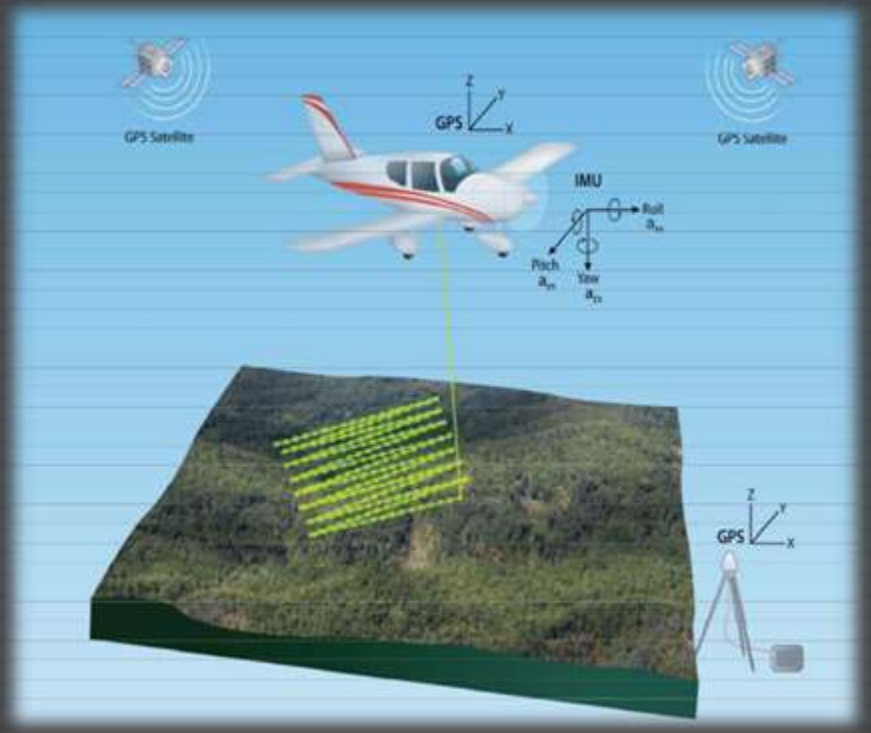
