A Valley Confinement Algorithm for Aquatic, Riparian, and Geomorphic Applications

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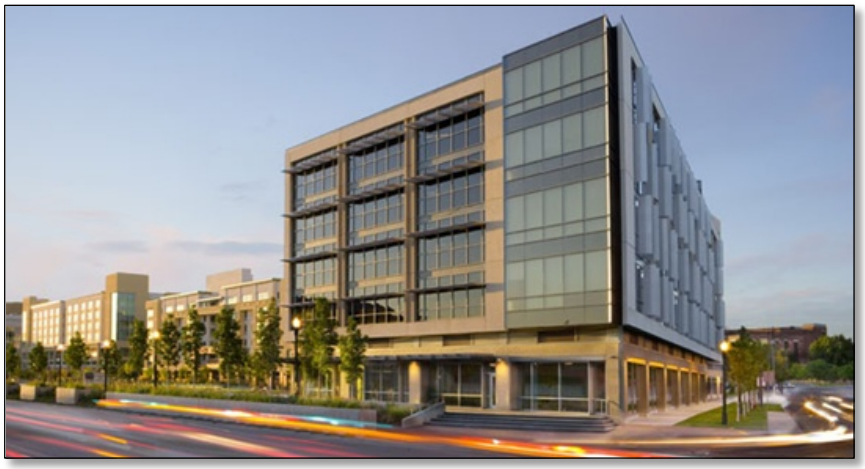
Boise Aquatic Sciences Lab



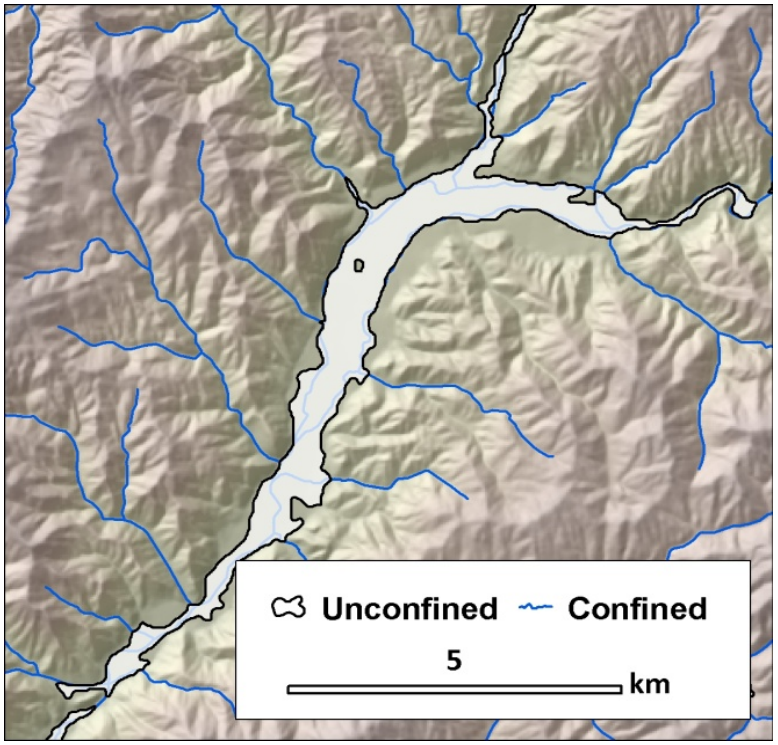
Idaho Water Center

Fish and watershed research

Valley Confinement Algorithm (VCA)

Python Script

Objective: Identify unconfined valleys at a landscape scale using nationally available GIS data

