Designing Sustainable Landscapes:
Stream gradient settings variable

A project of the University of Massachusetts Landscape Ecology Lab

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- North Atlantic Landscape Conservation Cooperative (US Fish and Wildlife Service, Northeast Region)
- Northeast Climate Science Center (USGS)
- University of Massachusetts, Amherst

Reference:

McGarigal K, Compton BW, Plunkett EB, DeLuca WV, and Grand J. 2018. Designing sustainable landscapes: stream gradient settings variable. Report to the North Atlantic Conservation Cooperative, US Fish and Wildlife Service, Northeast Region.

General description

Stream gradient is one of several ecological settings variables that collectively characterize the biophysical setting of each 30 m cell at a given point in time (McGarigal et al 2017). Stream gradient (**Fig. 1**) is a measure of the percent slope of a stream, which is a primary determinate of water velocity and thus sediment and nutrient transport, and habitat for aquatic plants, invertebrate, fish, and other organisms. Stream gradient is often approximated by categories such as pool, riffle, run, and cascade. Stream gradient is 0% for lentic waterbodies, palustrine, and uplands. It ranges from 0% to infinity (theoretically) for streams.

Use and interpretation of this layer

This ecological settings variable is used for the similarity and connectedness ecological integrity metrics.

This layer carries the following assumptions:

- The digital elevation model is accurate. Although this seems to be true at broader scales, the NED does include many fine-scale errors. Our algorithm (see below) is designed to minimize the effect of such errors.
- Stream gradient of 100-200 m reaches are ecologically meaningful. Stream gradient is a multi-scale phenomenon, but the grain of our digital elevation data precludes assessing gradient at finer scales. Gradient is often assessed at longer scales, often dependent on defining "reaches" between stream confluences. We generally avoid such arbitrary patch definitions, and wanted to use a scale as close to our cells as we reasonably could.

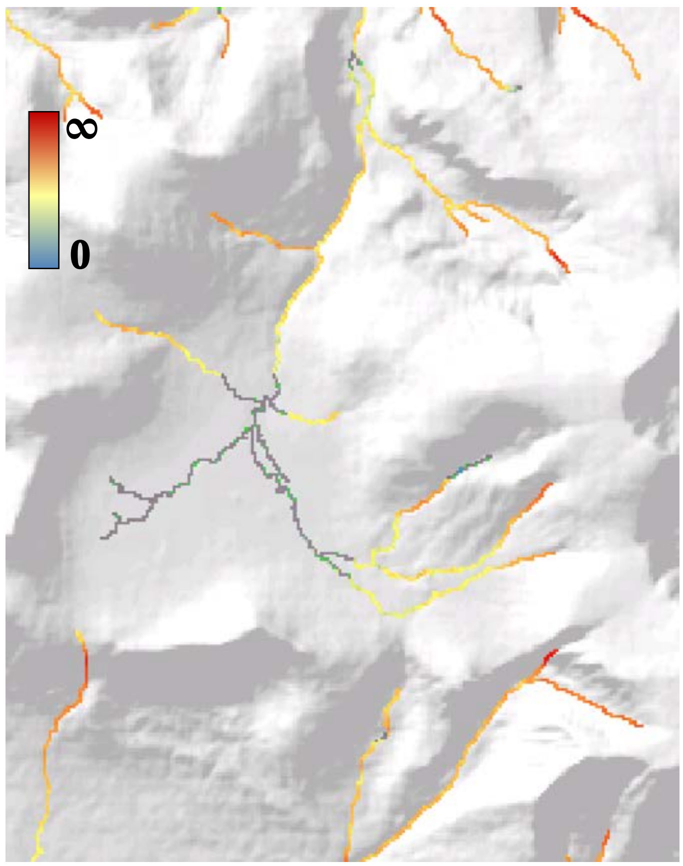

Figure 1. Flow gradient (on top of topographic hillshading) on the west slope of Mount Katahdin, Maine.

Derivation of this layer

Data sources

- Stream centerlines grid, derived from National Hydrography Dataset (NHD) 1:25,000 flow lines, and custom editing and processing.

- Flow direction grid, derived from National Elevation Dataset's (NED) elevation grid, National Hydrography Dataset (NHD) 1:25,000 flow lines, and custom editing and processing. Stream centerlines were burned into the flow direction grid to force flow direction to agree with observed streams, so errors in the DEM didn't incorrectly divert streams.
- Digital elevation model (DEM). We used the National Elevation Dataset's (NED) 10 m DEM, resampled to 30 m. We used a depressionless version of the DEM, created with ArcMap.

Algorithm

For each stream centerline cell, we measured the percent slope $\left(\frac{rise}{run} \times 100\right)$ from the previous three upstream cells (following the major flow) to the next three downstream cells, thus giving gradient for a three-cell, five-cell, and seven-cell window around the focal cell. We dropped any uphill gradients, as these obviously are results of errors in the DEM, and took the mean of the remaining gradients. Thus, stream gradient is the mean gradient over reaches of 90-127 m, 150-212 m, and 210-297 m, depending on whether cells are orthogonal or diagonal. For wide rivers, we used the nearest centerline cell for all off-centerlines.

GIS metadata

This data product is distributed as a geoTIFF raster (30 m cells). The cell values are continuous, representing stream gradient in percent slope. Lentic waterbodies, wetlands, and uplands have values of zero. This data product can be found at McGarigal et al (2017).

Literature Cited

McGarigal K, Compton BW, Plunkett EB, DeLuca WV, and Grand J. 2017. Designing sustainable landscapes products, including technical documentation and data products. https://scholarworks.umass.edu/designing_sustainable_landscapes/