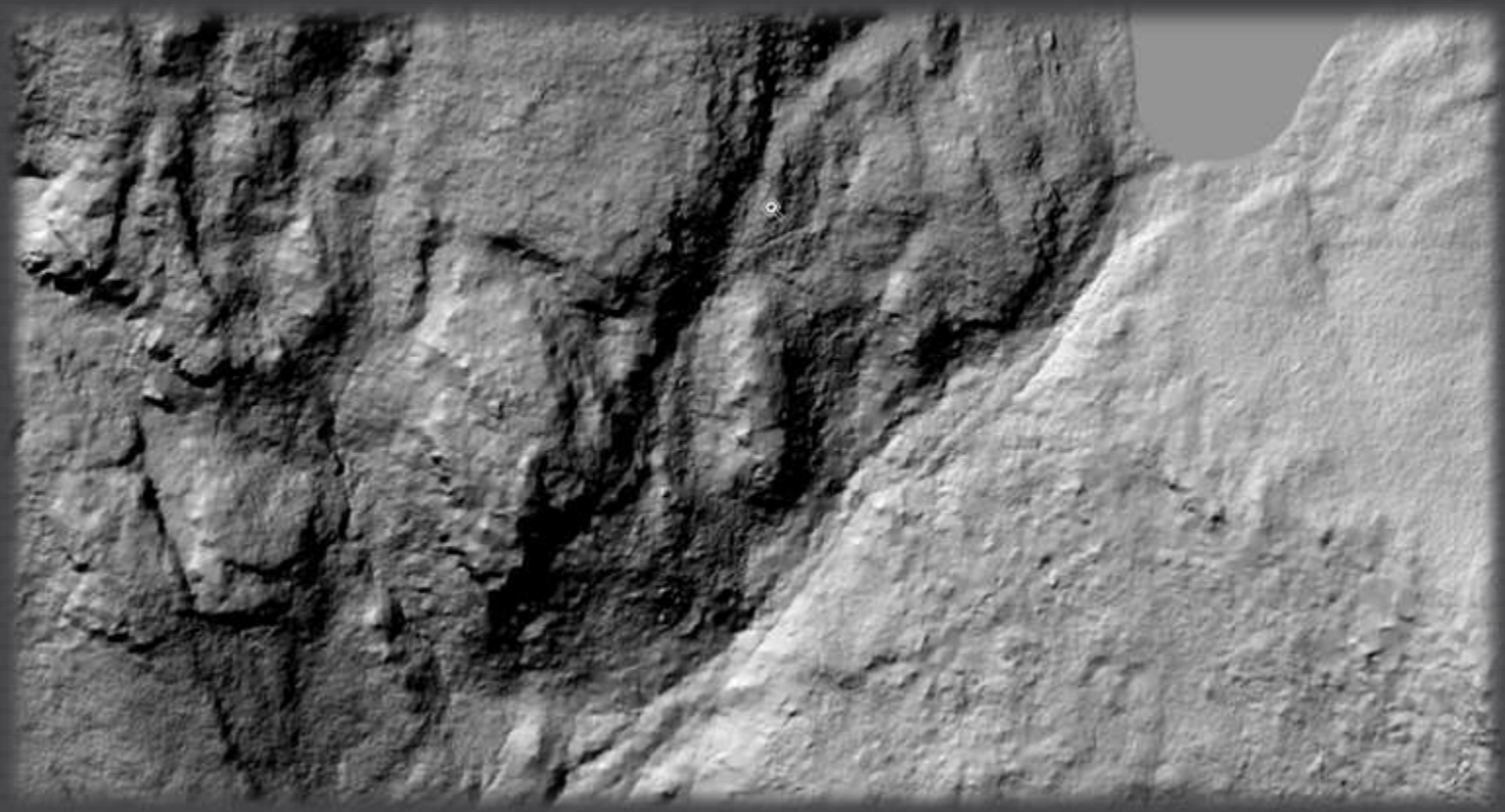