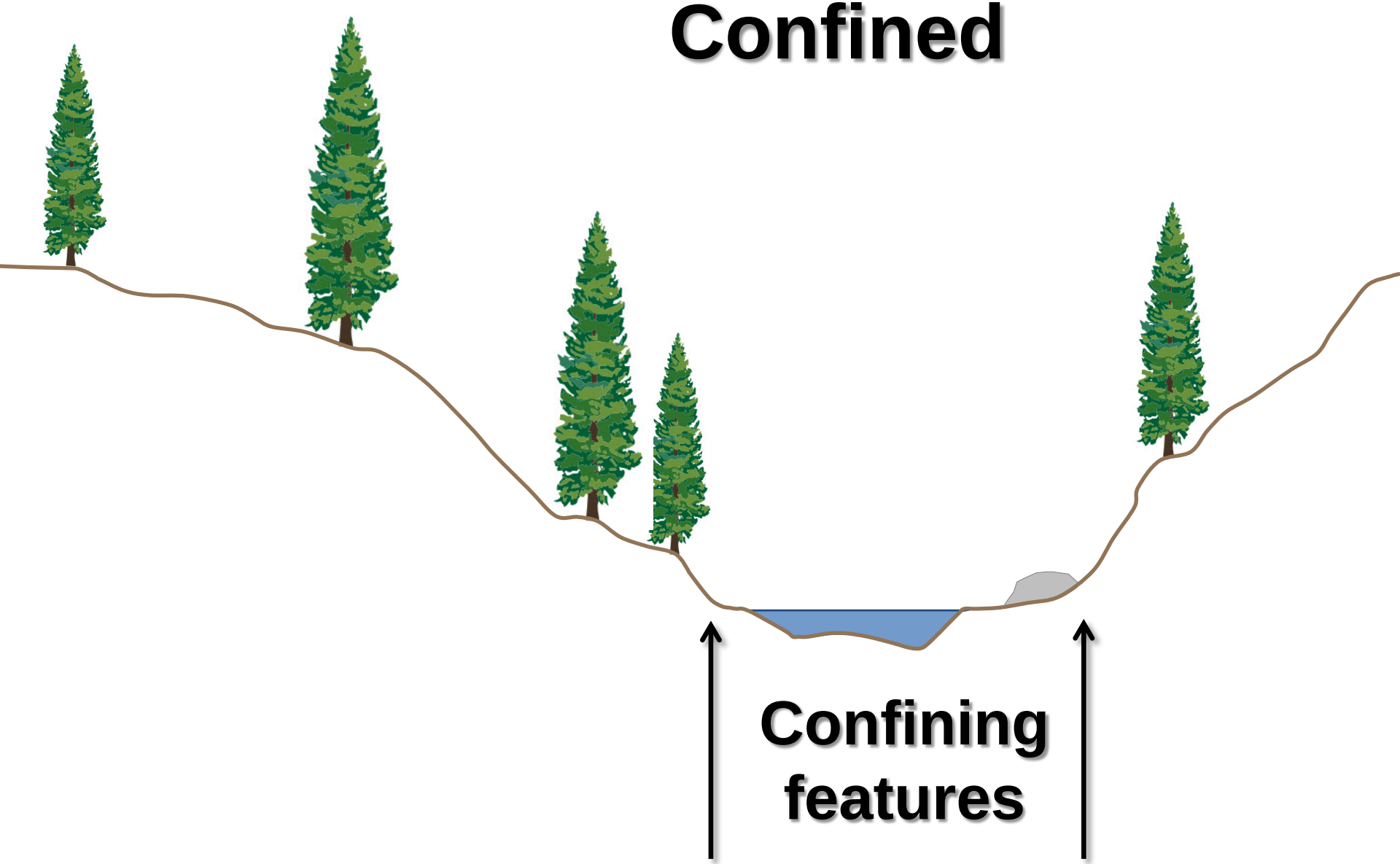


Valley Characteristics and Justification

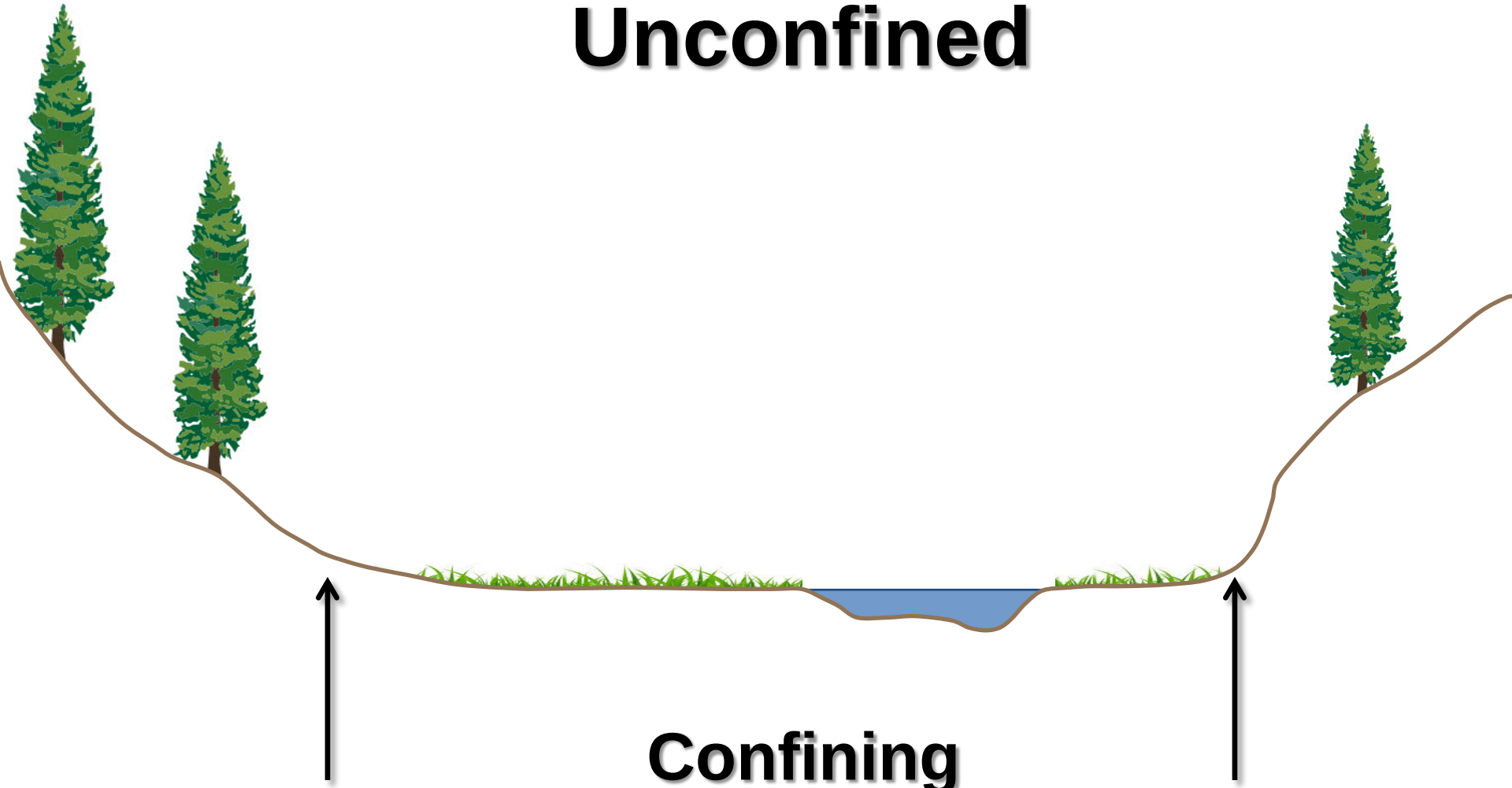
Valley Confinement

Degree of lateral confinement of a valley, constrained by topographic features

Confined

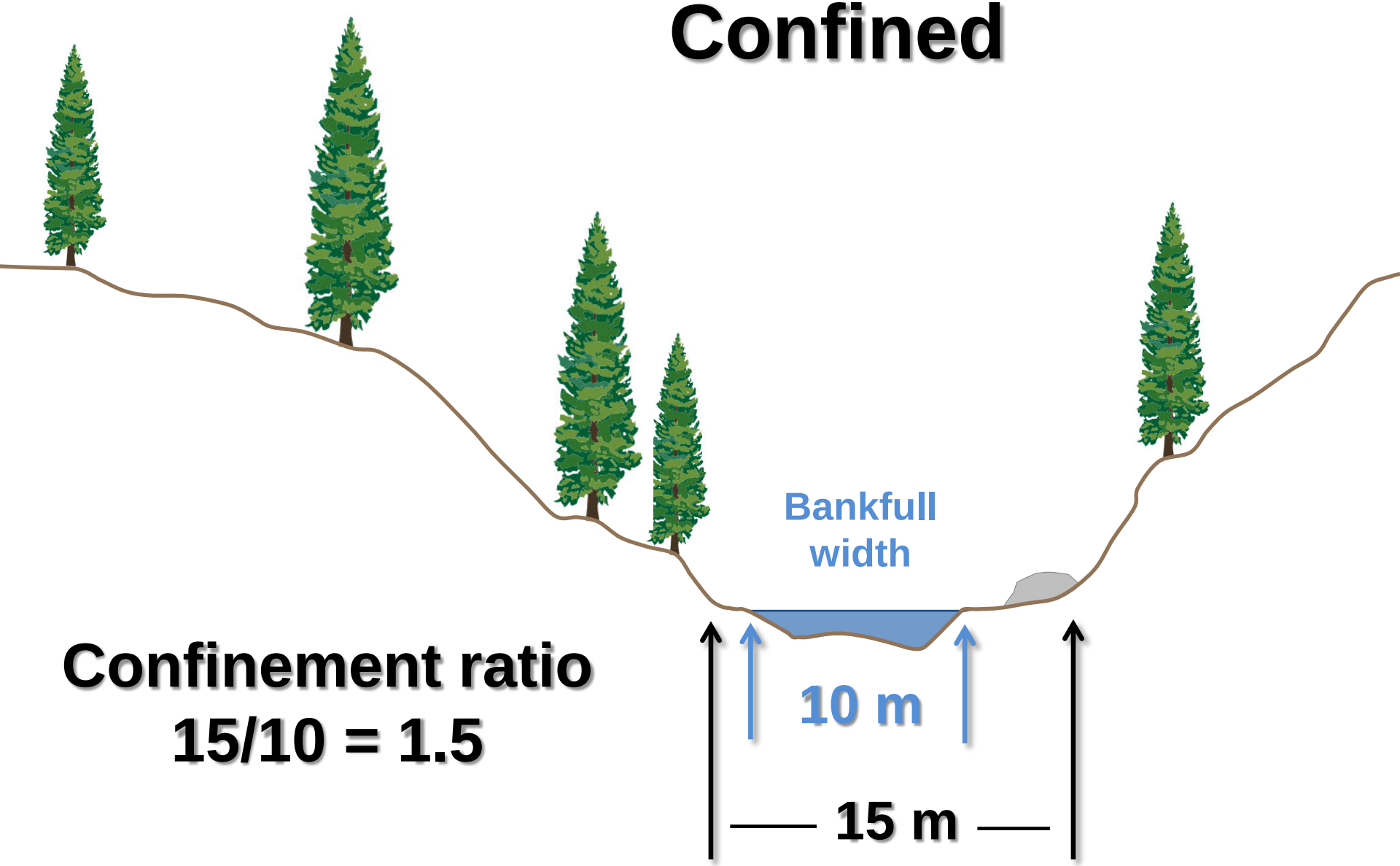


Unconfined



Confining features

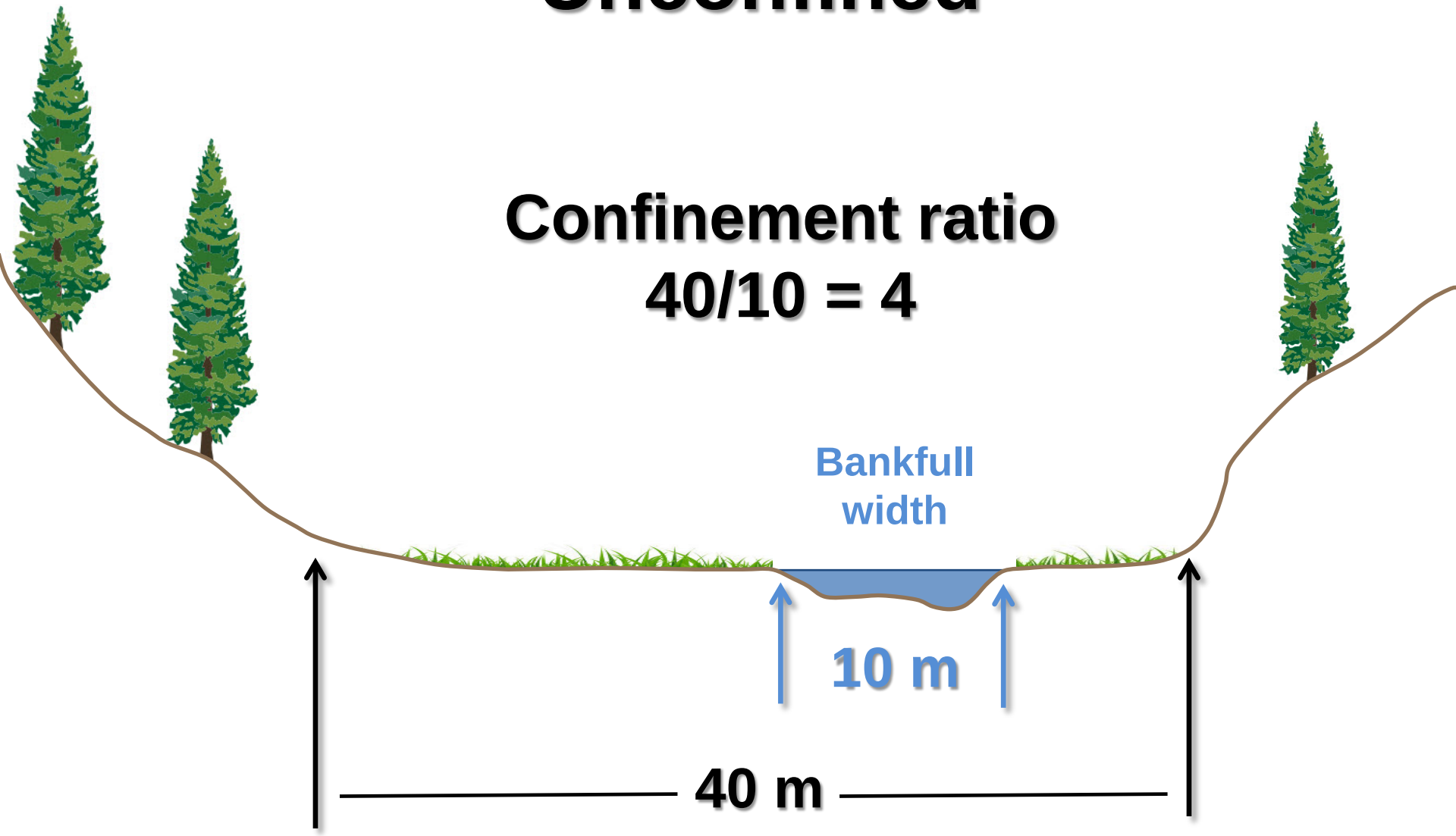
Confined



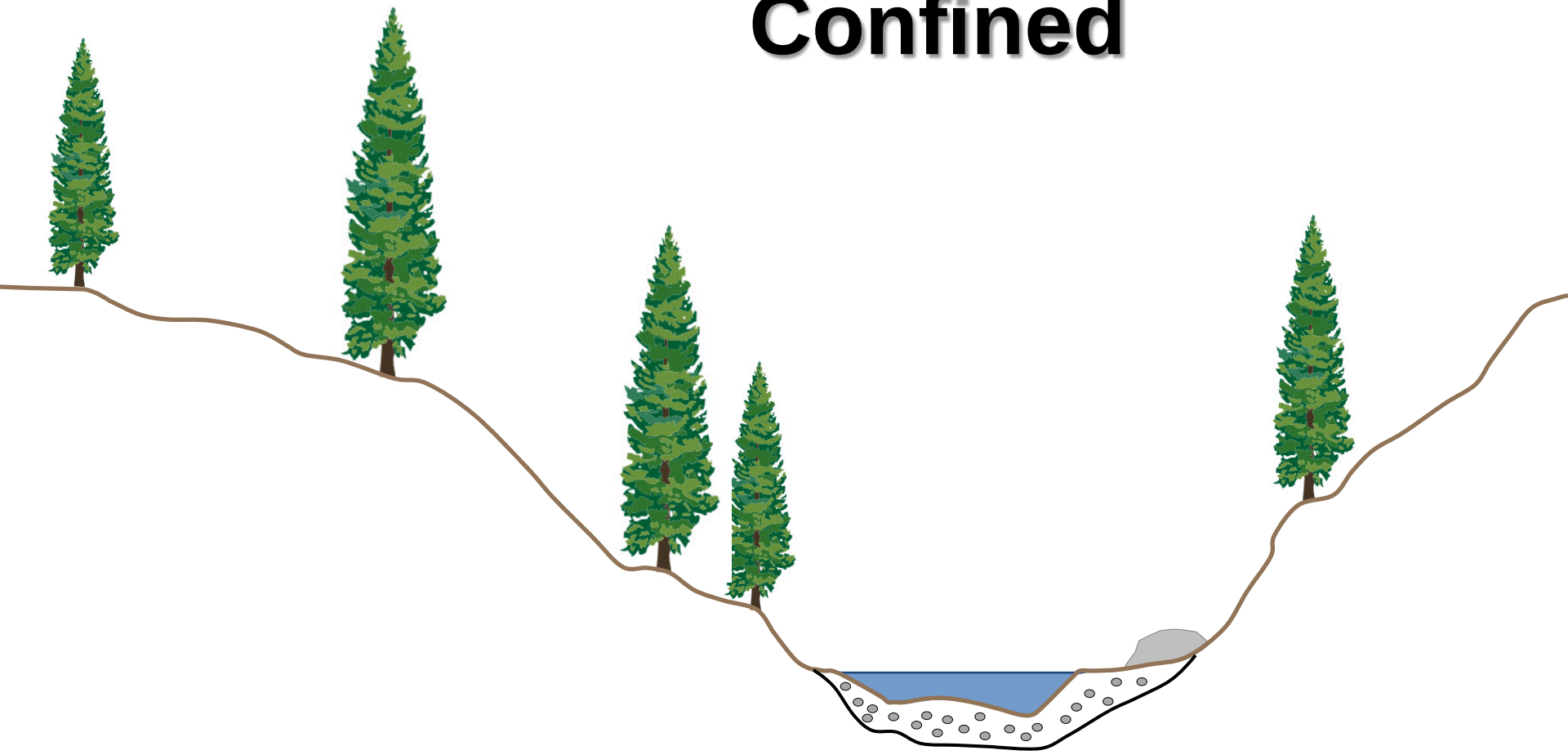
Confinement ratio
15/10 = 1.5

Unconfined

Confinement ratio
40/10 = 4

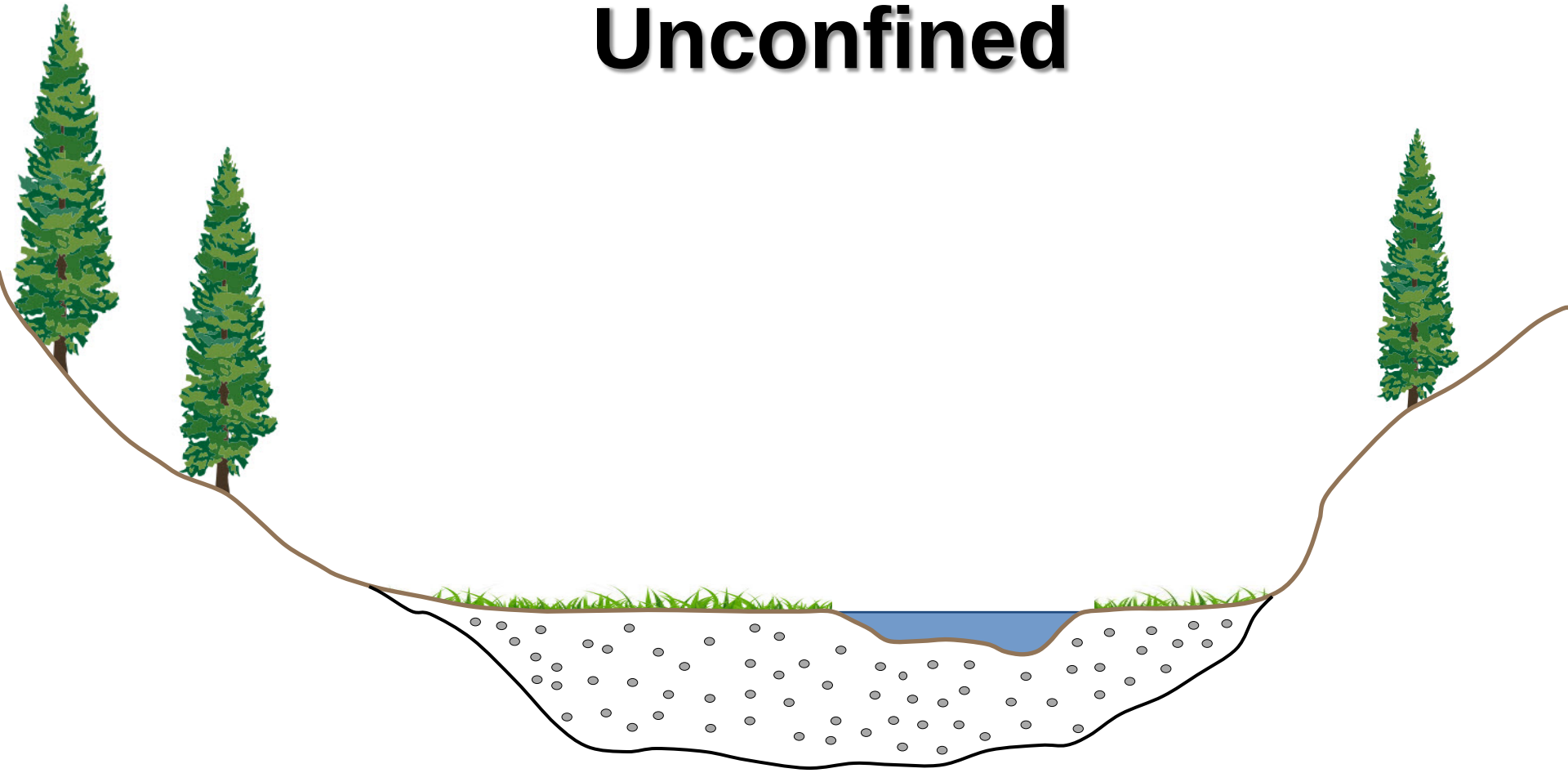


