Estimating Valley Confinement using DEM Data to Support Cutthroat Trout Research

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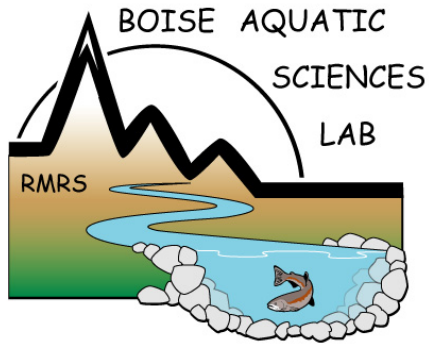
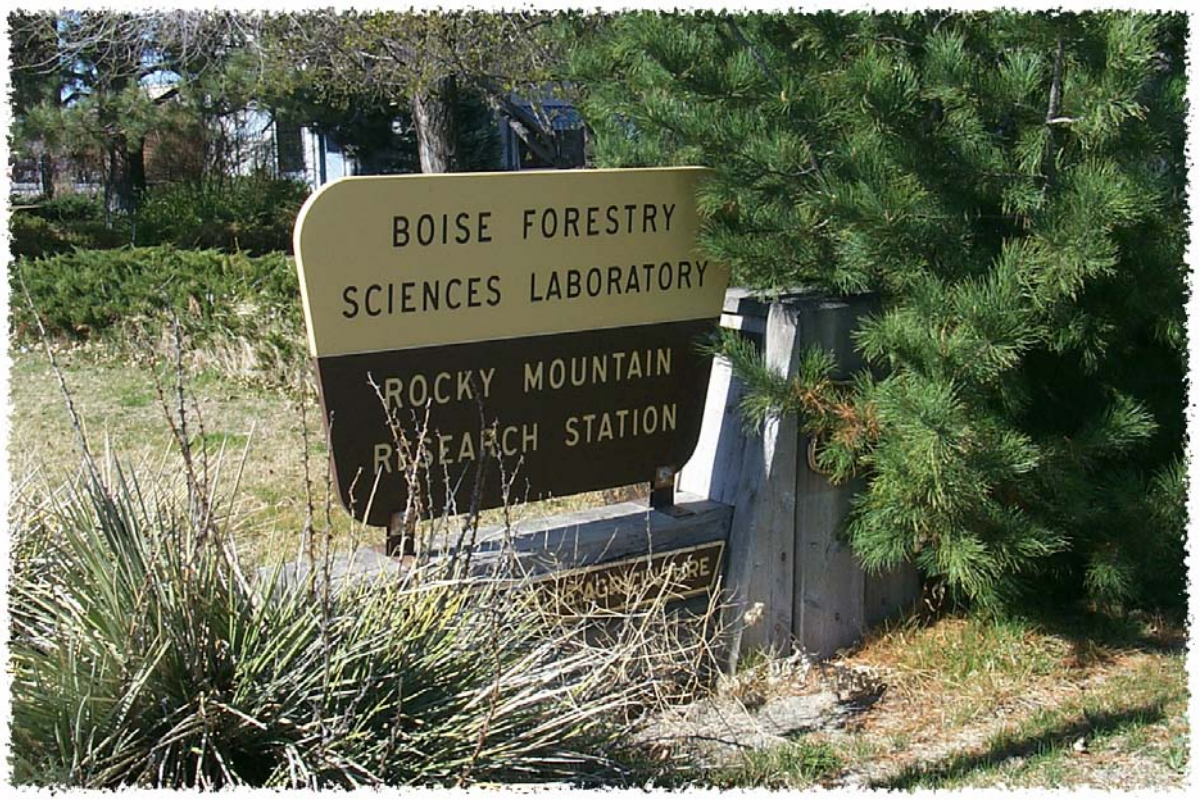
Boise Lab



Boise Aquatic Sciences Lab



Idaho

Boise Aquatic Sciences Lab
Old and New

Boise Lab Disciplines

Fisheries – biology

Watershed – physical

Outline

- Brook trout invasion project
- Valley confinement algorithm
- Validation and preliminary results

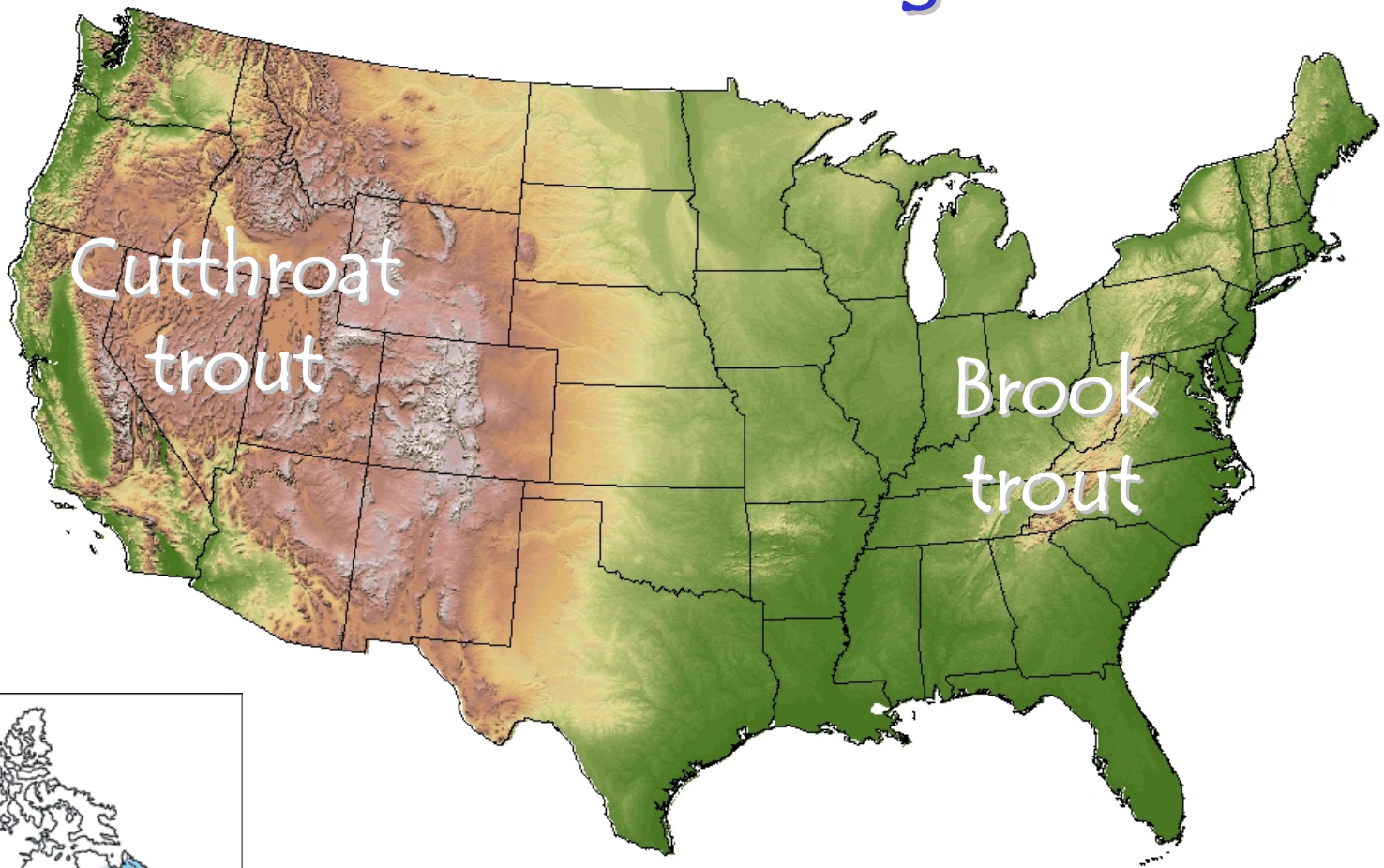
Brook Trout Invasion Project

Objective: Determine the physical factors that permit brook trout to coexist with, or replace native cutthroat trout