Recreation Ecology Research and Geospatial Applications to Enhance the Sustainability of Trails

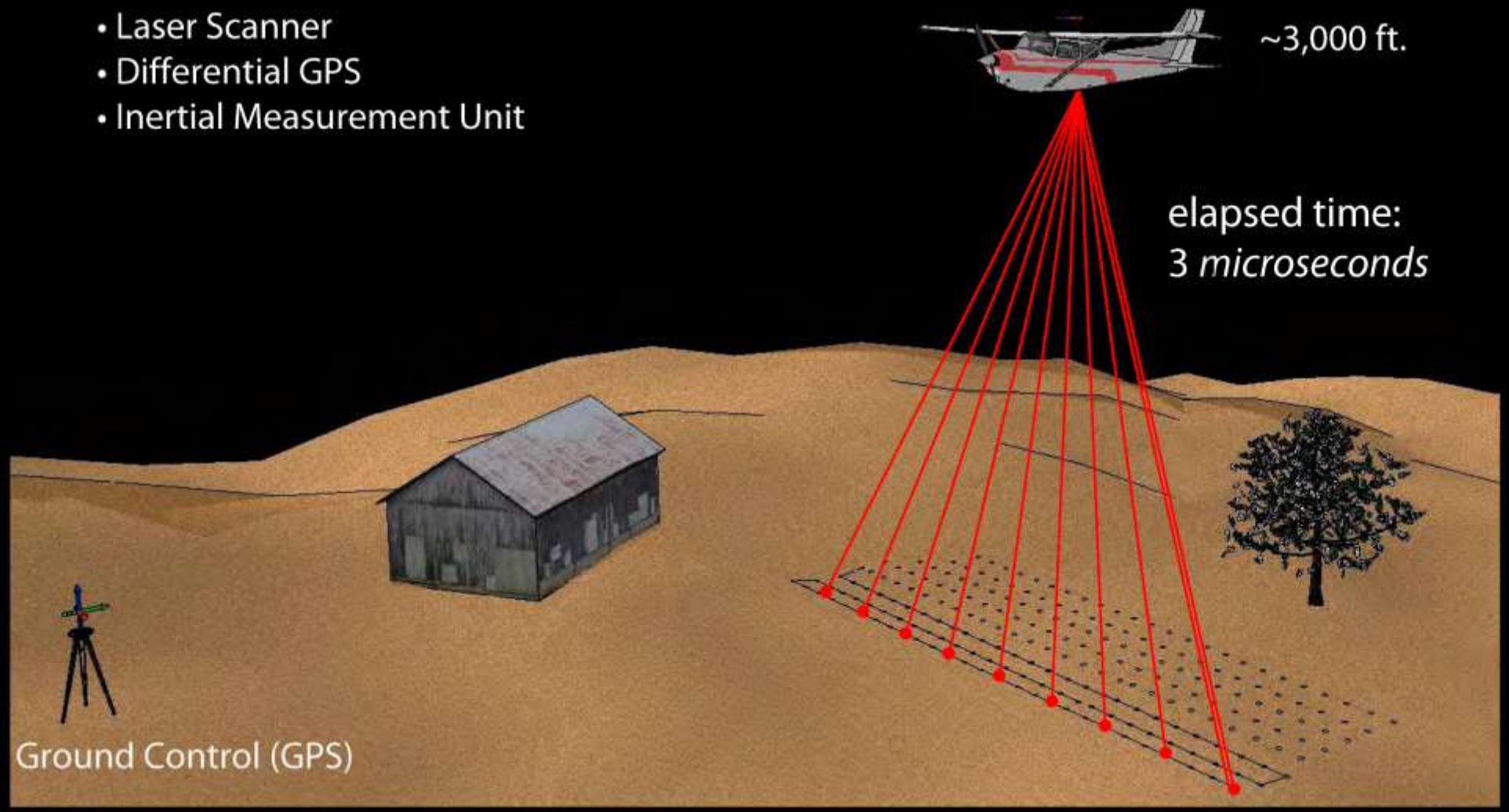
Dr. Jeremy Wimpey
Dr. Jeff Marion
Johanna Arredondo



Light Detection and Ranging (LiDAR)