Confined



Shallow alluvial deposits

Unconfined



Deeper alluvial deposits

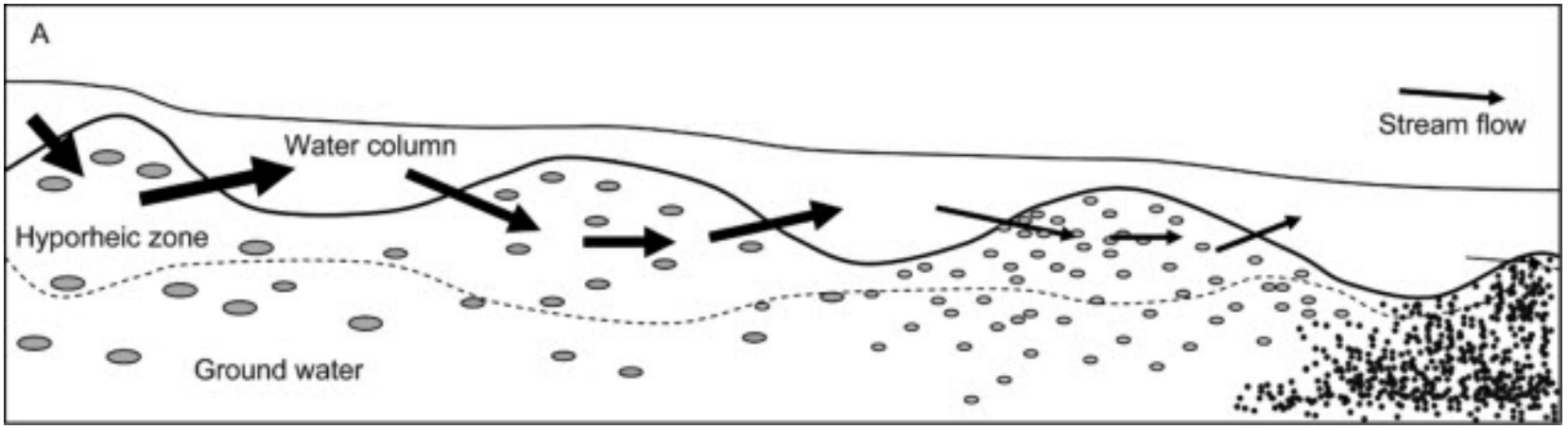
Confined

Unconfined

Characteristics of Unconfined Valleys

- Hyporheic exchange
- Channel morphology
- Grain size
- Riparian habitat

Hyporheic Exchange



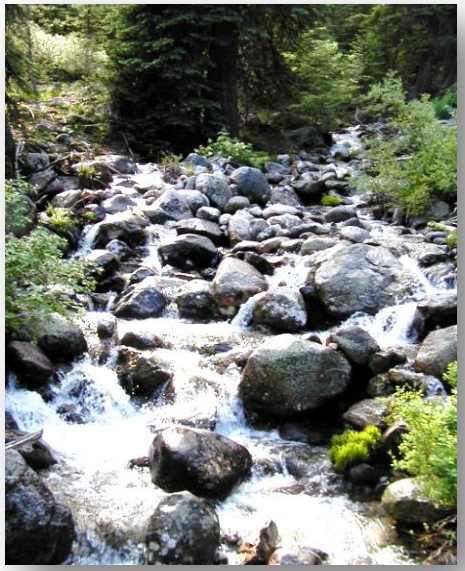
Baxter and Hauer 2000

Bull trout preferentially spawn at the downstream end of unconfined valleys where hyporheic upwelling may warm stream temperatures for overwintering embryos