Brook trout are an invasive species west of the Mississippi

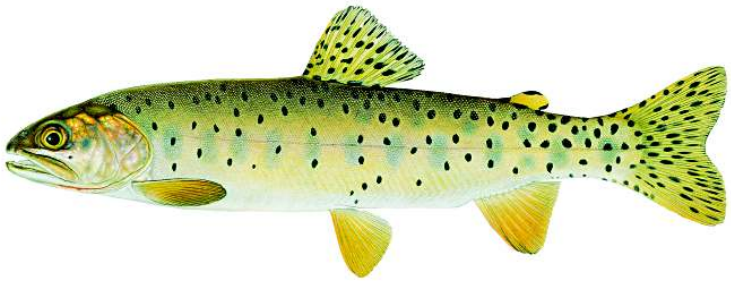
Courtesy J. Tomelleri

Historical Ranges

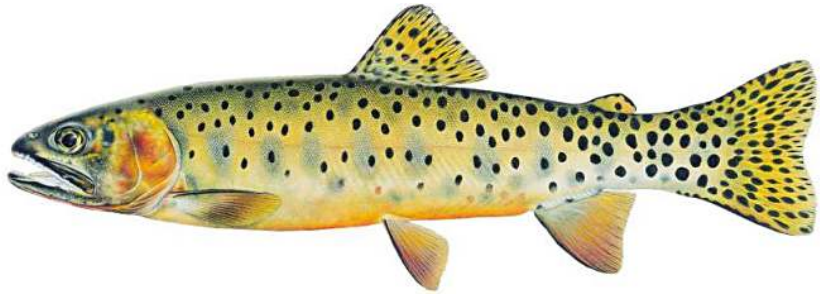


Current brook trout range

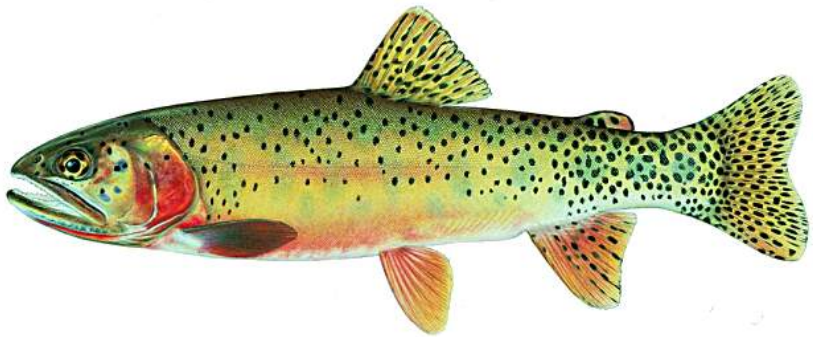
Some Cutthroat Trout Subspecies



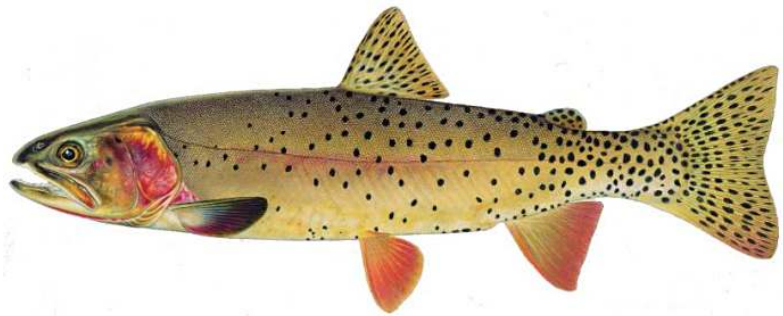
Bonneville



Colorado River



Rio Grande



Yellowstone

Courtesy J. Tomelleri

Westslope Cutthroat Trout

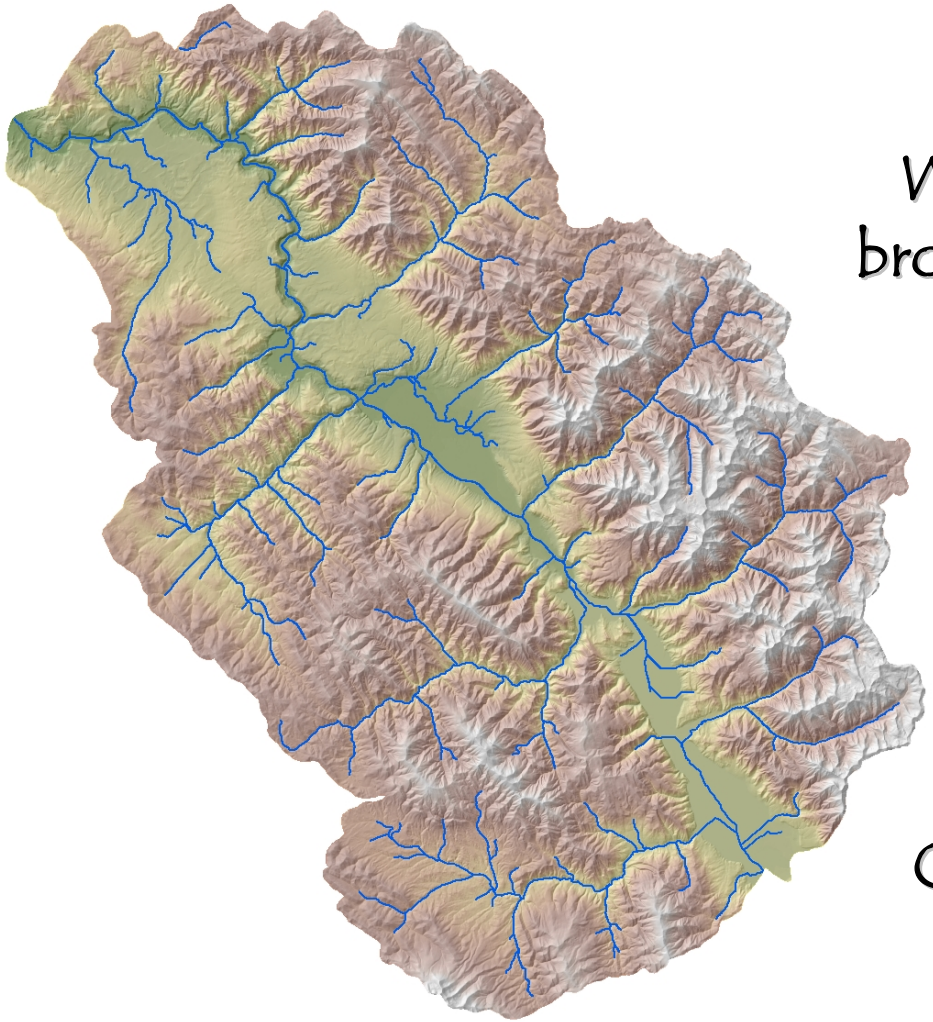
- The westslope cutthroat trout now only occupies between 19-27% of its historic range in Montana and about 36% of its historical range in Idaho (Van Eimeren 1996).

- Non-native species have taken a huge toll on westslope cutthroat trout.

Source: Montana Chapter of the American Fisheries Society

Courtesy J. Tomelleri

Questions



Where on the landscape do brook trout displace or replace cutthroat?

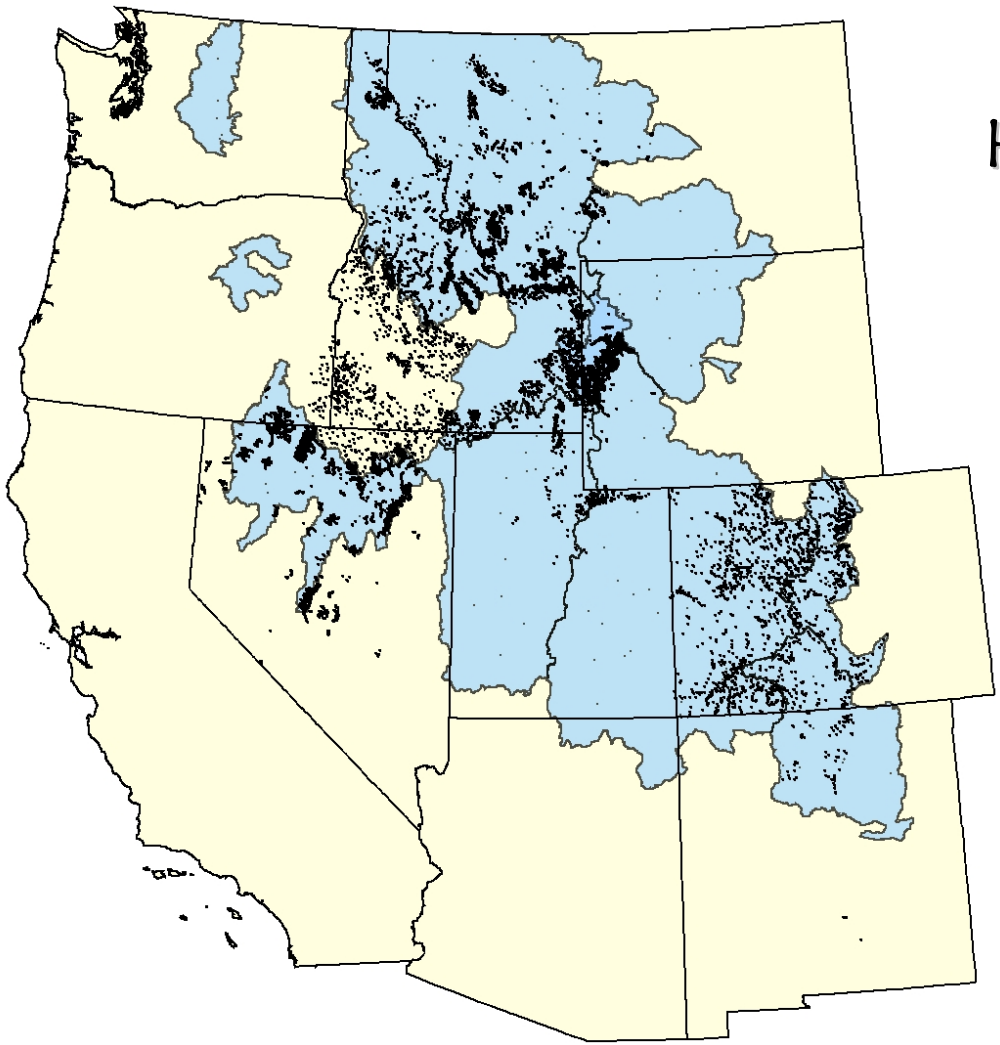
Where are cutthroat at risk?

Can barriers protect at risk populations?

Historical Range of Cutthroat Trout and Study Extent

Study extent attempts to include all subspecies ……..

Fish Sample Points



However, the extent is limited by the availability of fish sample data

What Are Fish Sample Points?

Possible Attributes

- Fish species
- Fish length
- Stream width
- Stream temperature
- Stream gradient
- Elevation

Data Collection

- Over 10 different agencies
- More than 18,000 points
- Nine months to receive data

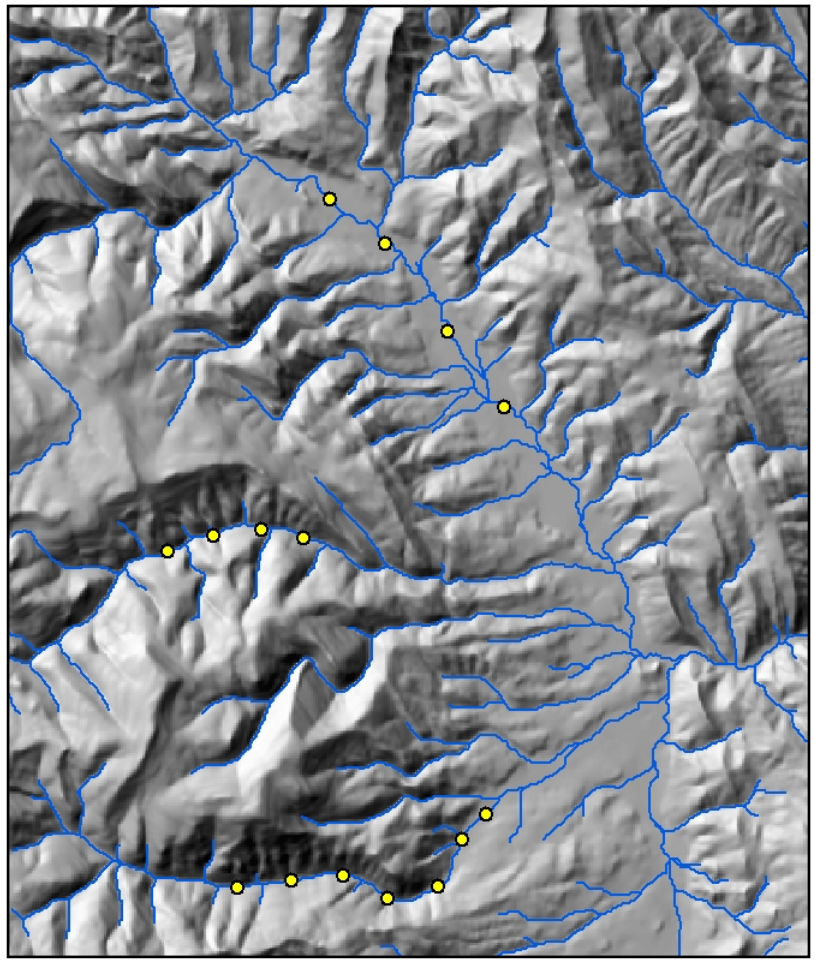
tblMain : Table

	Strean	Streamname	Streamsite	Subbasin	Region	UTMEast	UTMNorth	Lat	Lo	GPSz
▶	1	Crow Creek		18	3	461714	4827654			12
	5	Palisades Creek	Site 2	31	6	486690	4804929			12
	6	Elk Creek	Only (1980's site)	56	6	481860	4790587			12
	7	Pine Creek	Site 3A	31	6	476295	4822036			12
	8	West Pine Creek	Site 1	31	6	476209	4822223			12
	9	North Fork Pine Creek	Site 1	31	6	477985	4823003			12
	10	Pine Creek	Site 2A	31	6	475166	4820313			12
	11	Burns Canyon	Upper	31	6	462800	4828594			12
	12	Rainey Creek	Lower	31	6	472632	4810846			12
	13	Rainey Creek	Upper	31	6	481836	4813772			12
	14	Rainey Creek	Middle	31	6	478513	4811828			12
	15	Fall Creek	Only (@ Currant Holl	31	6	464734	4805717			12

Record: 1 of 2103

Overlay Fish Data with Physical Environmental Variables

- Elevation
- Stream gradient
- Catchment area
- Valley confinement
- Temperature
- Headwater lakes
- Proximity to roads
- Alkalinity



Confined and Unconfined Valleys

Why Look at Valley Confinement?