Survey Aircraft

- Laser Scanner
- Differential GPS
- Inertial Measurement Unit



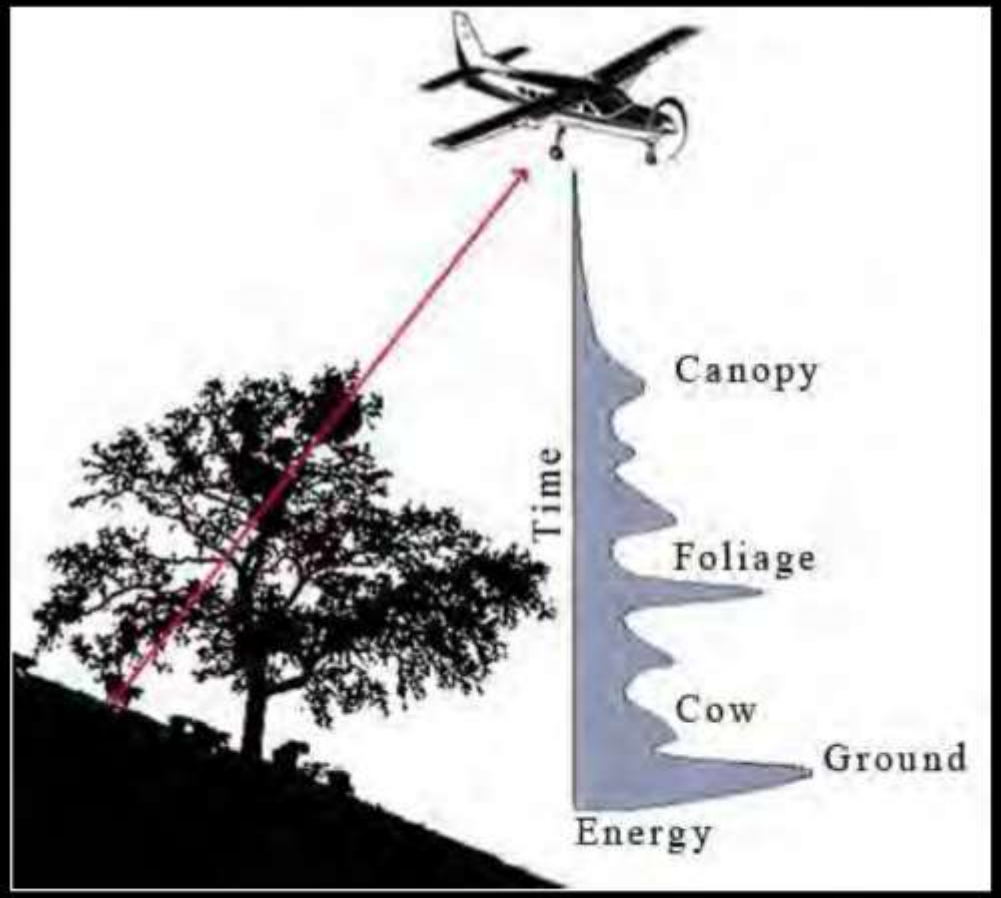
Multiple Returns

For each pulse, one or more returns

Typically, 1-4 returns per pulse

Provides vertical profile

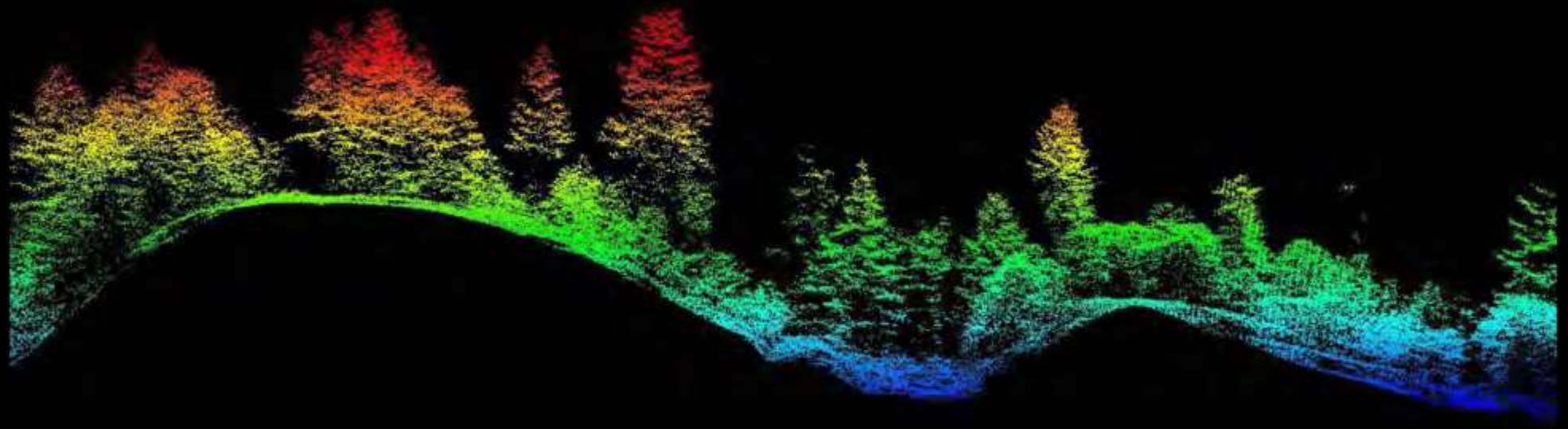
Last returns used to determine the ground surface