Boulton and others 2010

Channel morphology

Cascade



Step-pool

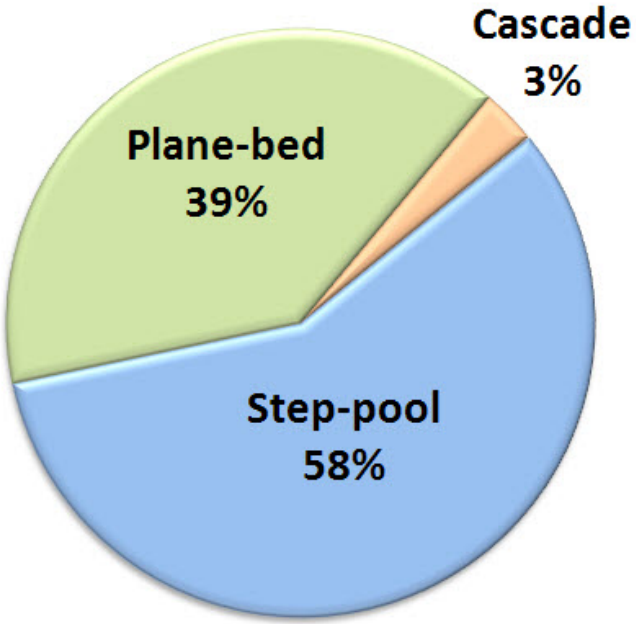
Plane-bed

Pool-riffle

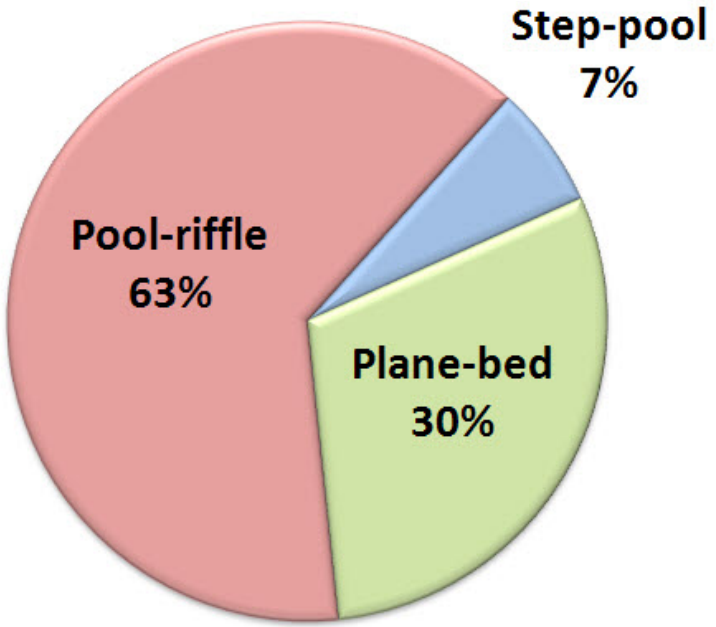
Montgomery and Buffington 1997

Channel morphology

Confined



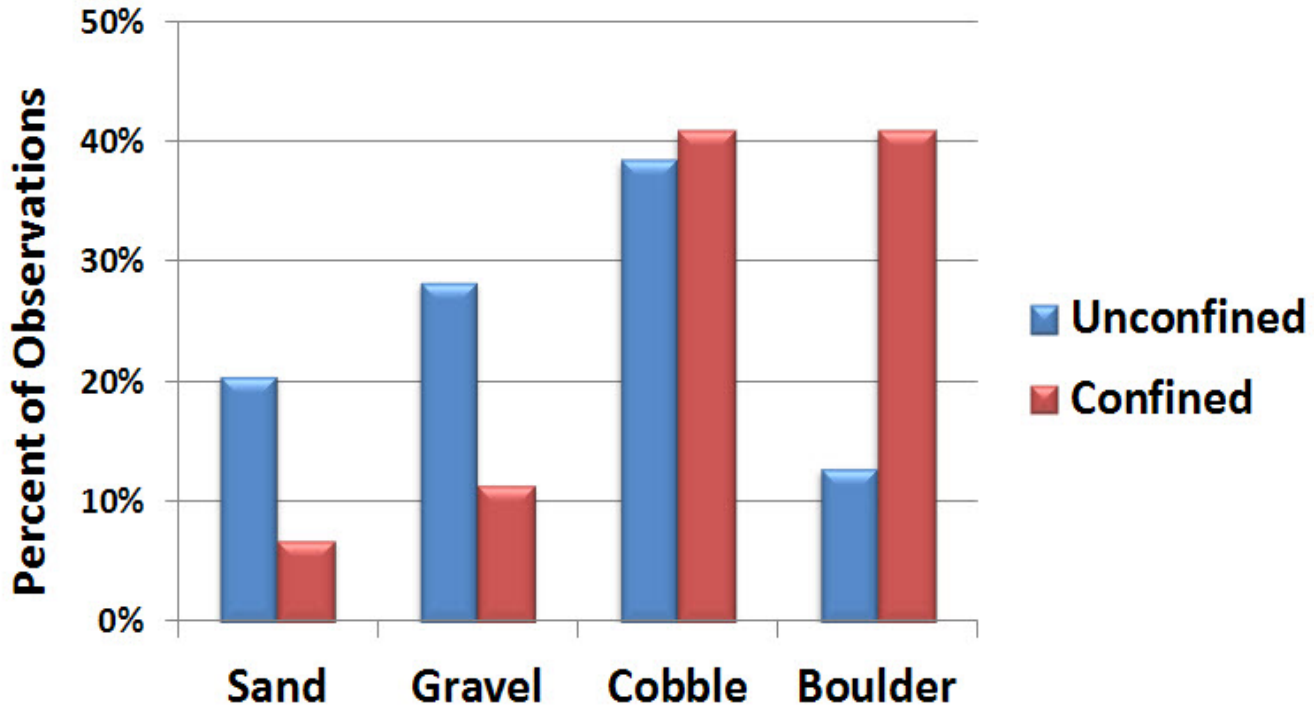
Unconfined



Pool-riffle morphology has 80% more pool area and 40% deeper pools, favored by juvenile salmon

McDowell 2001; Hall and others 2007

Grain Size



Spawning Chinook salmon prefer grain sizes that are often associated with unconfined valleys

Isaak and Thurow 2006

Riparian Areas

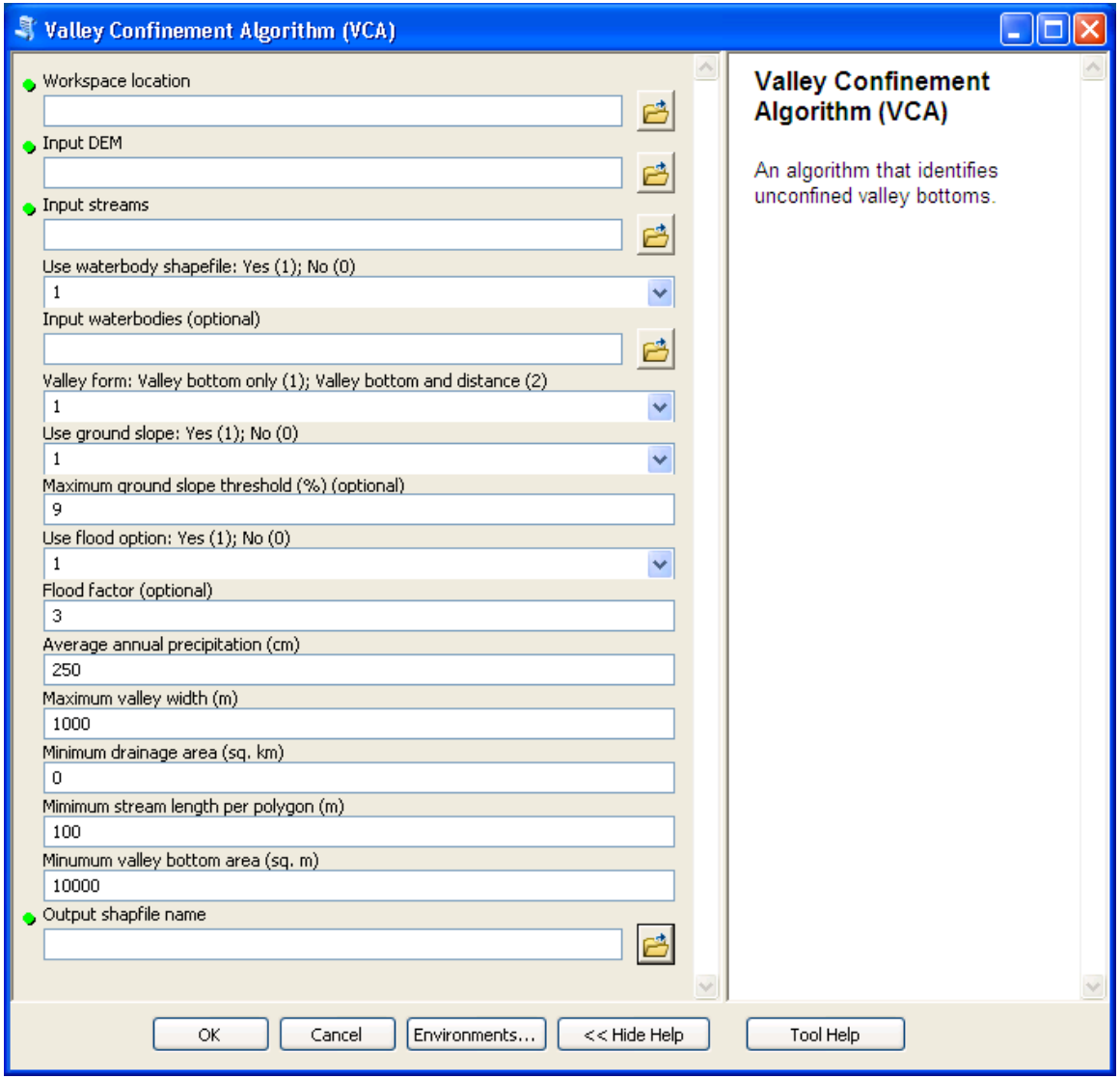
Riparian areas, often associated with unconfined valleys, provide disproportionately important ecosystem functions compared to confined valleys

Wissmar 2004

VCA

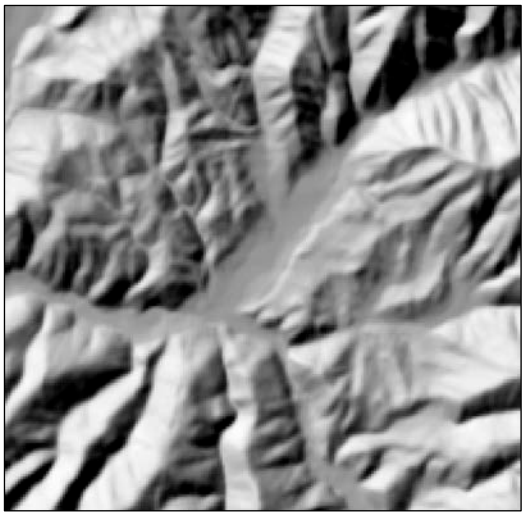
Valley Confinement Algorithm

Python script with an interface that allows users to vary the results based on the needs of the application