Brook trout may prefer lower gradient streams

Slope <= 2%

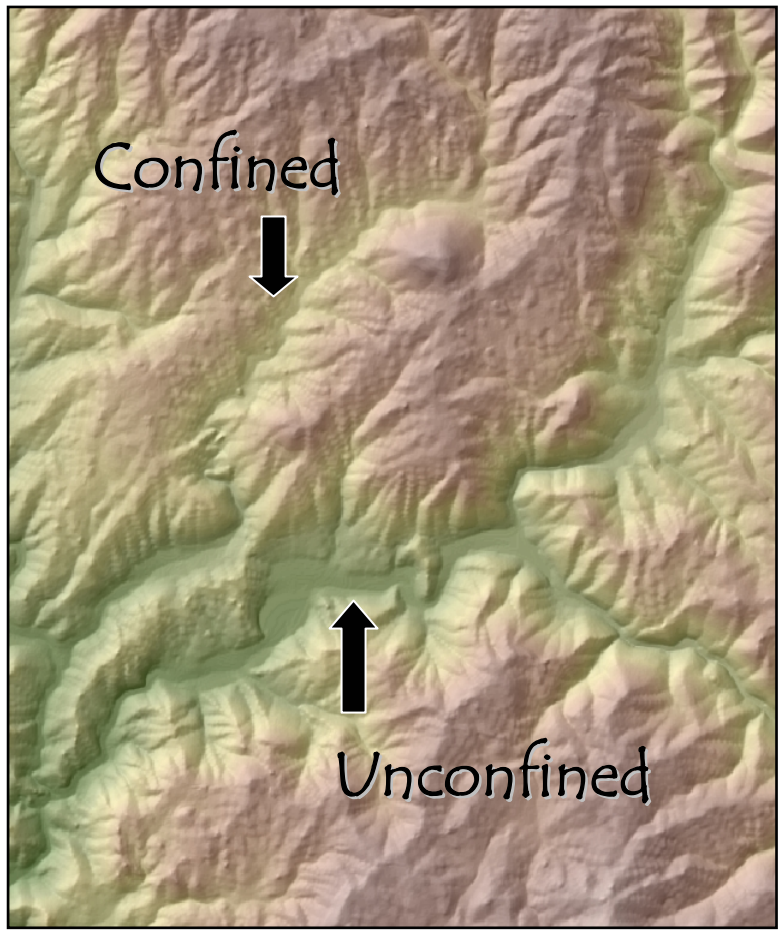
Slope 0 - 10%

Unconfined streams usually have a lower gradient

Courtesy J. Tomelleri

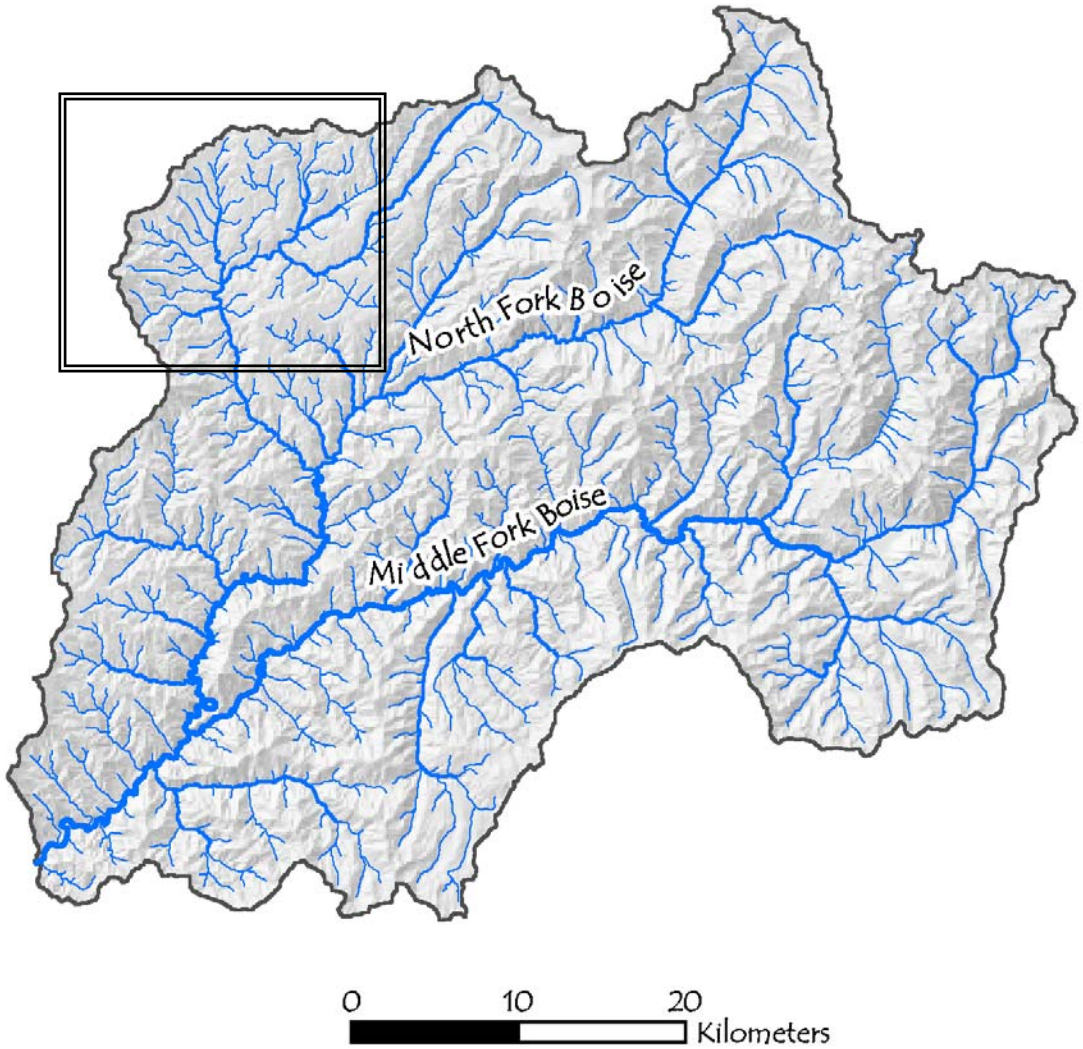
Valley Confinement Algorithm

- Attempts to identify unconfined valleys
- Computes network distance from each unconfined valley
- Uses 30 m DEM as input
- Written using Python and ArcGIS 9.0 Geoprocessor