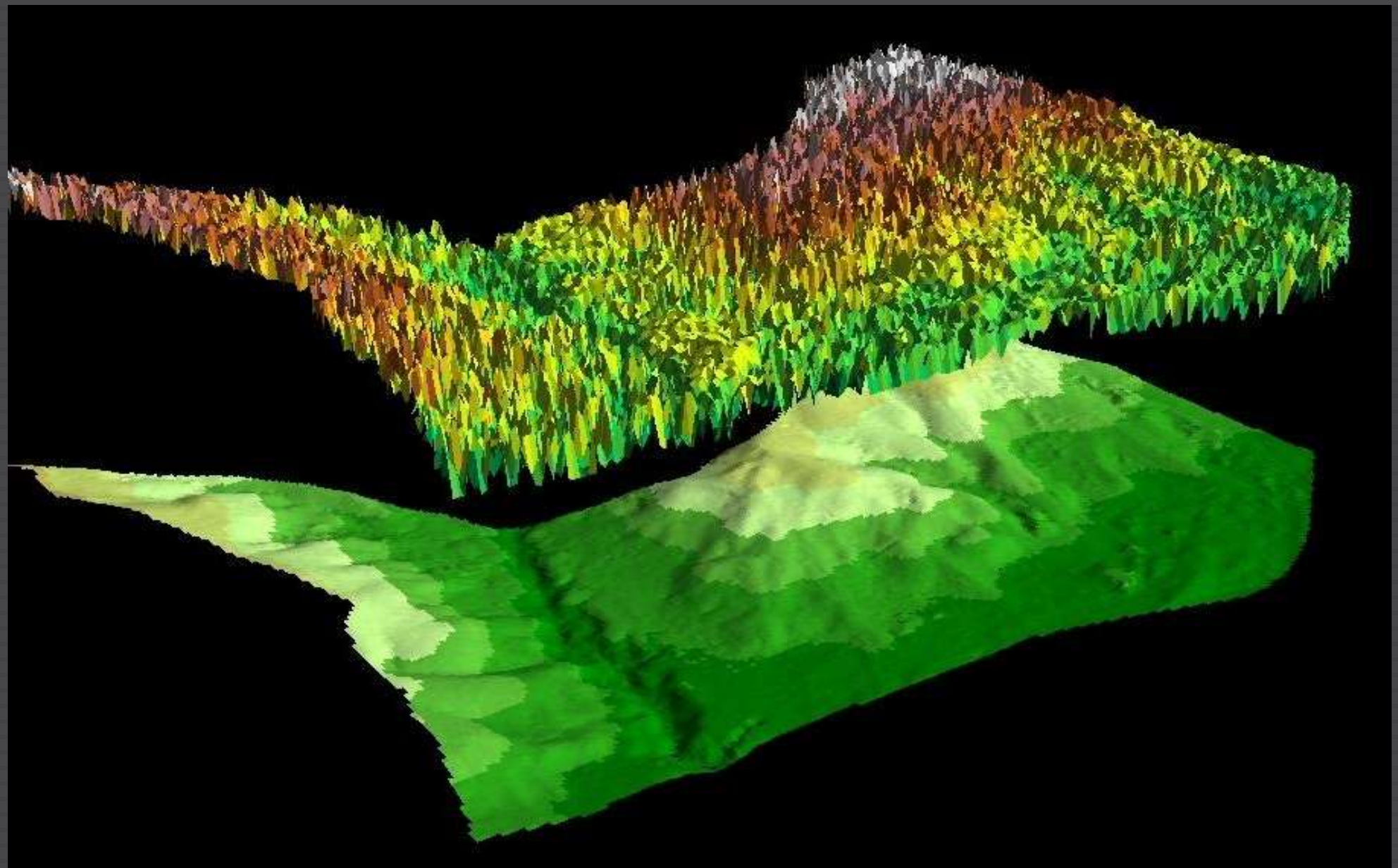
http://www.ensisjv.com/Portals/0/lidarimage002.jpg