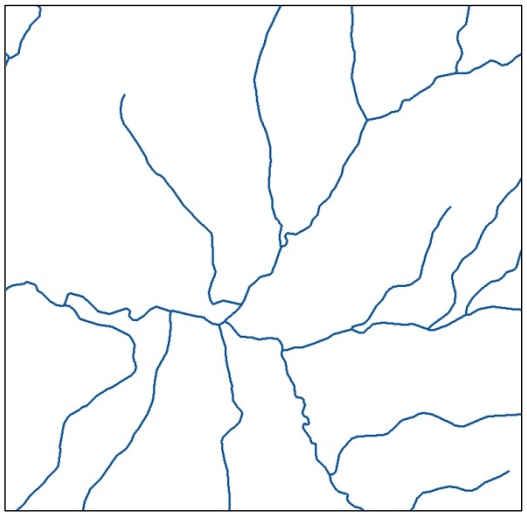


VCA Inputs

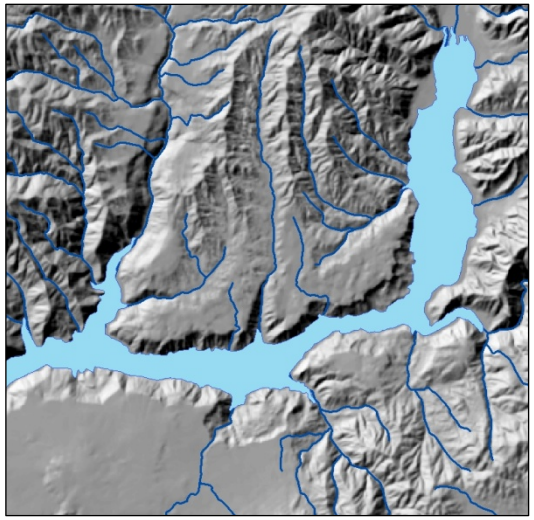
Uses nationally available NHDPlus data



DEM

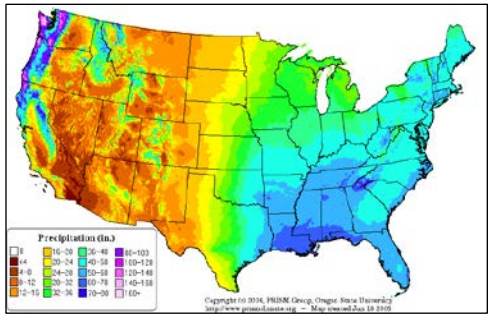


Flow lines



Water bodies

Average annual precipitation



Algorithm Sequence

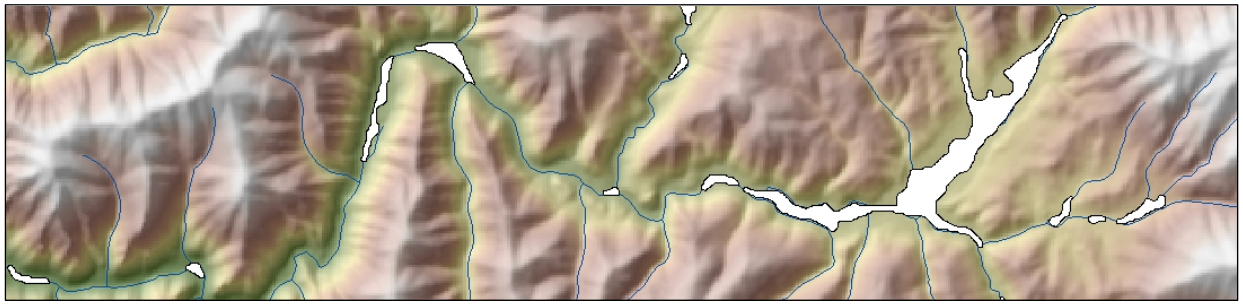
Valley flood

Slope cost distance

Ground slope

Initial valley bottom extent

Filtering

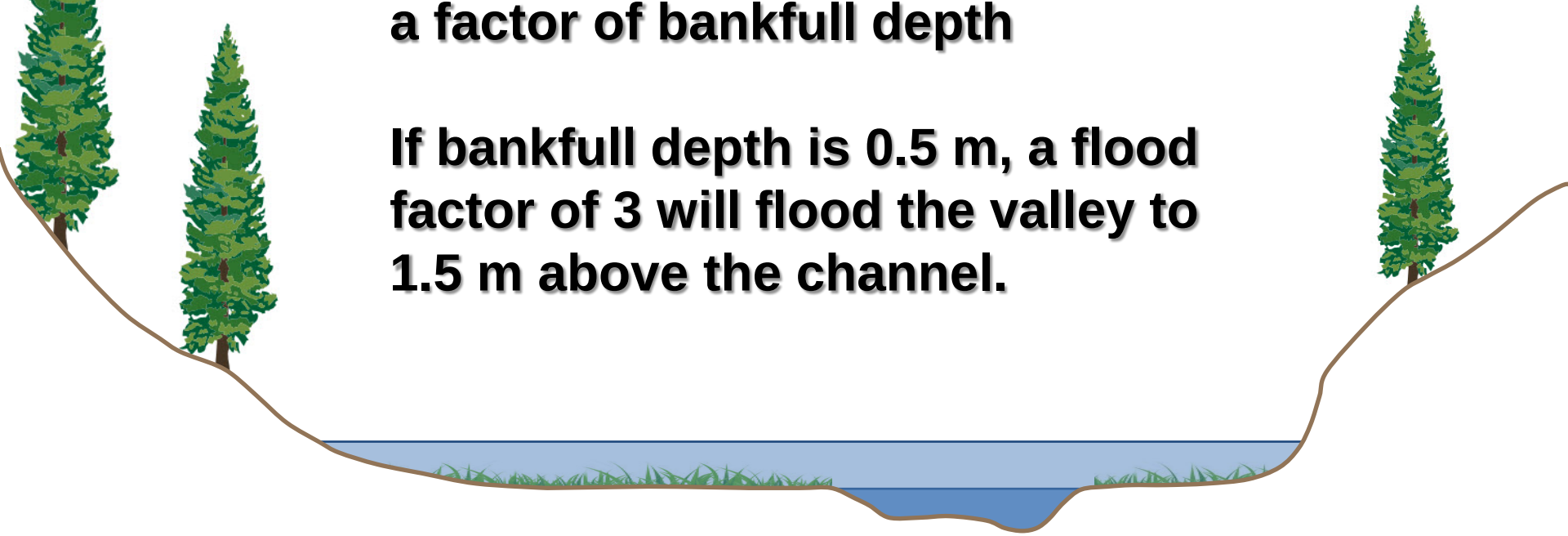


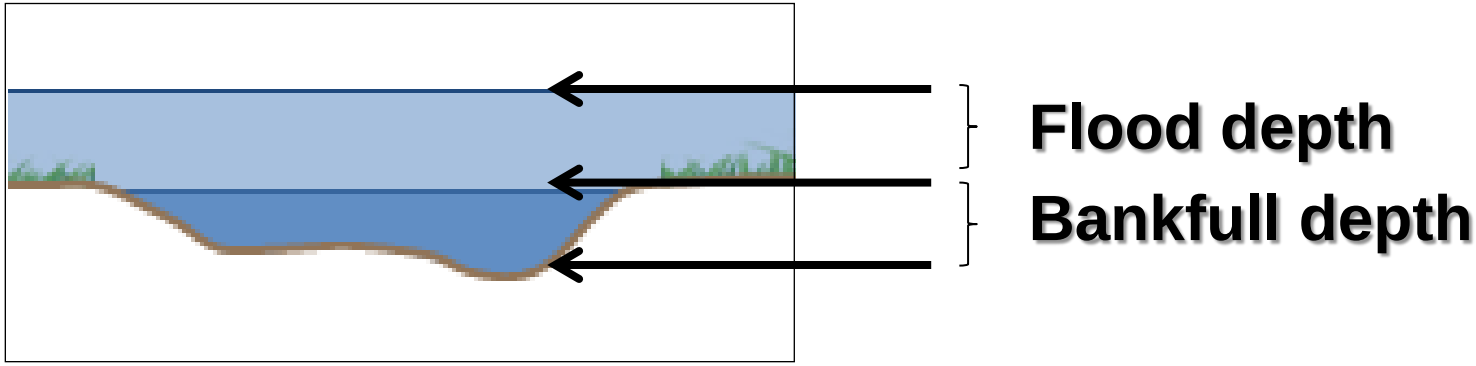
Valley bottom polygons

Valley Flood

Objective: Flood the valley floor as a factor of bankfull depth

If bankfull depth is 0.5 m, a flood factor of 3 will flood the valley to 1.5 m above the channel.





Computing Bankfull Depth

For channels in the Columbia River basin

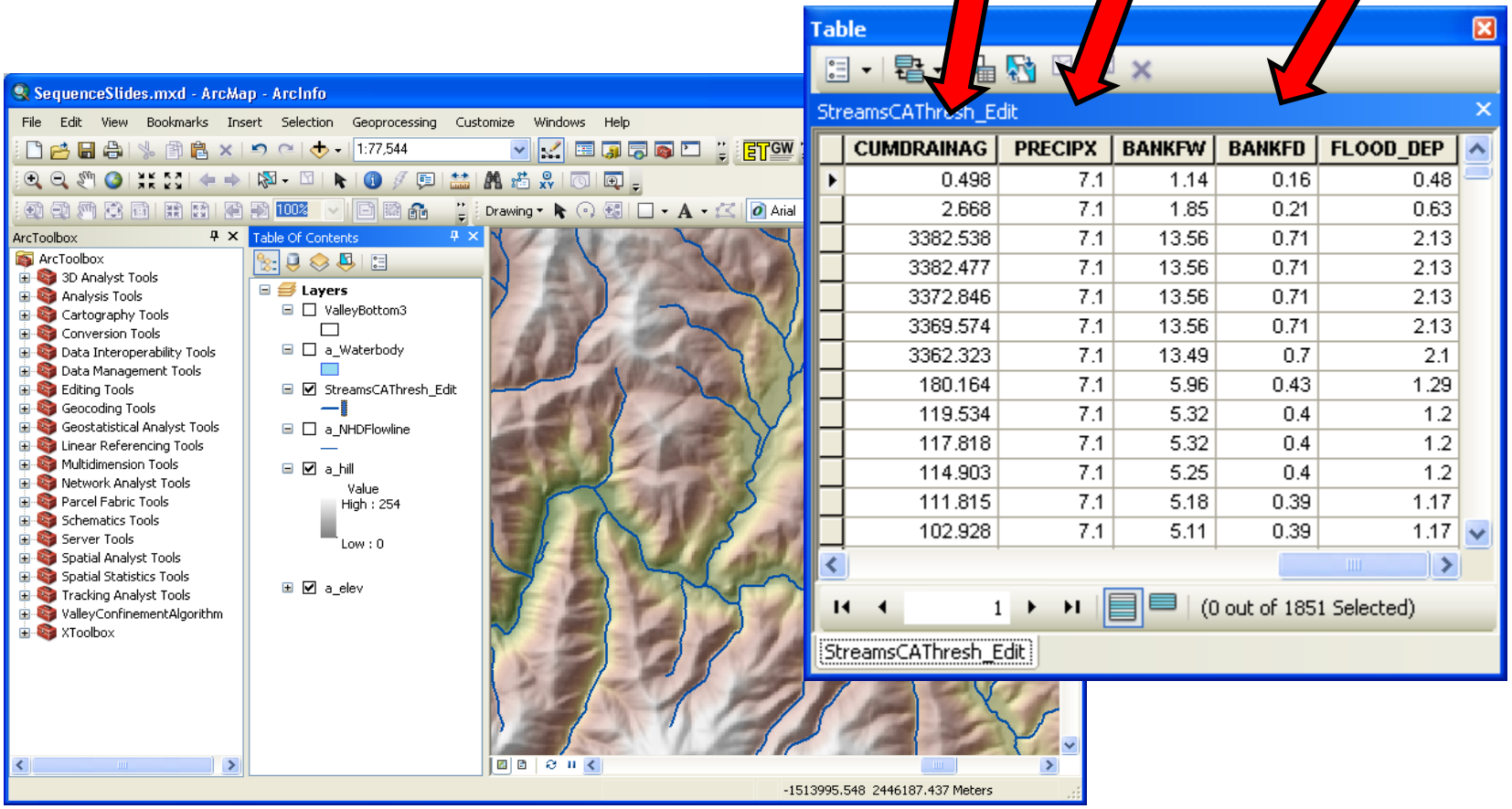
$$h_{bf} = 0.054A^{0.170}P^{0.215}$$

h_{bf} is bankfull depth (m)
A is contributing area (km^2)
P is average annual precipitation (cm)

Hall and others 2007

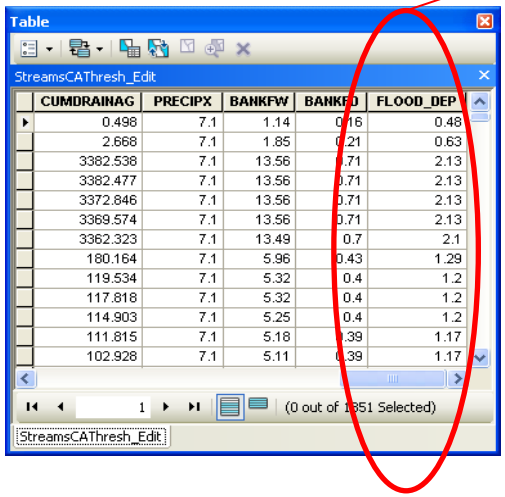
Computing Bankfull Depth

$$0.054A^{0.170}P^{0.215} = h_{bf}$$



BANKFD * Flood factor = Flood depth

(3)



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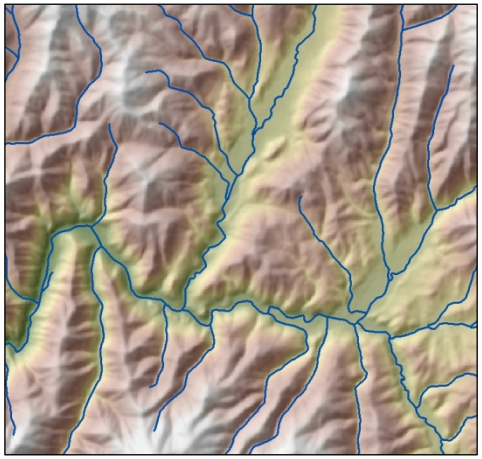