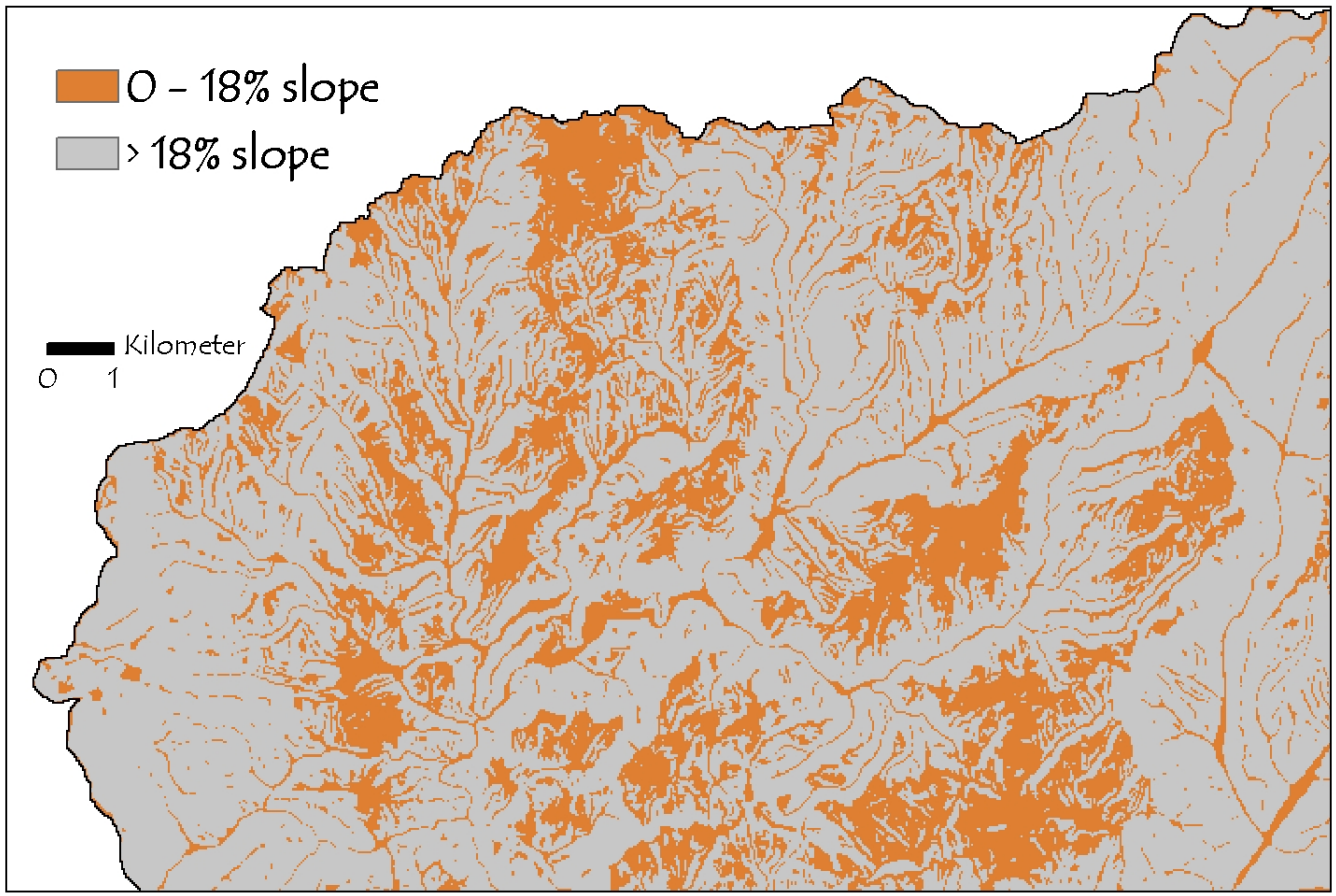


Middle Fork Boise River Watershed

Boise National Forest

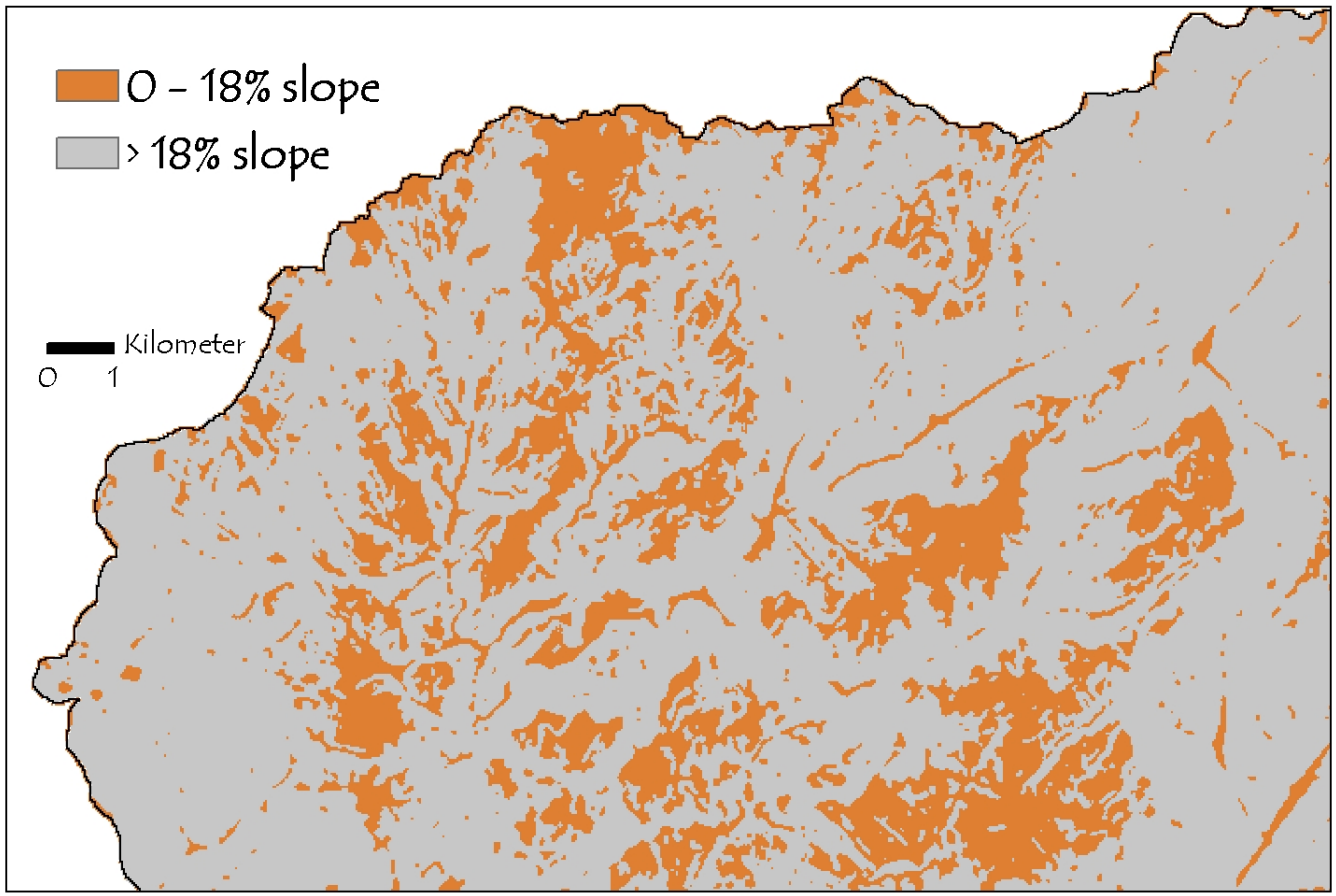


Compute Slope



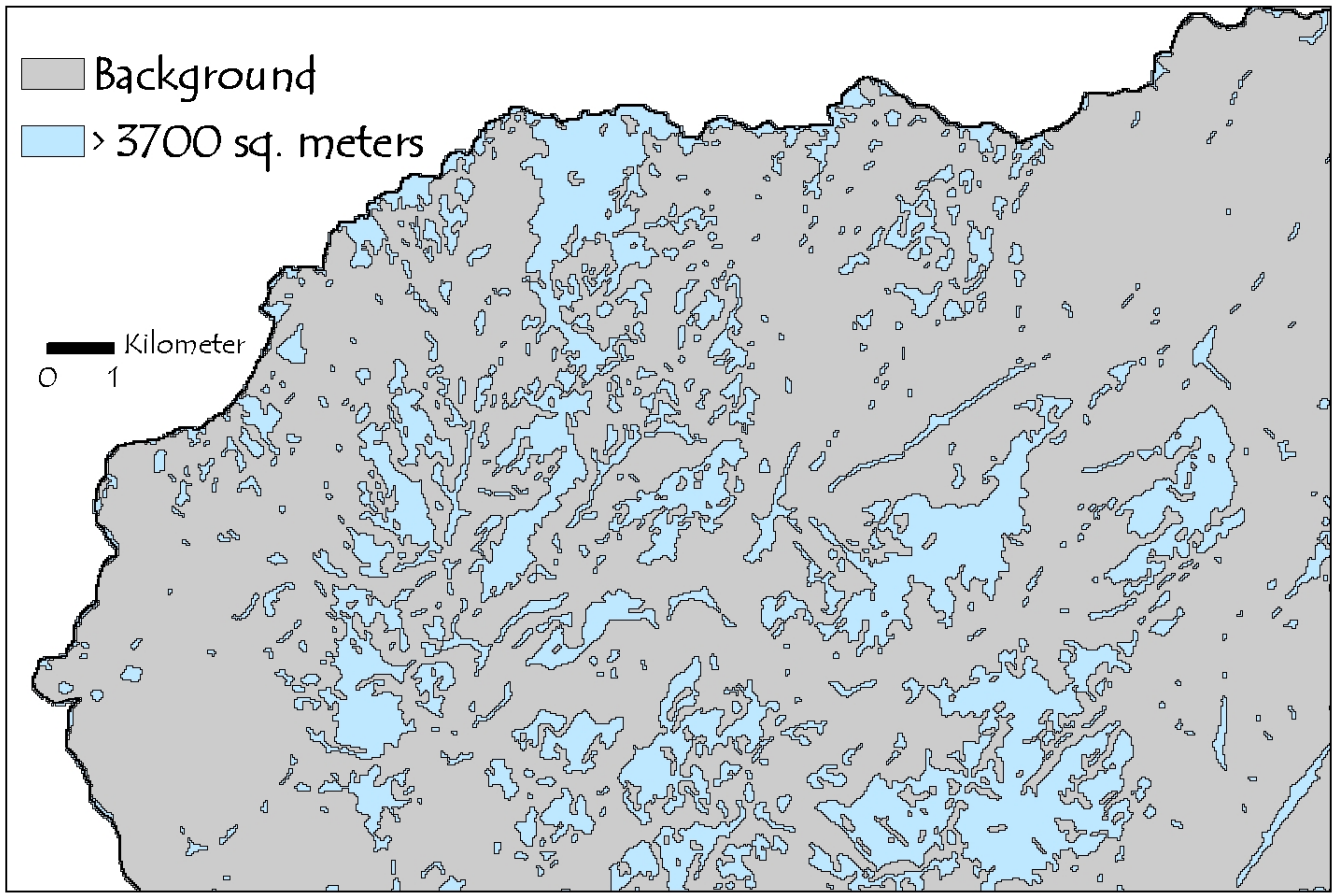

```
# Compute slope in percent using the input DEM
gp.Slope_sa("mfkb_dem", "slope_tmp", "PERCENT_RISE", "1")

# Reclassify the slope file so that flat areas are == 1 and all else == 2
gp.Reclassify_sa("slope_tmp", "Value", "0 18.5 1;18.5 500 2", "reclsslp_tmp", "DATA")
```

Filter Slope



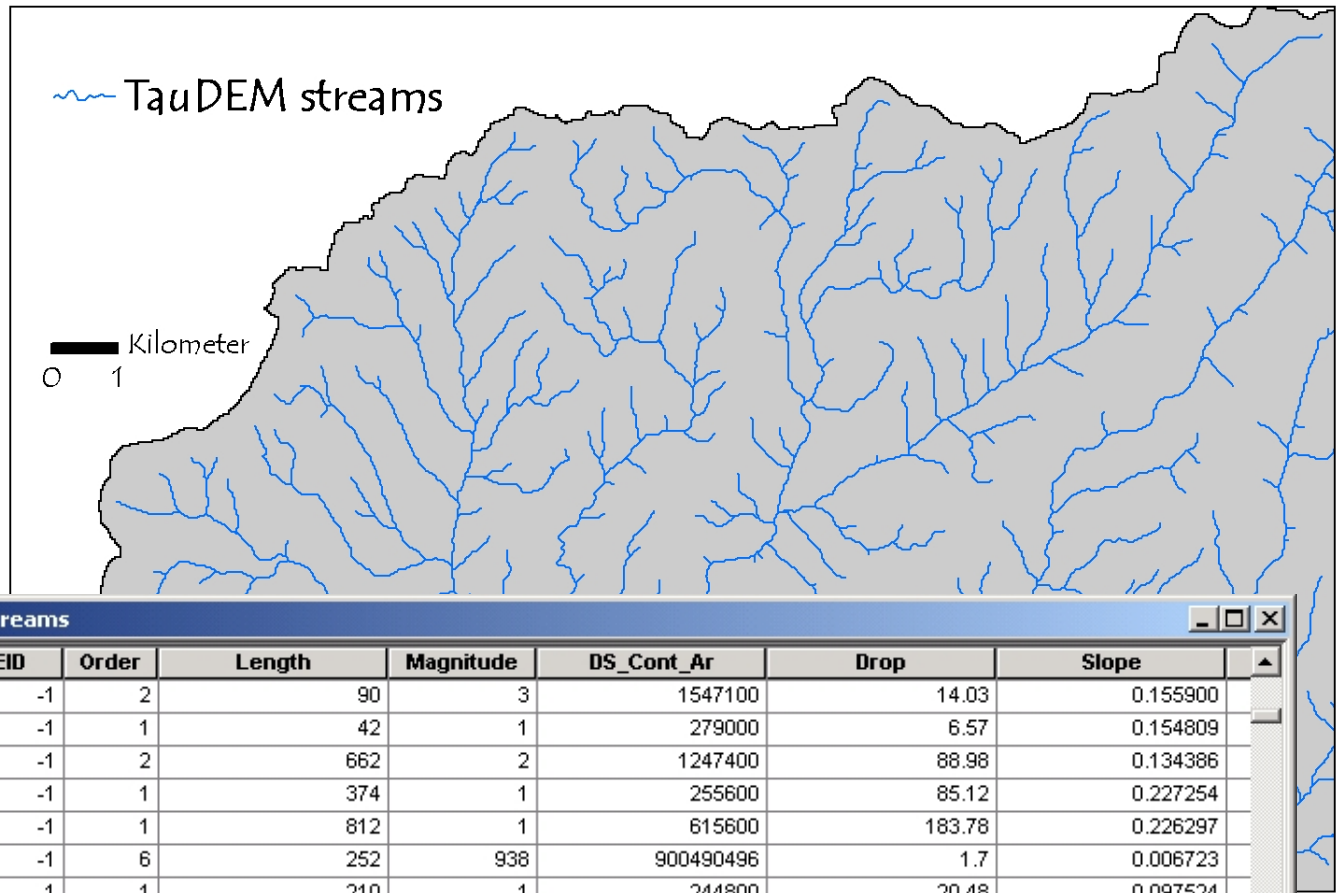

```
# Do 3x3 majority filter to generalize the slope layer
gp.FocalStatistics_sa("reclsslp_tmp", "slp3x3_tmp", "Rectangle, 3, 3,CELL", "MAJORITY", "DATA")
```

Convert to Polygons and Eliminate




```
# Select by attribute to create a selection set
gp.SelectLayerByAttribute_management("Layer", "NEW_SELECTION", "[Shape_Area] < 3700")

# Eliminate polygons selected above
gp.Eliminate_management("Layer", "Eliminate.shp", "LENGTH")
```

