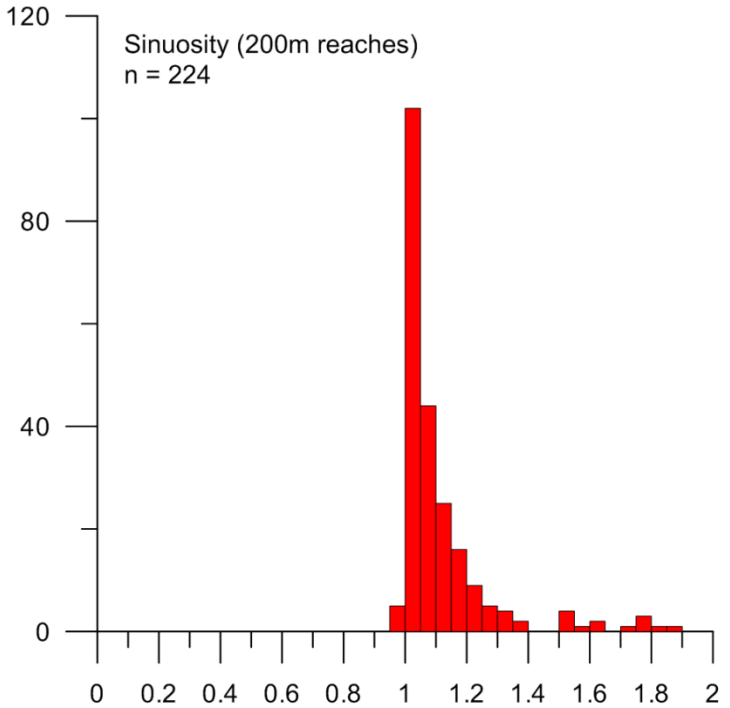

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