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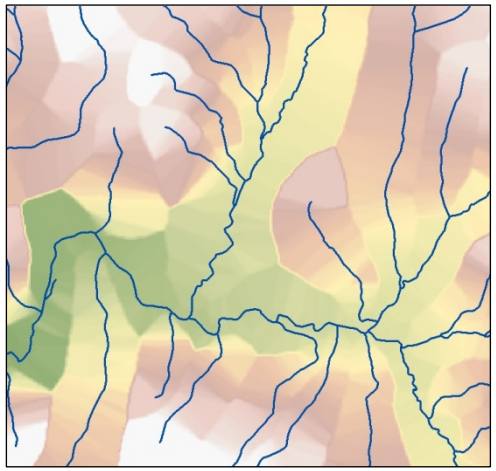
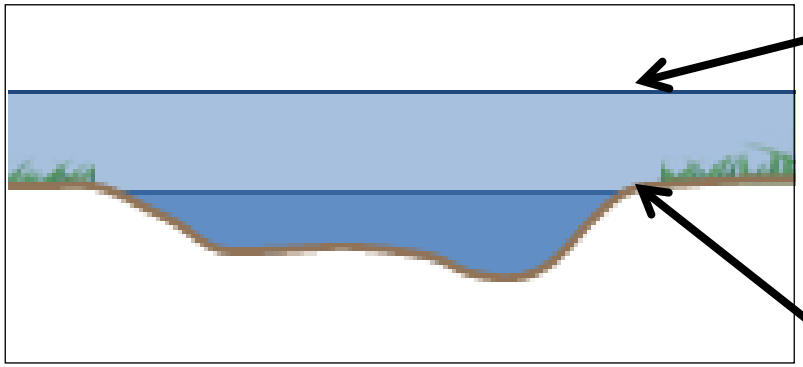
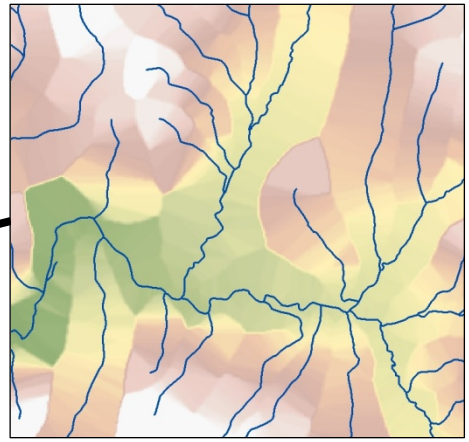


Elevation

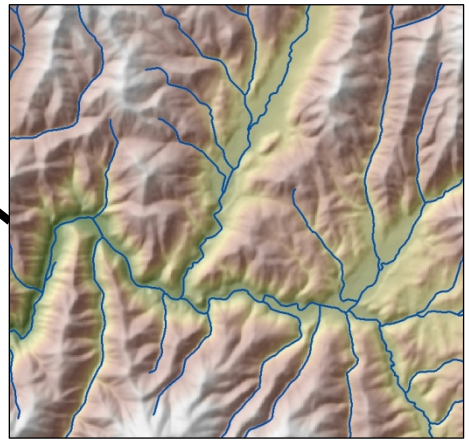
Flooded elevation

Flooded Elevation





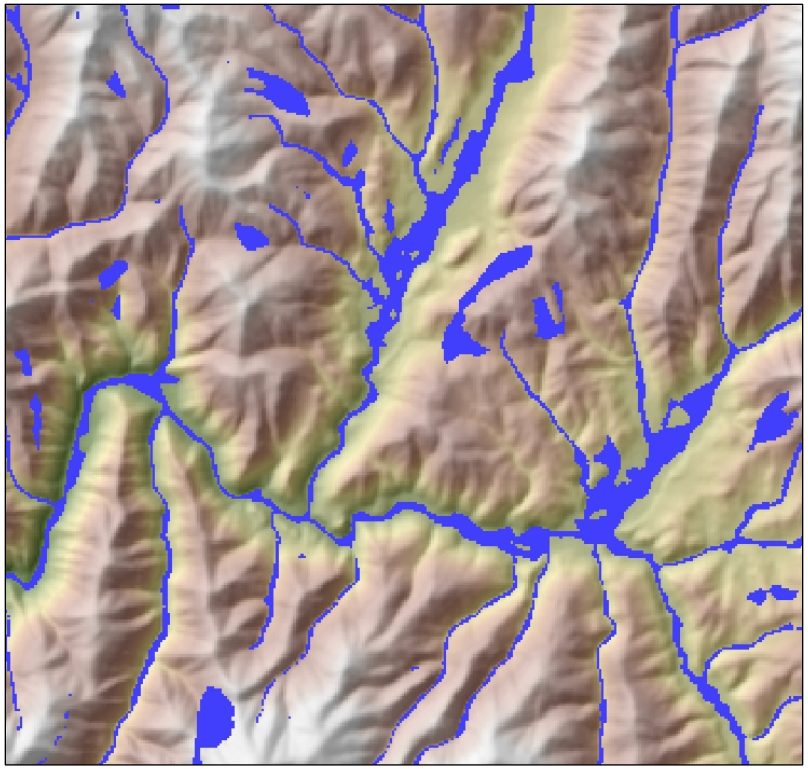
Flooded elevation



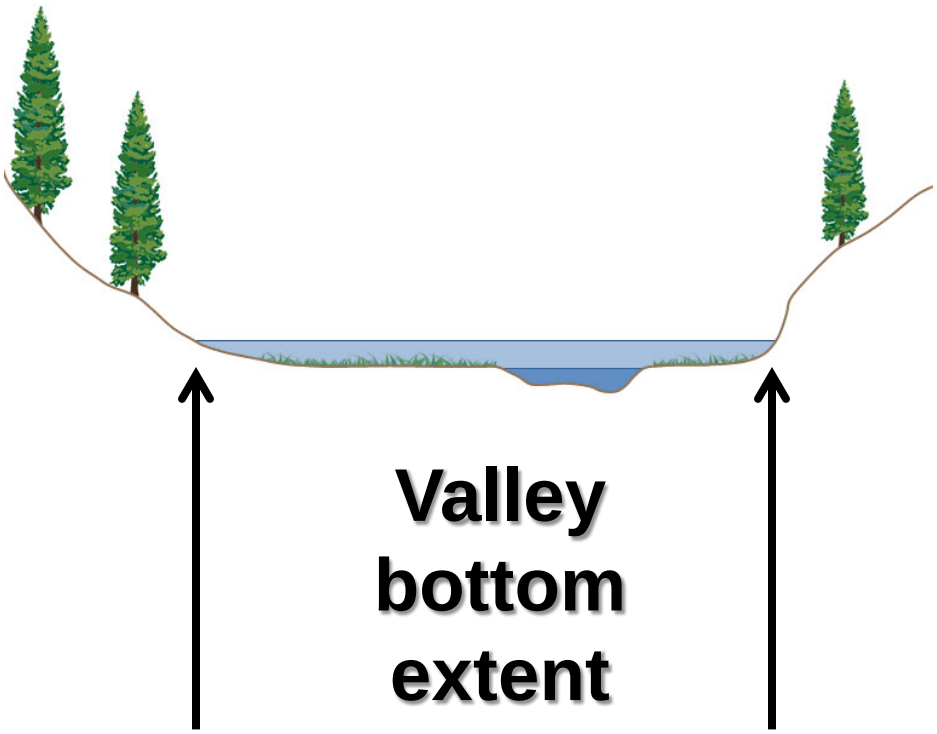
Ground elevation

Initial Valley Bottom

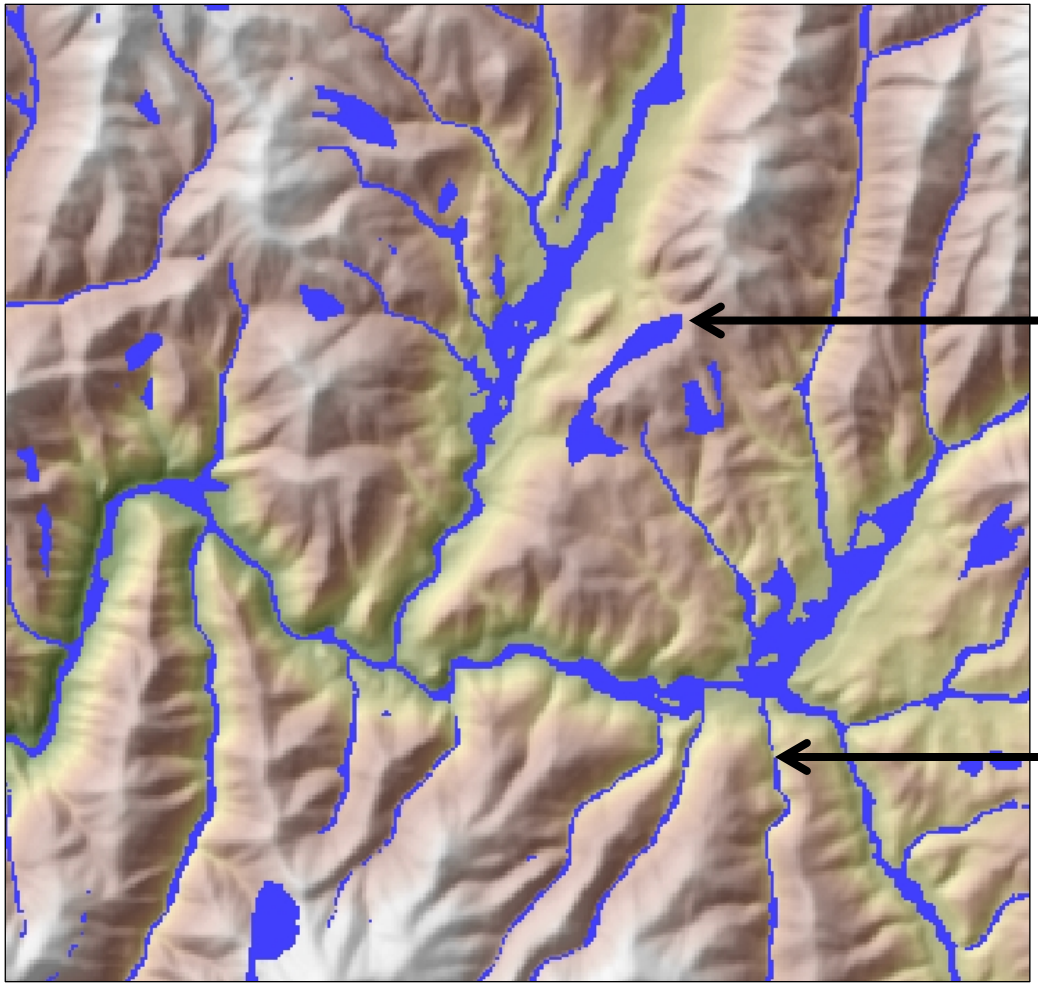
Intersection of flooded elevation with ground elevation