TauDEM Streams



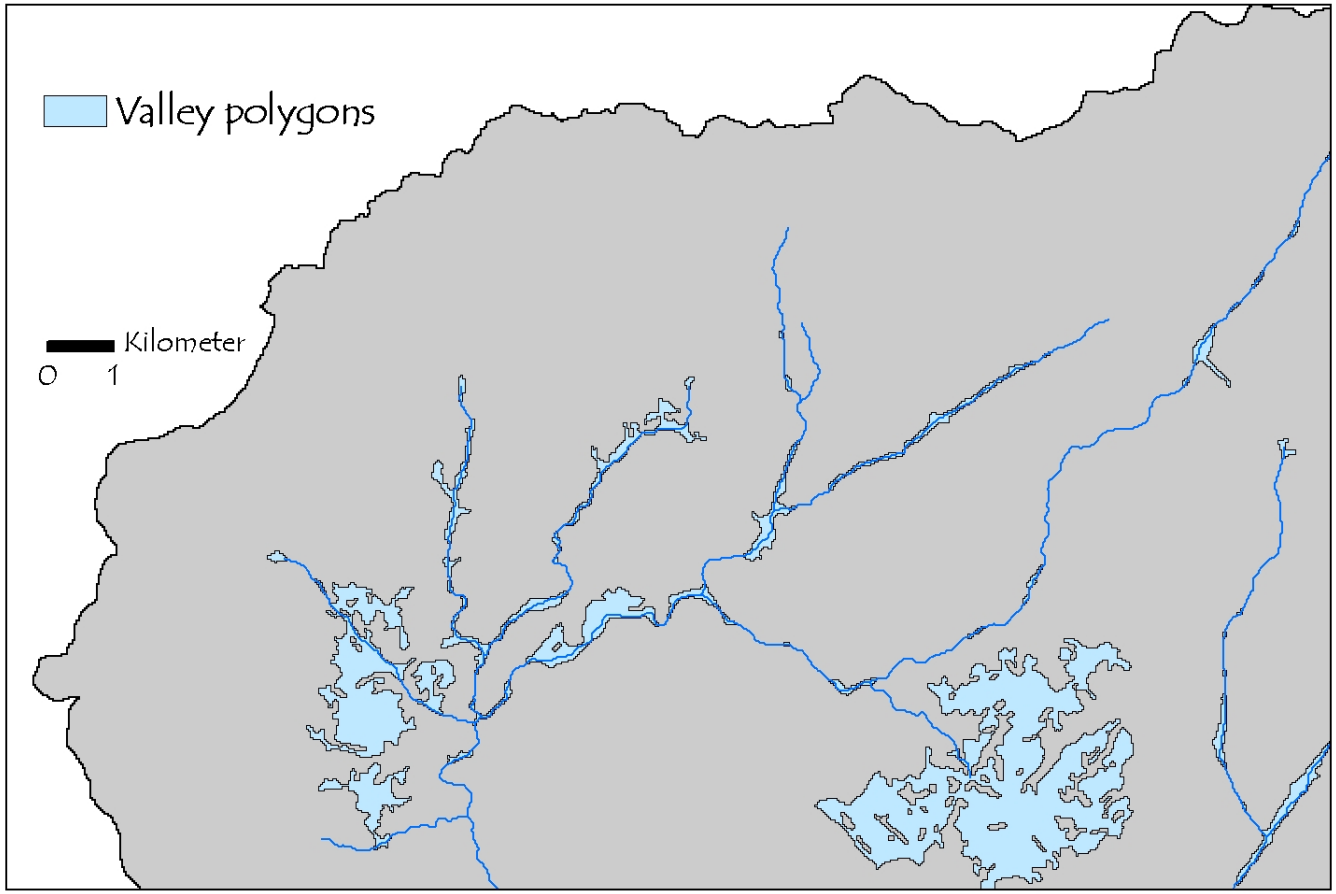
Attributes of TauDEM streams

USLINKNO2	DSNODEID	Order	Length	Magnitude	DS_Cont_Ar	Drop	Slope
3363	-1	2	90	3	1547100	14.03	0.155900
0	-1	1	42	1	279000	6.57	0.154809
3259	-1	2	662	2	1247400	88.98	0.134386
0	-1	1	374	1	255600	85.12	0.227254
0	-1	1	812	1	615600	183.78	0.226297
3483	-1	6	252	938	900490496	1.7	0.006723
0	-1	1	210	1	244800	20.48	0.097524
3414	-1	6	349	937	900112512	1.89	0.005405

Record: 1 Show: All Selected Records (0 out of 5023 Selected.) Options

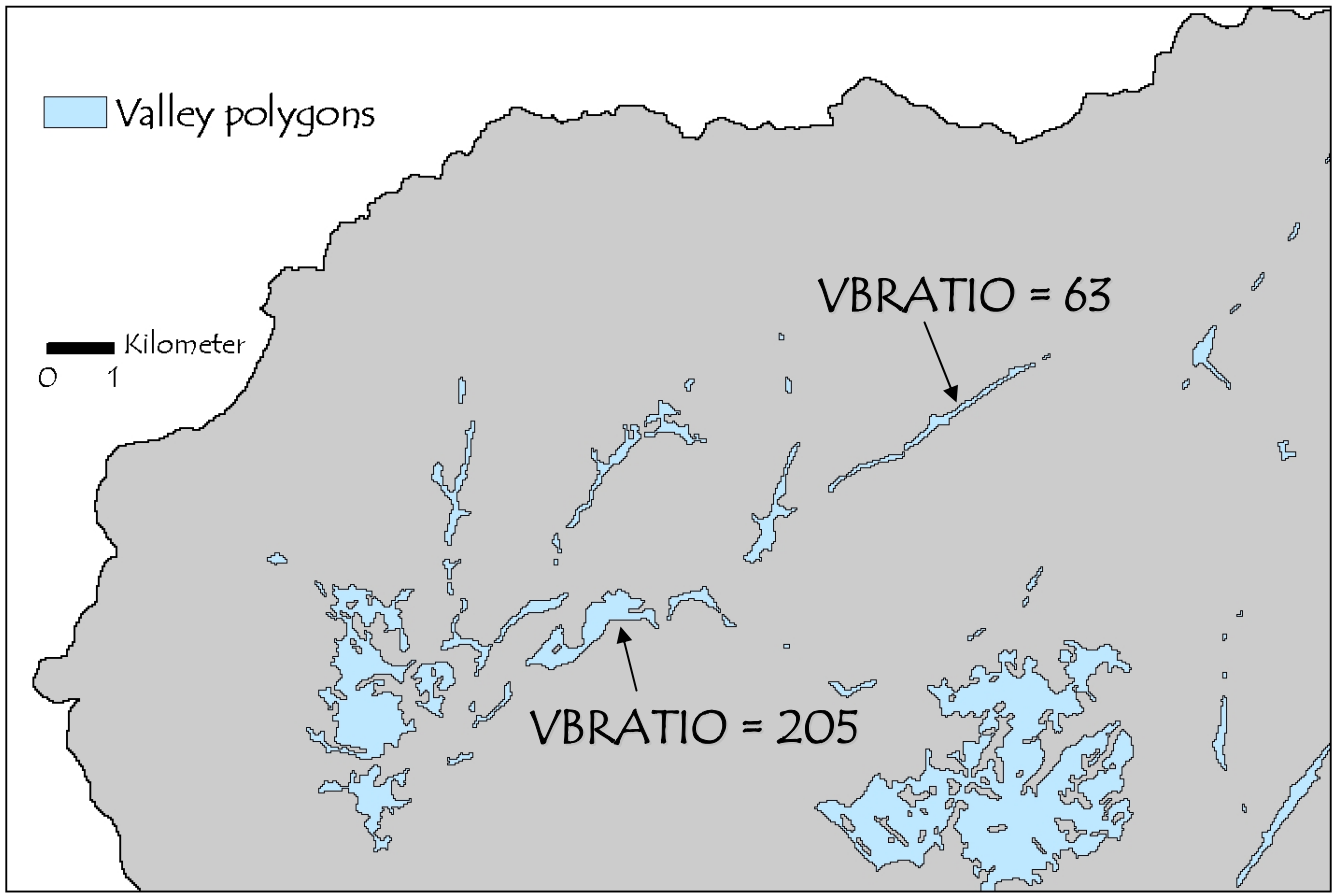
Google: TauDEM

Select Valley Polygons



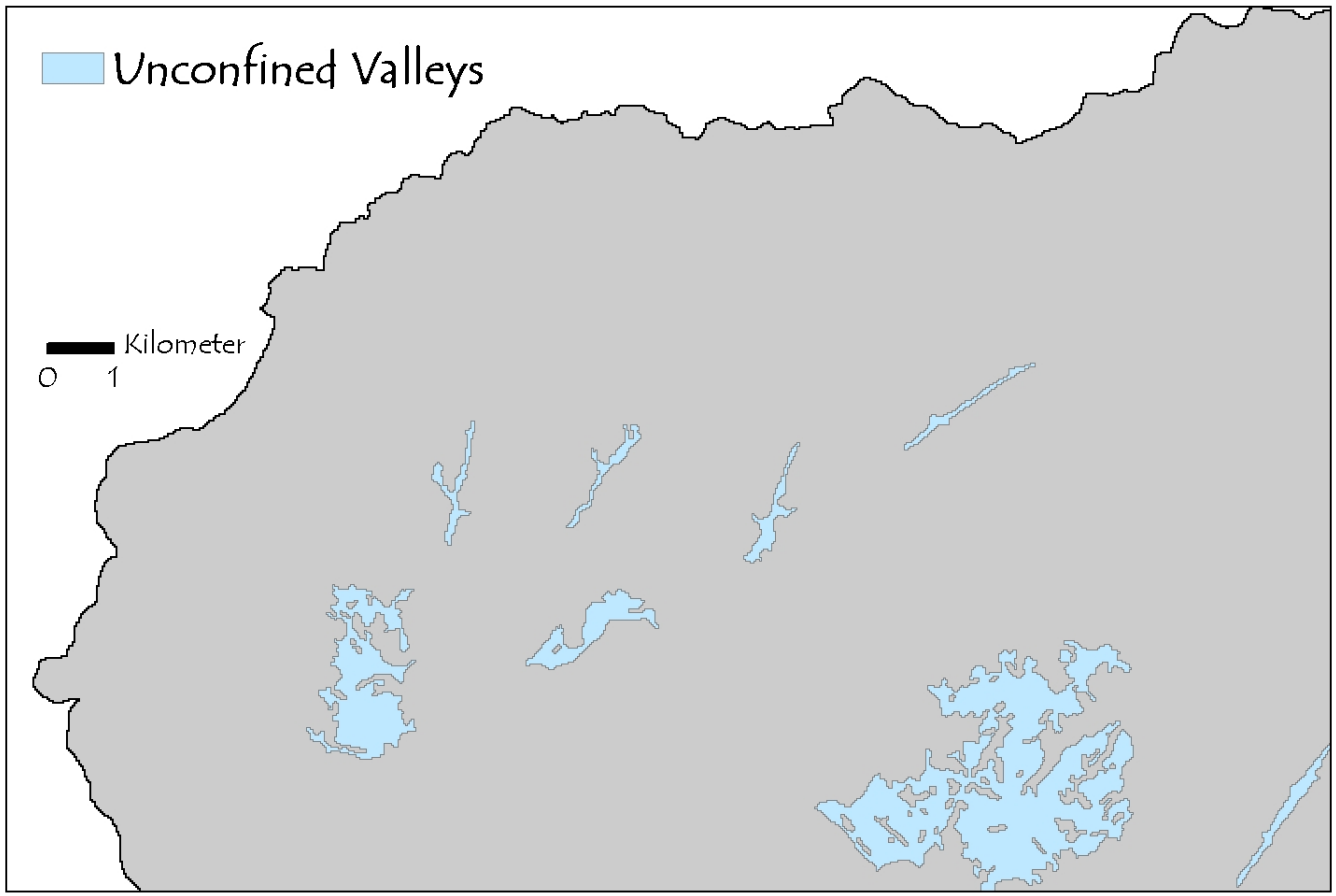

```
# Select polygons from GridCode1.shp (flat areas) that intersect mfkb_demnet.shp
# but only if the TauDEM stream is > the magnitude threshold
gp.SelectLayerByLocation_management("Layer", "INTERSECT", "net_Layer", "", "NEW_SELECTION")
```

