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

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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

Confining features
Confined

Confinement ratio

15/10 = 1.5

Bankfull width

10 m

15 m
Unconfined

Confinement ratio
40/10 = 4

Bankfull width

10 m

40 m
Confined

Shallow alluvial deposits
Unconfined

Deeper alluvial deposits
Confined
Unconfined
Characteristics of Unconfined Valleys

• Hyporheic exchange
• Channel morphology
• Grain size
• Riparian habitat
Bull trout preferentially spawn at the downstream end of unconfined valleys where hyporheic upwelling may warm stream temperatures for overwintering embryos.
Channel morphology

Cascade

Step-pool

Plane-bed

Pool-riffle

Montgomery and Buffington 1997
Pool-riffle morphology has 80% more pool area and 40% deeper pools, favored by juvenile salmon.

McDowell 2001; Hall and others 2007
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 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)

Elevation + Flooded elevation
Flooded Elevation

Floadded elevation

Ground elevation
Initial Valley Bottom

Intersection of flooded elevation with ground elevation

Valley bottom extent

10 km
Clean Up

Non-channeled valleys

Confined valleys
Slope Cost Distance
Restricts processing to near stream locations

Distance from streams \( X \) \( = \) 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

DEMVs may have higher ground slope than indicated by quad maps
Results

10 km
Filtering
Stream Length and Polygon Size Criteria

10 km
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

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**South Fork Boise River Basin**

Accuracy = 94%

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**South Fork Salmon River Basin**

Accuracy = 87%
Landscape Scale Results
THANK YOU

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References