10 km



Clean Up

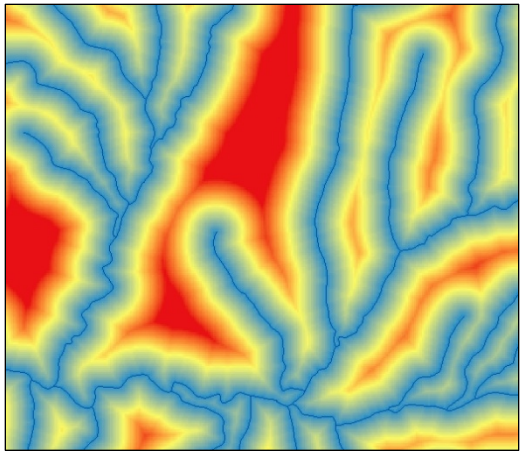


Non-channeled valleys

Confined valleys

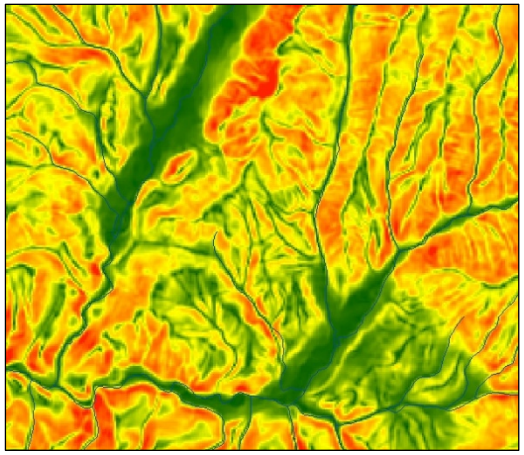
Slope Cost Distance

Restricts processing to near stream locations



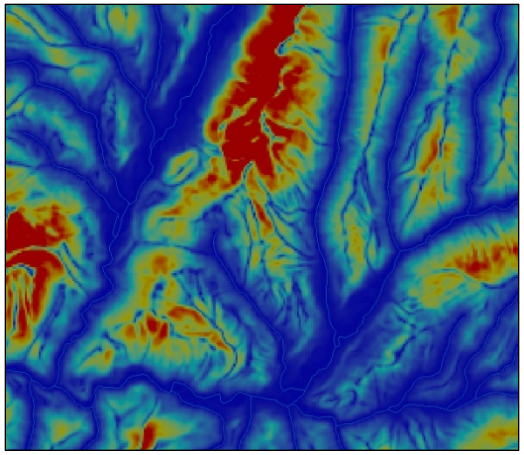
Distance from streams

x



Slope

=

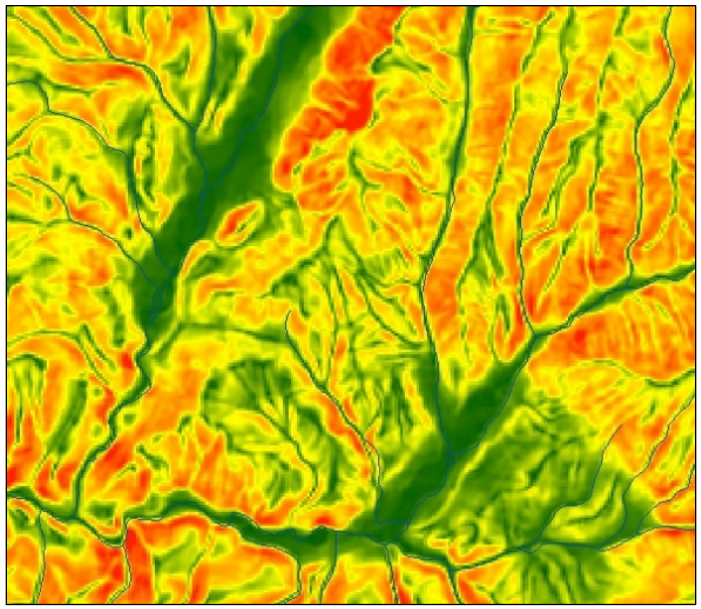


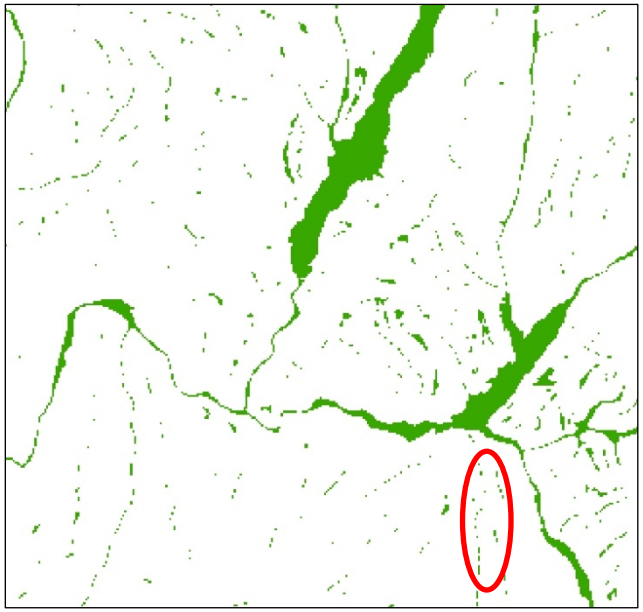
Slope cost

Slope cost distance threshold

Eliminates non-channeled valleys

Ground Slope Threshold



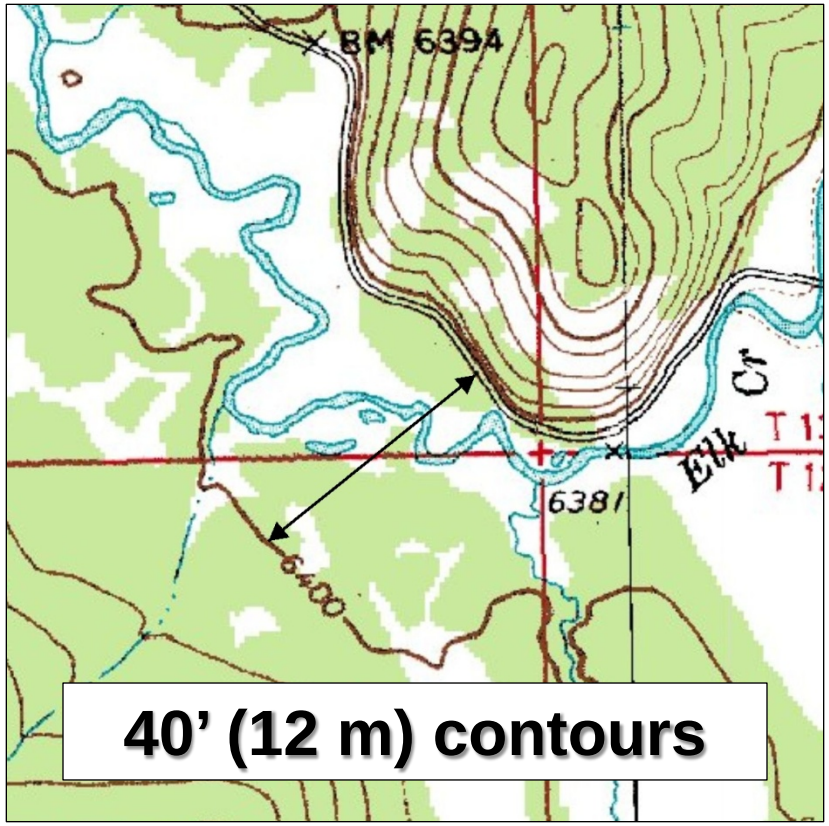


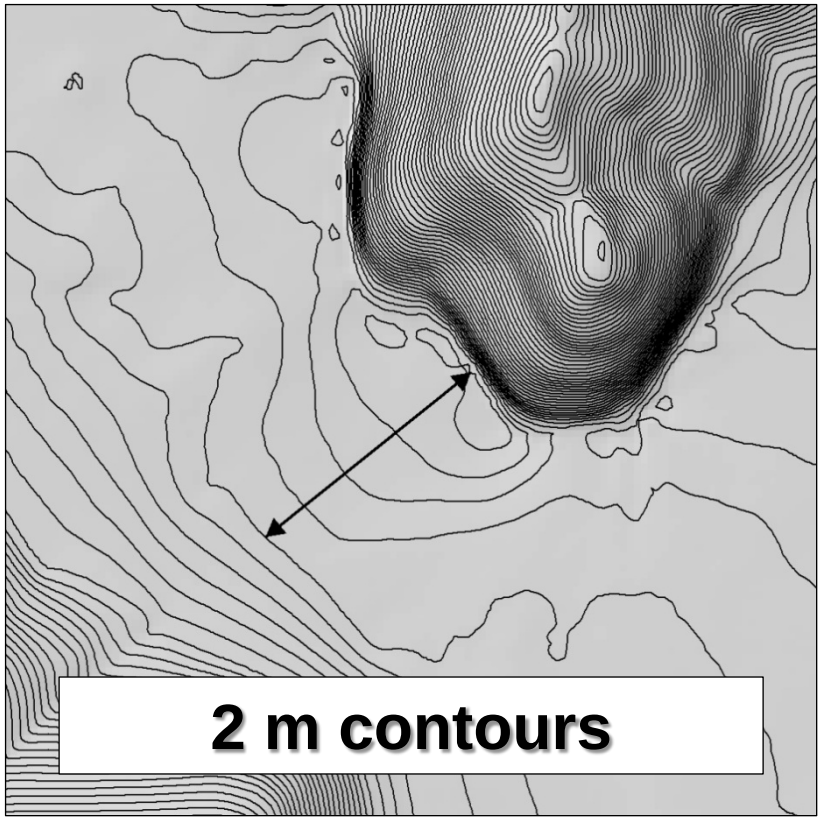
Slope

< 9% slope

Helps eliminate confined valleys

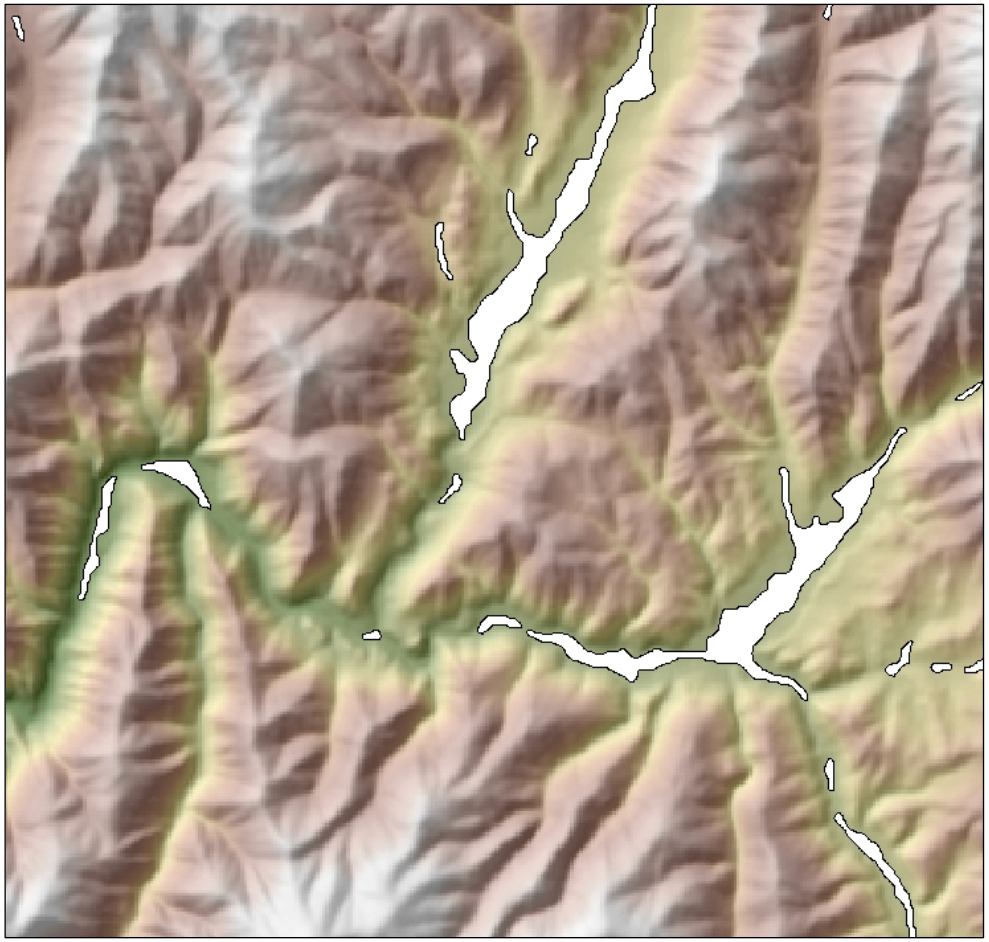
Quad Map and DEM Comparison





DEMs may have higher ground slope than indicated by quad maps