Compute VB Attributes



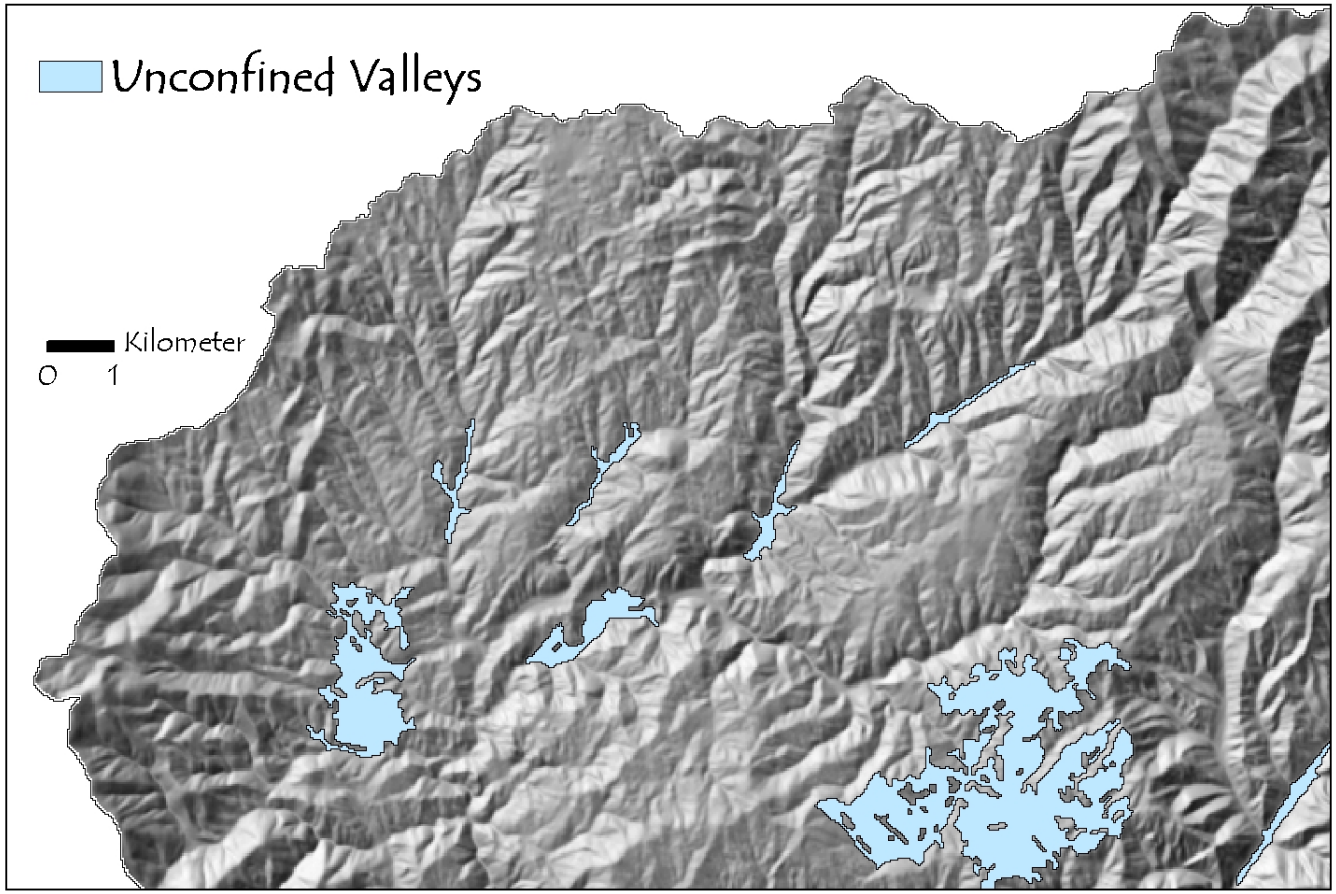
VBAREA – Polygon area
VBLENGTH – Stream length inside each polygon
VBRATIO – VBAREA / VBLENGTH

Filter Polygons Based on VB Attributes



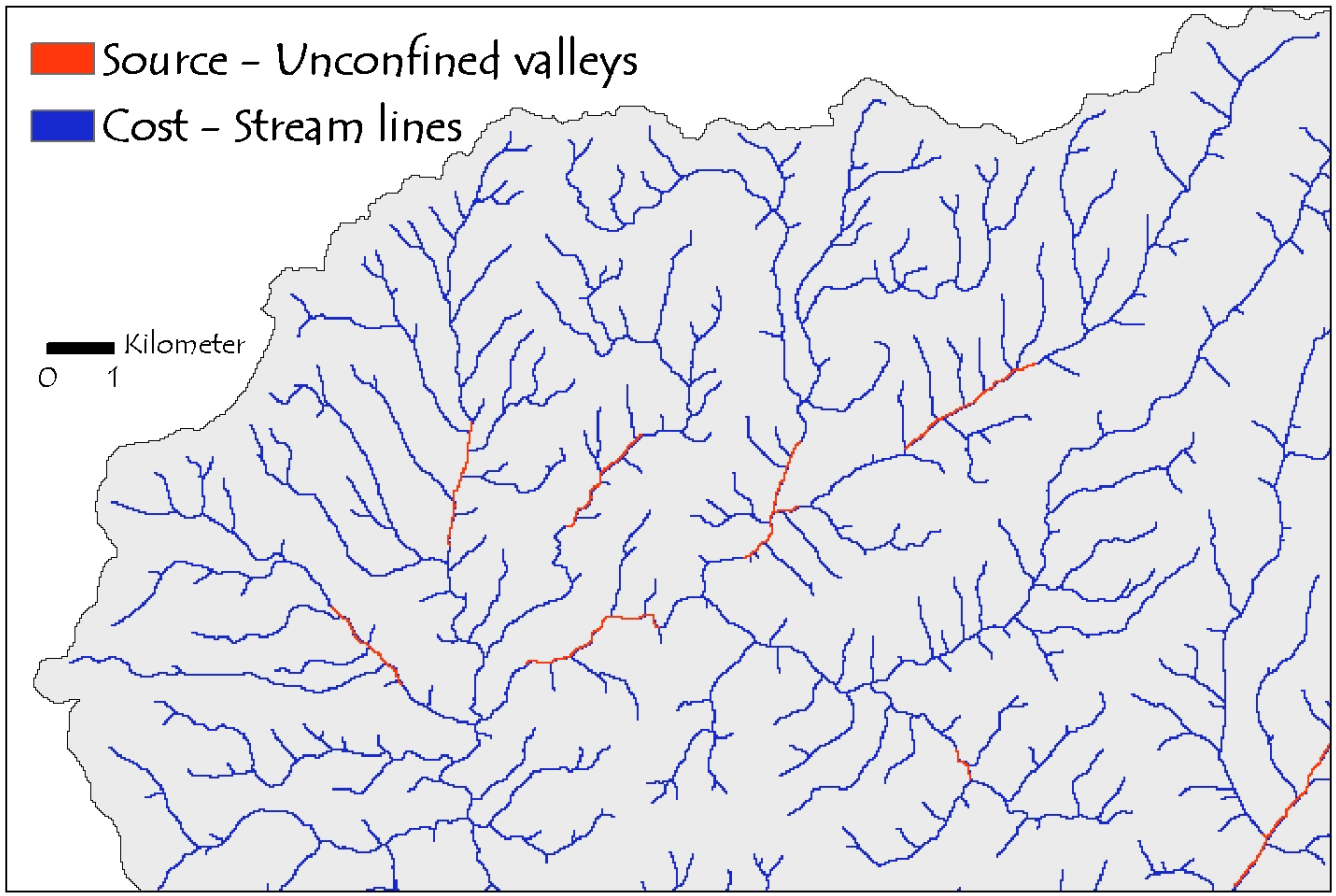
VBAREA > 15 HA
VBLENGTH > 2000
VBRATIO < 750

Unconfined Valleys



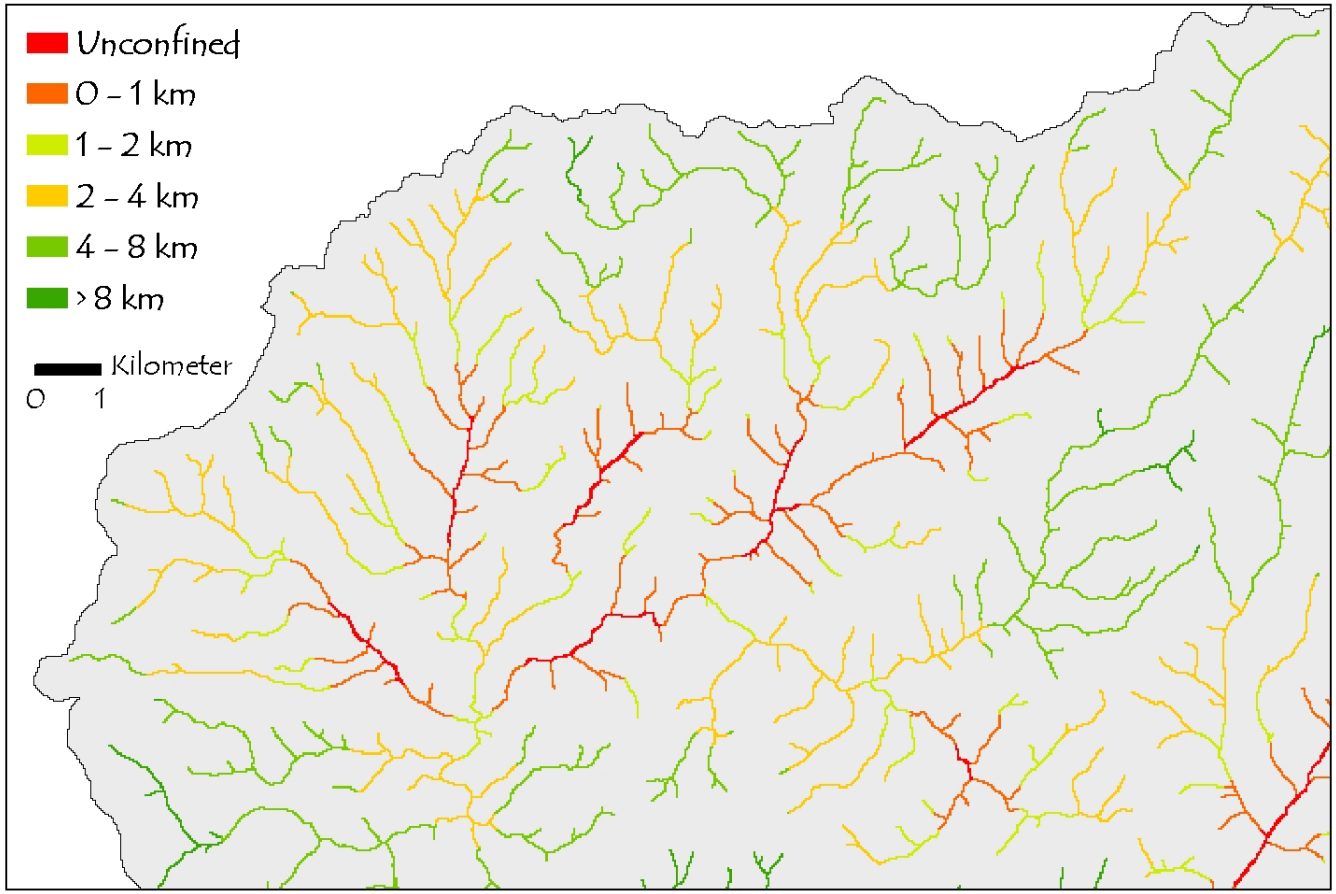
- Size threshold too large?
- Plateaus don't characterize stream valleys

Cost Distance Analysis




```
# Do cost distance and set distance threshold using reclassify

gp.CostDistance_sa("lrgflatlines", "strlines", "distance", "", "")

gp.Reclassify_sa("distance", "Value", "0 50 0;50 1000 1;1000 2000 2;2000 4000 3;4000
8000 4;8000 999000 5", "distreclas", "NODATA")
```

