Headwater stream channel mapping for impact assessment in the mid-Atlantic, USA

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Knowing where streams are informs...

Watershed modeling



Land-use and ecosystem interactions



Climate change and landform evolution



In most cases, only streams in the National Hydrography Data set (NHD 24k) are covered under environmental regulations



Stream burial rate increases with decreasing catchment area



Elmore and Kaushal (2008) Frontiers Eco. Environ. 6(6):308-312

Land use has influenced stream network density



Land use has influenced stream network density



We need to increase the accuracy of stream maps, but Where do streams begin?



Not only scientists are concerned about the origin of streams

As Chief Justice Roberts said during the *Rapanos* (2006) oral arguments, "where a tributary ends [the confluence] is clear; but where it begins is a problem."

Indicators of stream presence depend on annual precipitation and vertical relief



Doyle and Bernhardt (2011) ES&T; 24(2):354-359

Catchment area decreases with increasing valley gradient



Montgomery and Dietrich (1988) Nature 336:232-234

A geomorphic definition of channel head locations

Most upstream evidence of bank erosion and bed load



We started by mapping 256 channel heads in forested watersheds across Potomac basin





Field Mapping: Ridge and Valley

1st Observation: NHD 24k flow lines grossly underestimate total channel length







andscape Variables



Logistic regression for predicting the probability of channel presence

$$P_{stream} = \left(1 + e^{-(b_0 + b_1 * \log(A_c) + b_2 * S + ...)}\right)^{-1}$$

 P_{stream} = Probability of stream presence A_c = catchment area S = local slope b_0 = intercept



NHD Field obs.

Model results

NHD	Field obs.	Model result
6 channel	46 channel	24 channel
heads	heads	heads
1.8%	3.6%	2.9%
Stream	Stream	Stream
pixels	pixels	pixels



Probability of channel presence

Withheld 20% for validation



Observations

Providence	Stream Accuracy	Total Accuracy	Stream Density
Coastal Plain	76%	94%	1.8%
Piedmont	87%	93%	3.1%
Blue Ridge	82%	99%	1.0%
Ridge and Valley	81%	96%	2.3%
Appalachian Plateau	87%	99%	0.7%

What was stream density along the fall line prior to development?



Potential uses of these data

- Data will eventually be made available on the UMCES Appalachian Laboratory website.
- We will encourage the use of these data for watershed modeling and for estimating the impacts of land use change on streams over large areas.
- Inferences of presence of individual streams are likely to be unreliable, especially at small catchment areas.

Thank you!

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