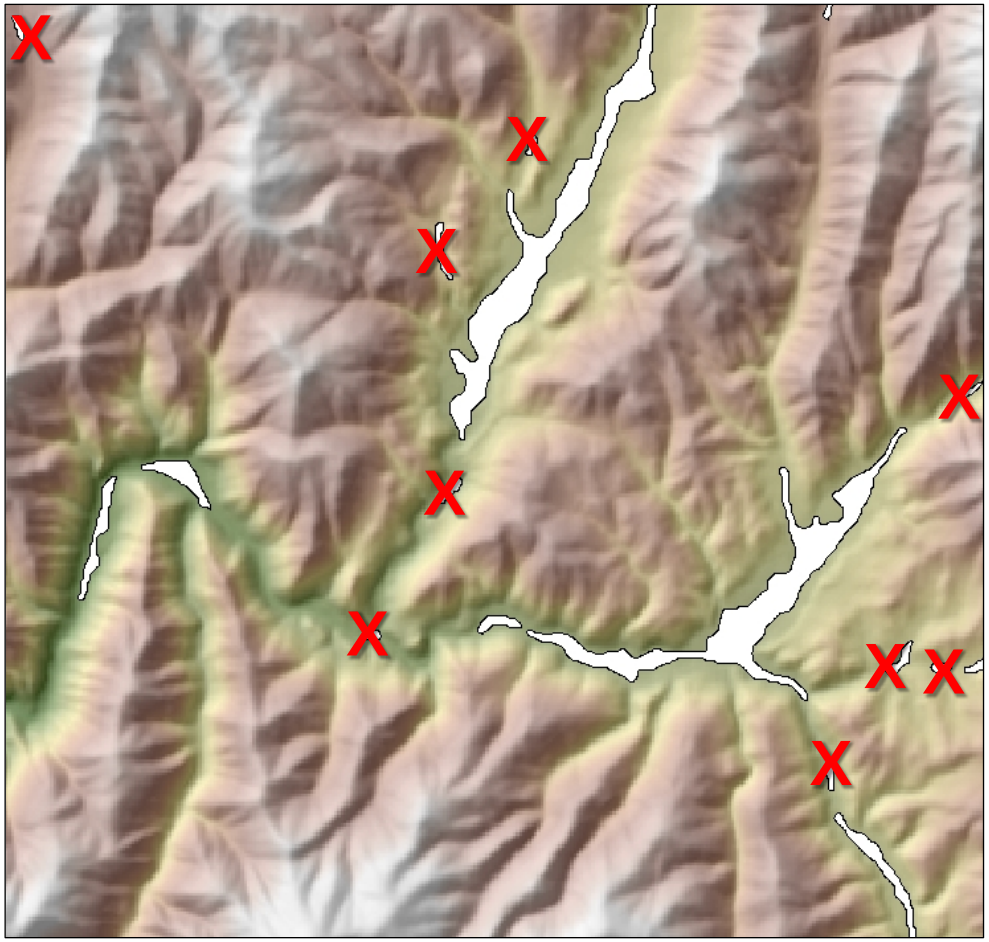
Results



10 km

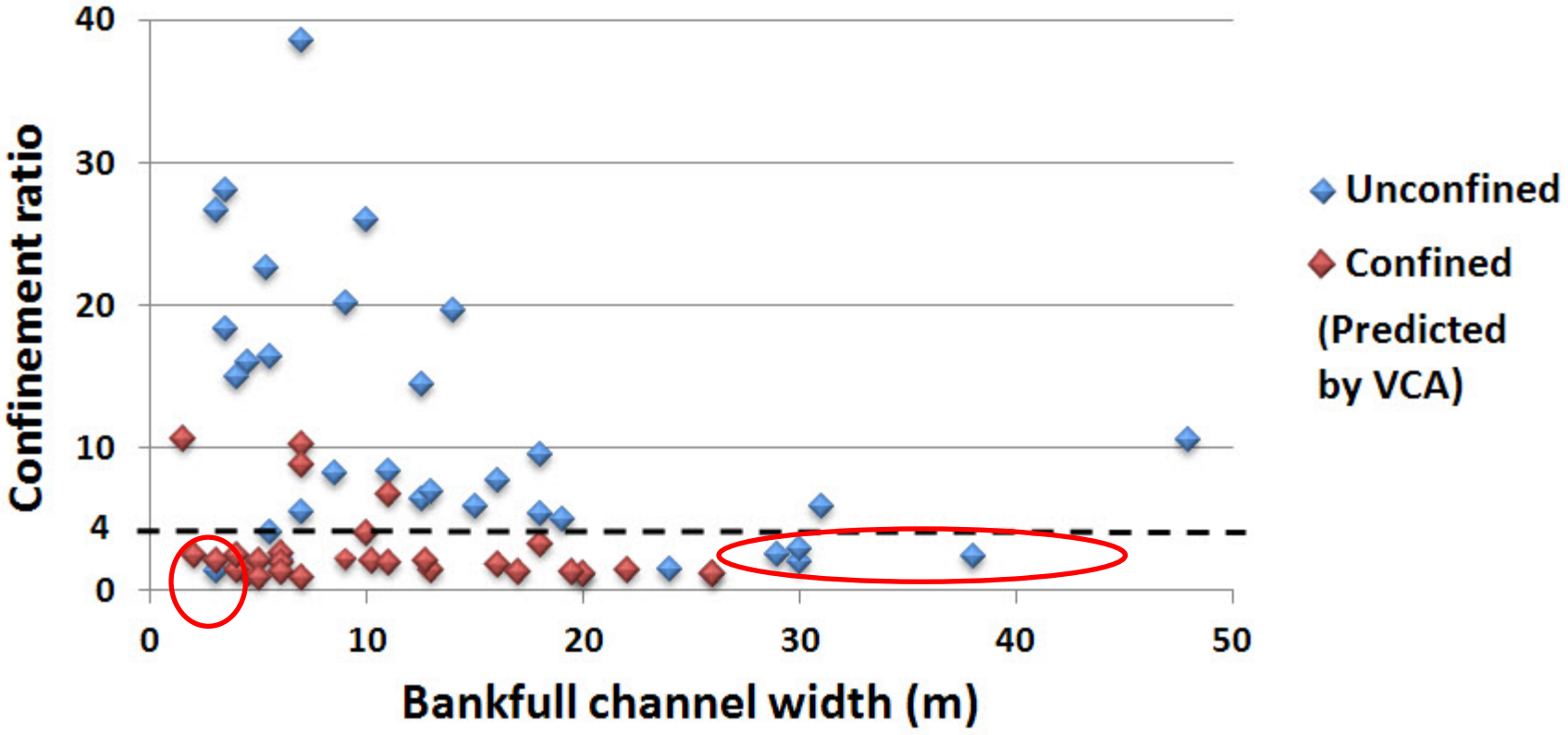
Filtering

Stream Length and Polygon Size Criteria



Validation and Results

Field Validation



78% of field sites identified as unconfined by the VCA had a confinement ratio greater than 4.

Office Validation

Quad Maps and Aerial Photography

		Actual	
		Unconfined	Confined
Predicted	Unconfined	58	3
	Confined	3	56
	Column count:	61	59

South Fork Boise River Basin

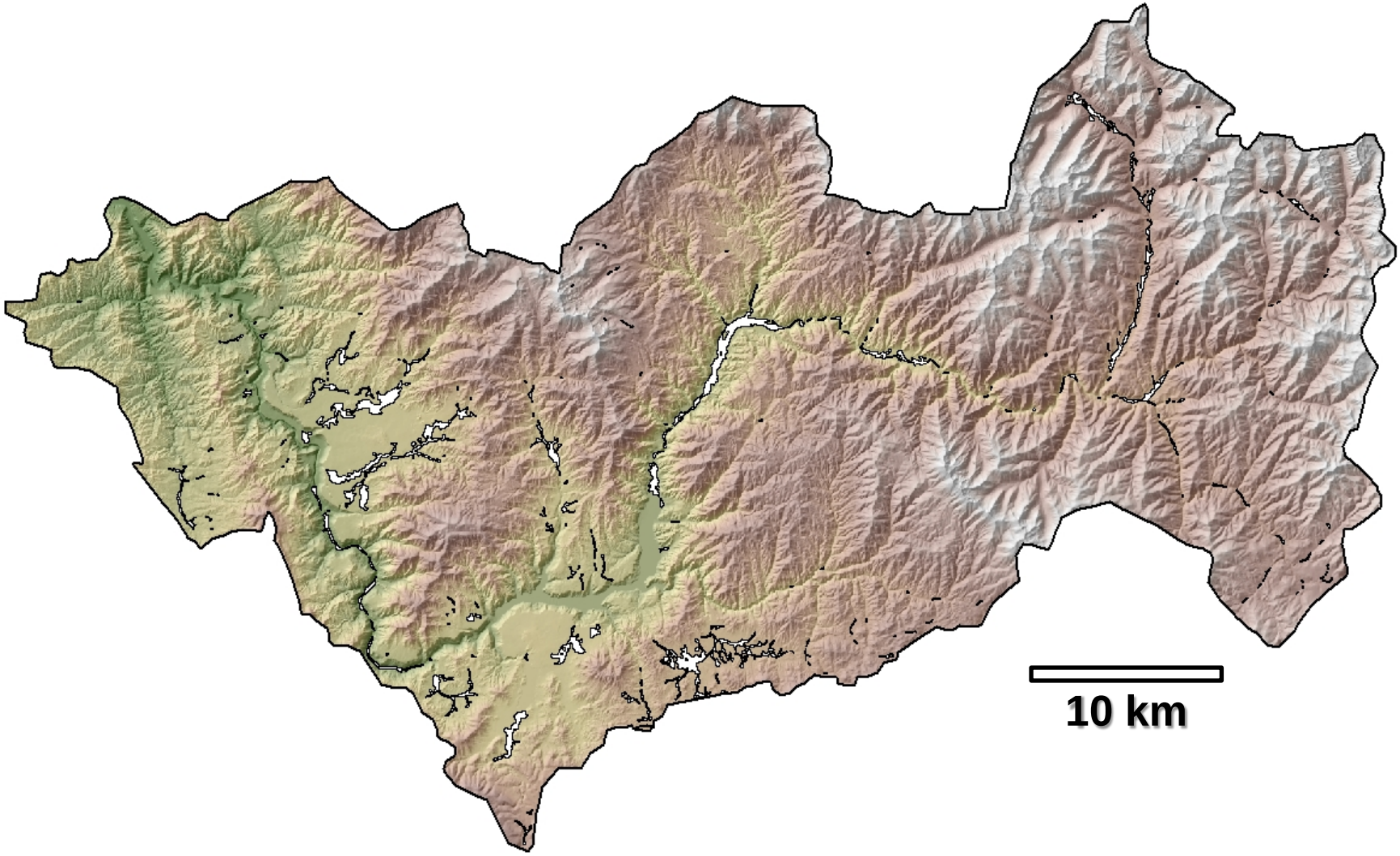
Accuracy = 94%

		Actual	
		Unconfined	Confined
Predicted	Unconfined	52	8
	Confined	8	52
	Column count:	60	60

South Fork Salmon River Basin

Accuracy = 87%

Landscape Scale Results



THANK YOU

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