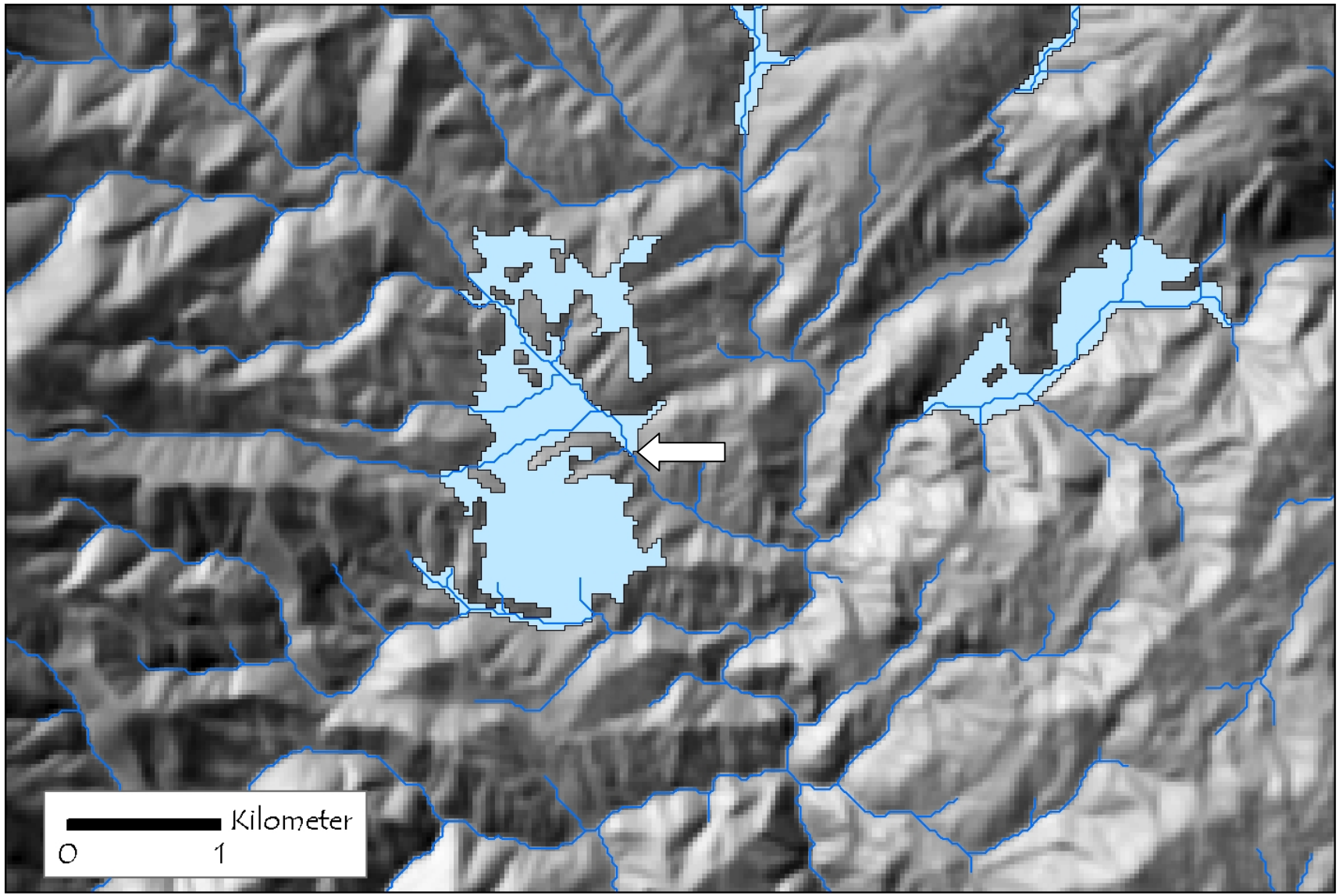
Distance Classes



Cutthroat refugia?

"Validation" and Preliminary "Results"

Validation – Edna Creek

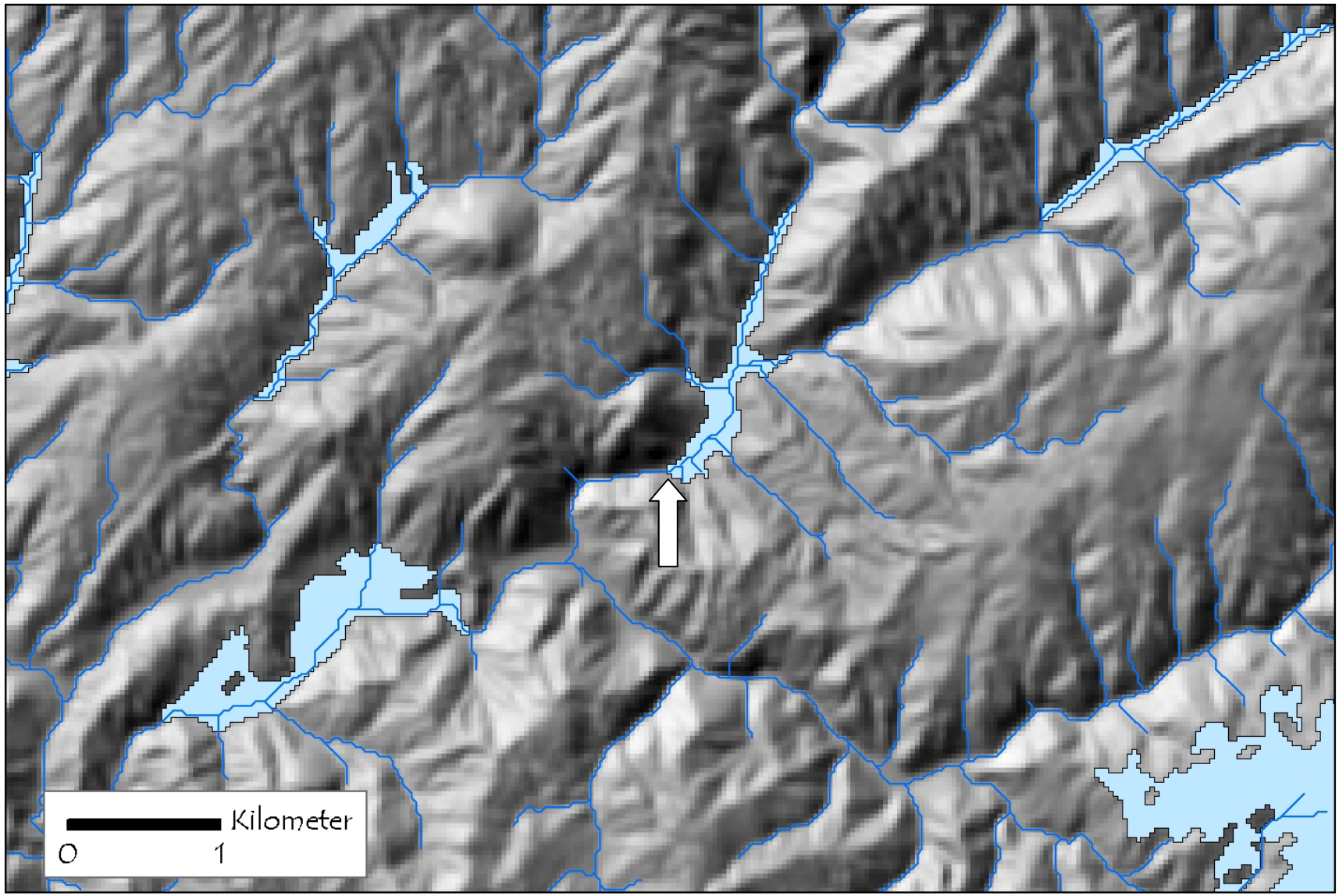


Validation – Edna Creek

Downstream - Confined

Upstream - Unconfined

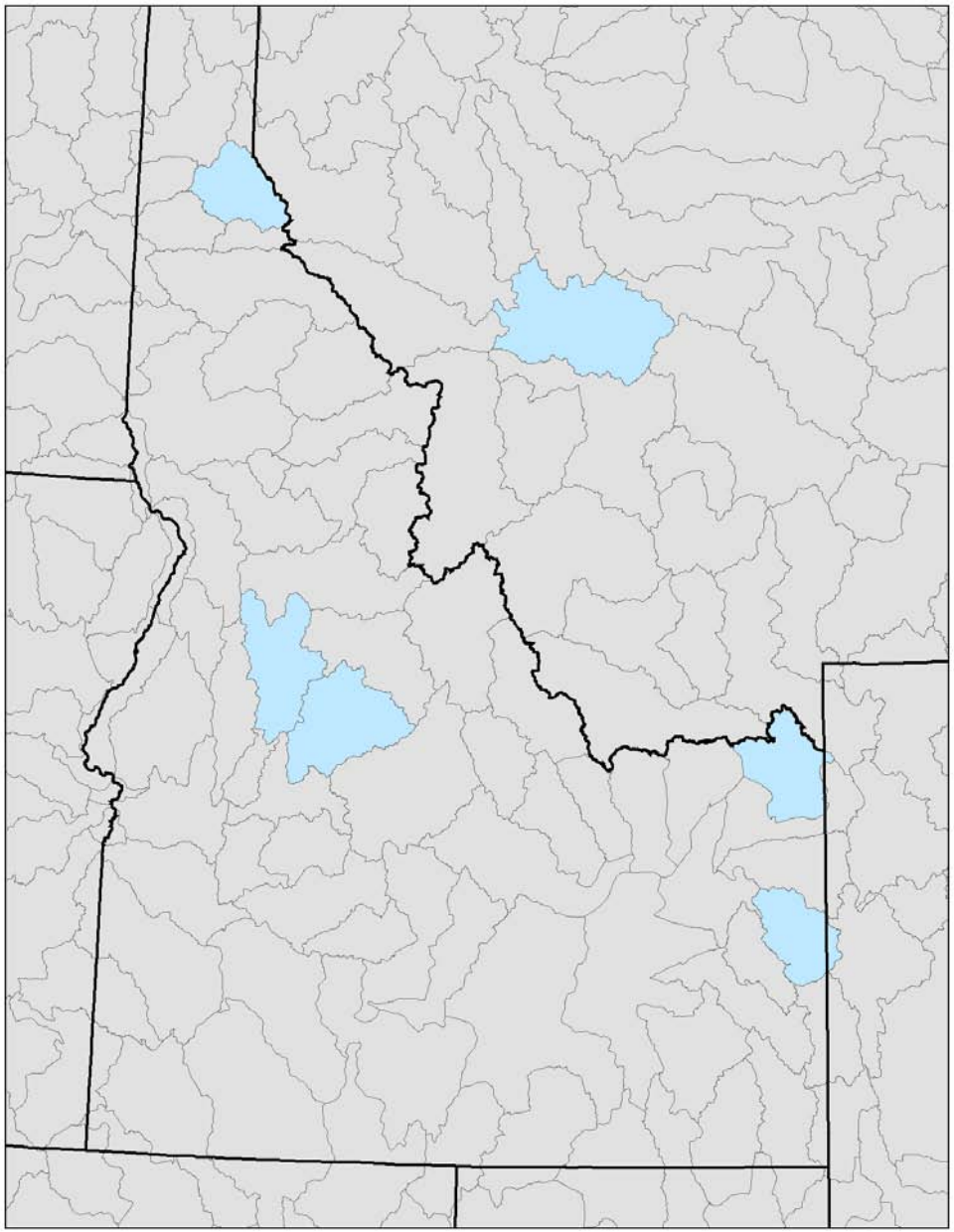
Validation – Pikes Fork



Validation – Pikes Fork

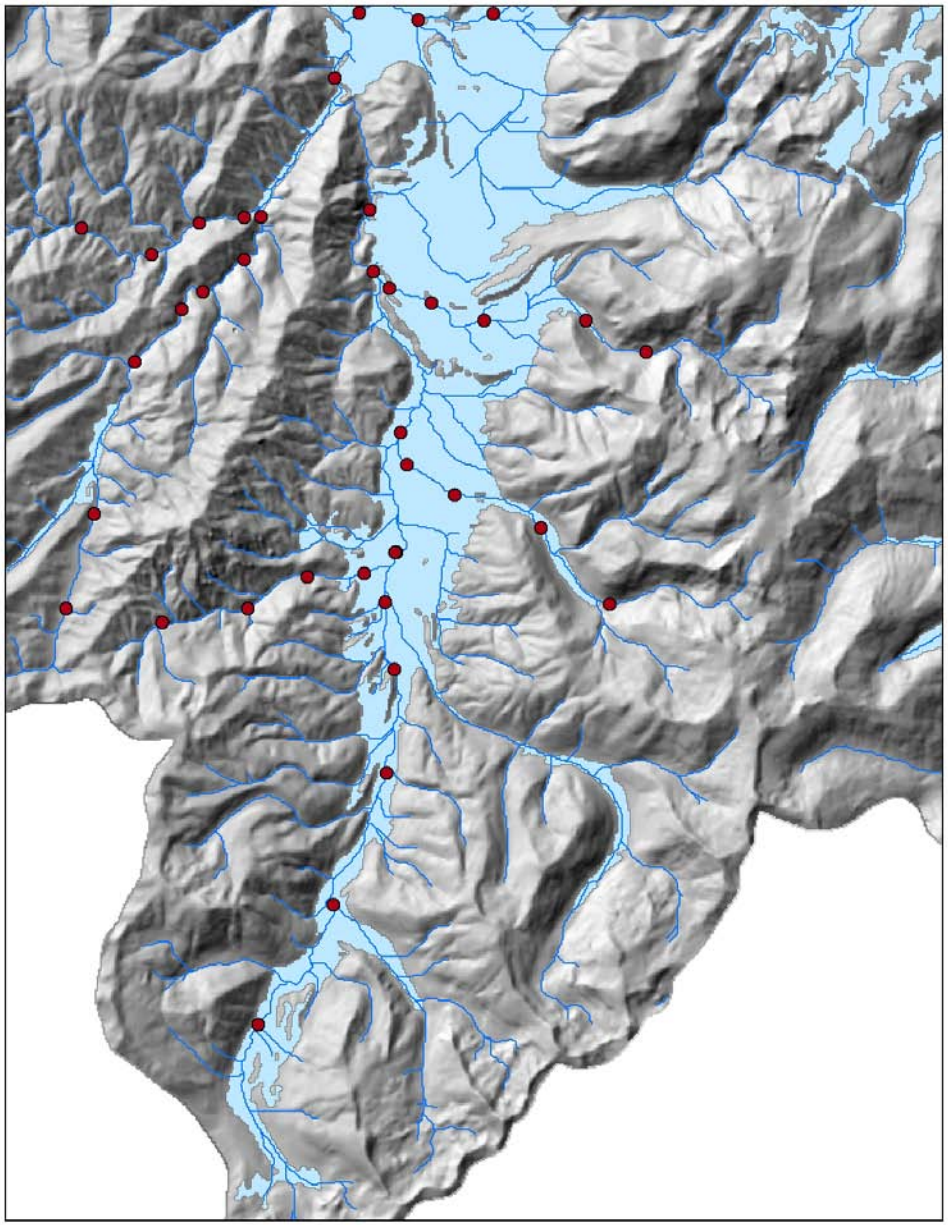
Downstream - Confined

Upstream - Unconfined



Preliminary Analysis HUCs

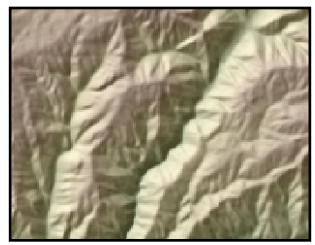
- Six 4th code HUCs
- 1,302 sample points



Unconfined Valleys and Fish Sample Data

Number of Fish Present vs. Valley Confinement

Unconfined



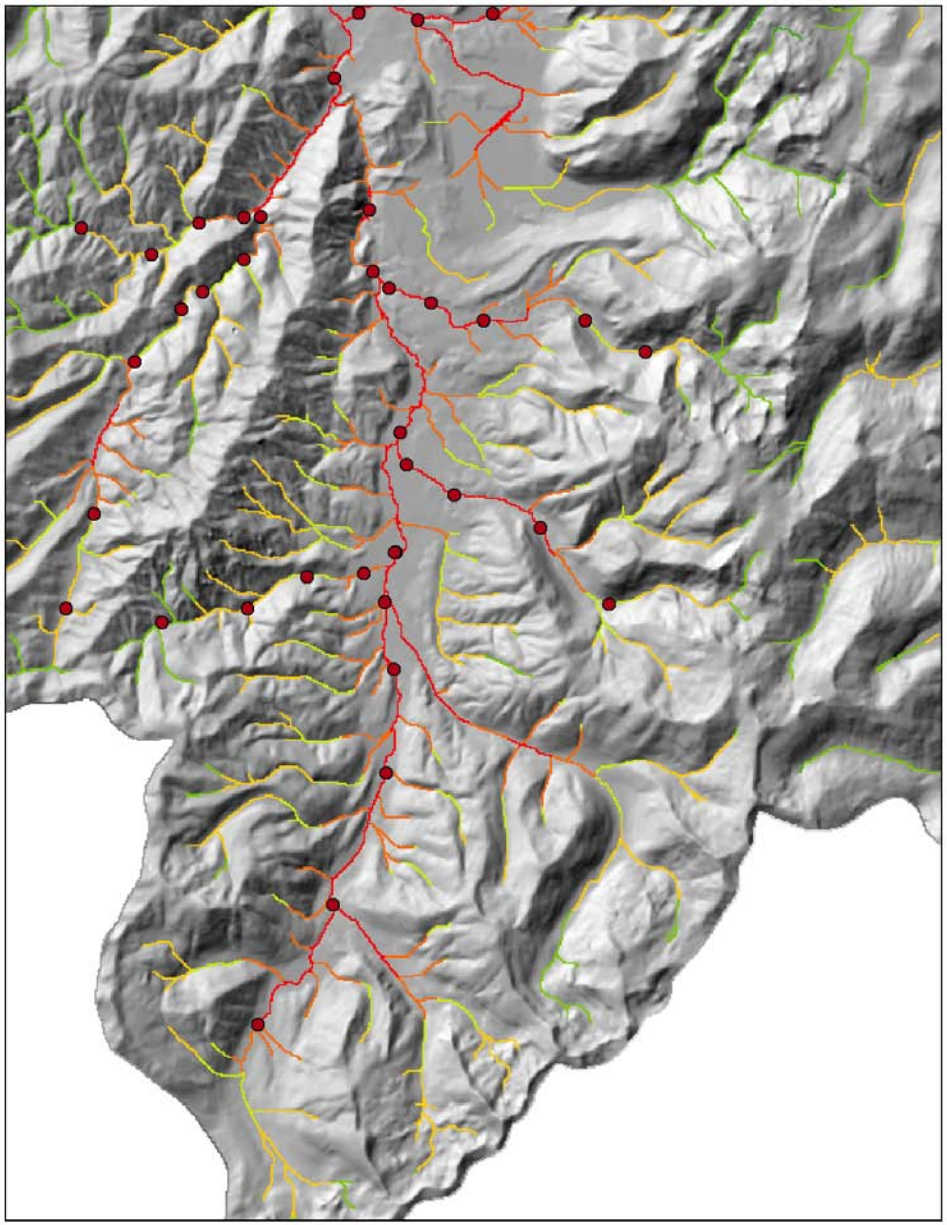
Confined

Brook trout

Cutthroat

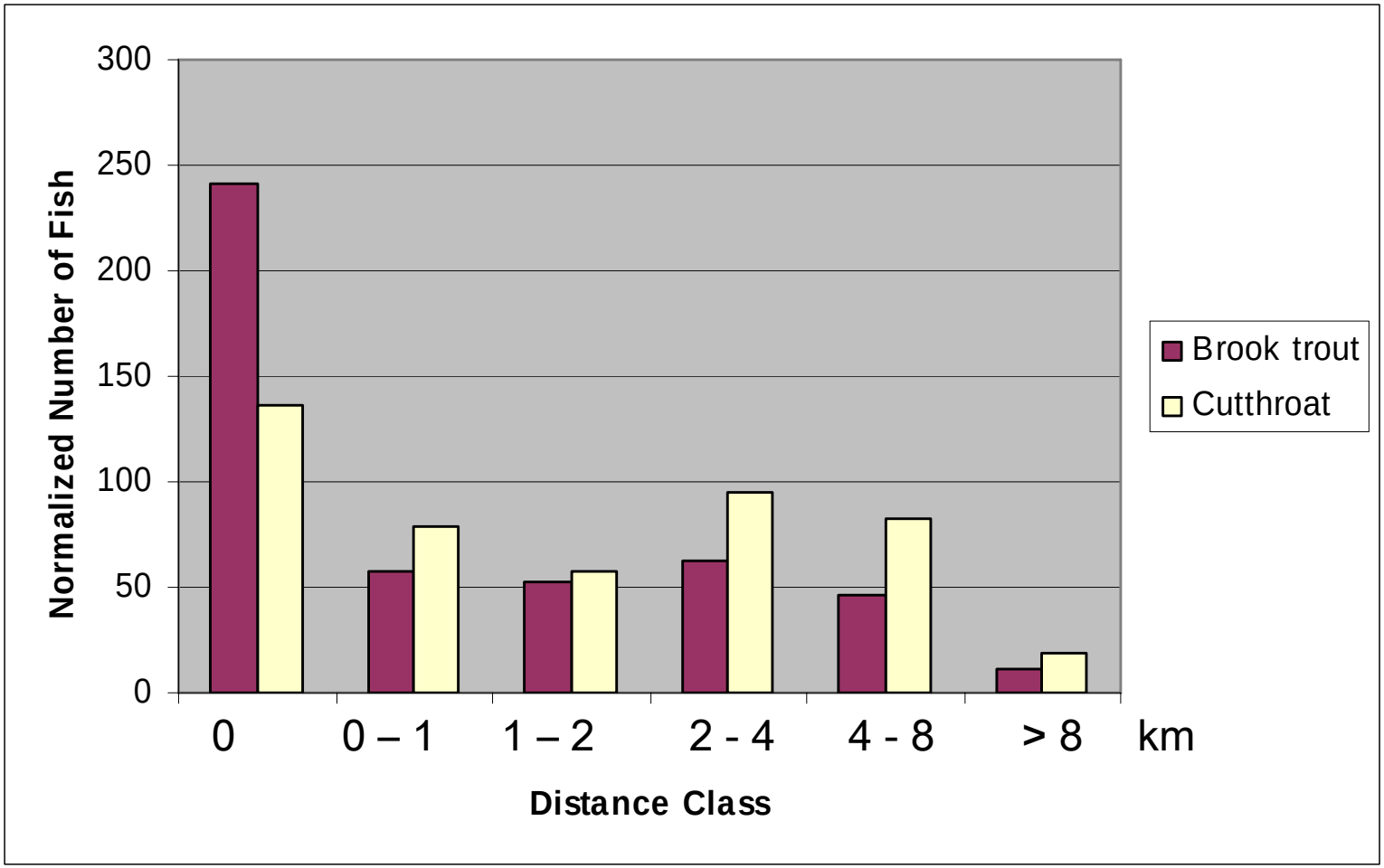
343	127
210	408

Courtesy J. Tomelleri



Distance Classes and Fish Sample Data

Distance Class Analysis



Original

n = 470 brook trout n = 618 cutthroat

Conclusion

- Python and the Geoprocessor are appropriate tools for raster and vector processing and are a good alternative to AML
- Unconfined valleys can be modeled with 30 m DEM data at a scale that is meaningful for fish, however the results must be verified
- Brook trout seem to prefer unconfined valleys and may be displacing cutthroat from these areas

Courtesy J. Tomelleri

Acknowledgements

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