Point Cloud: Profile View

All Returns

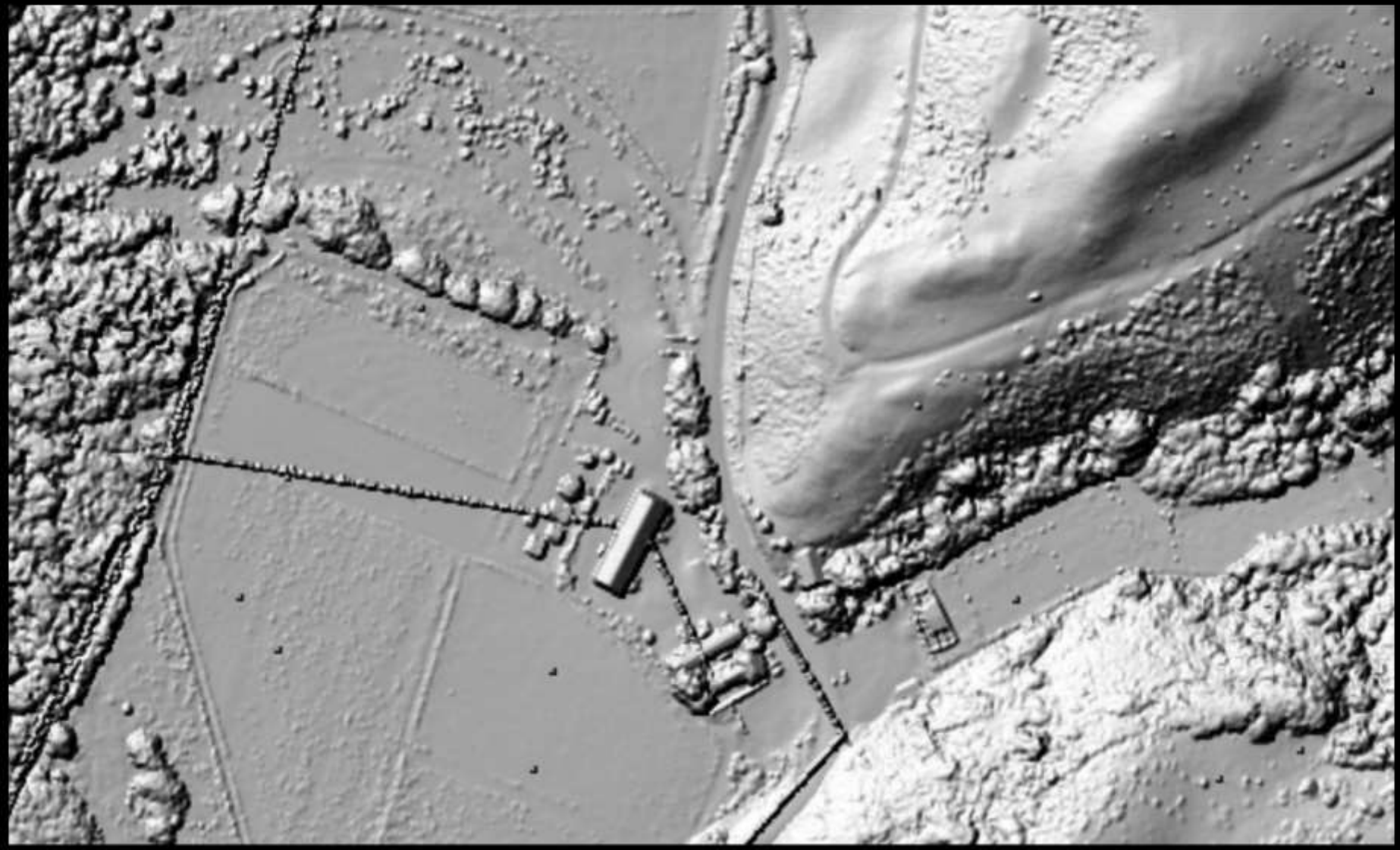


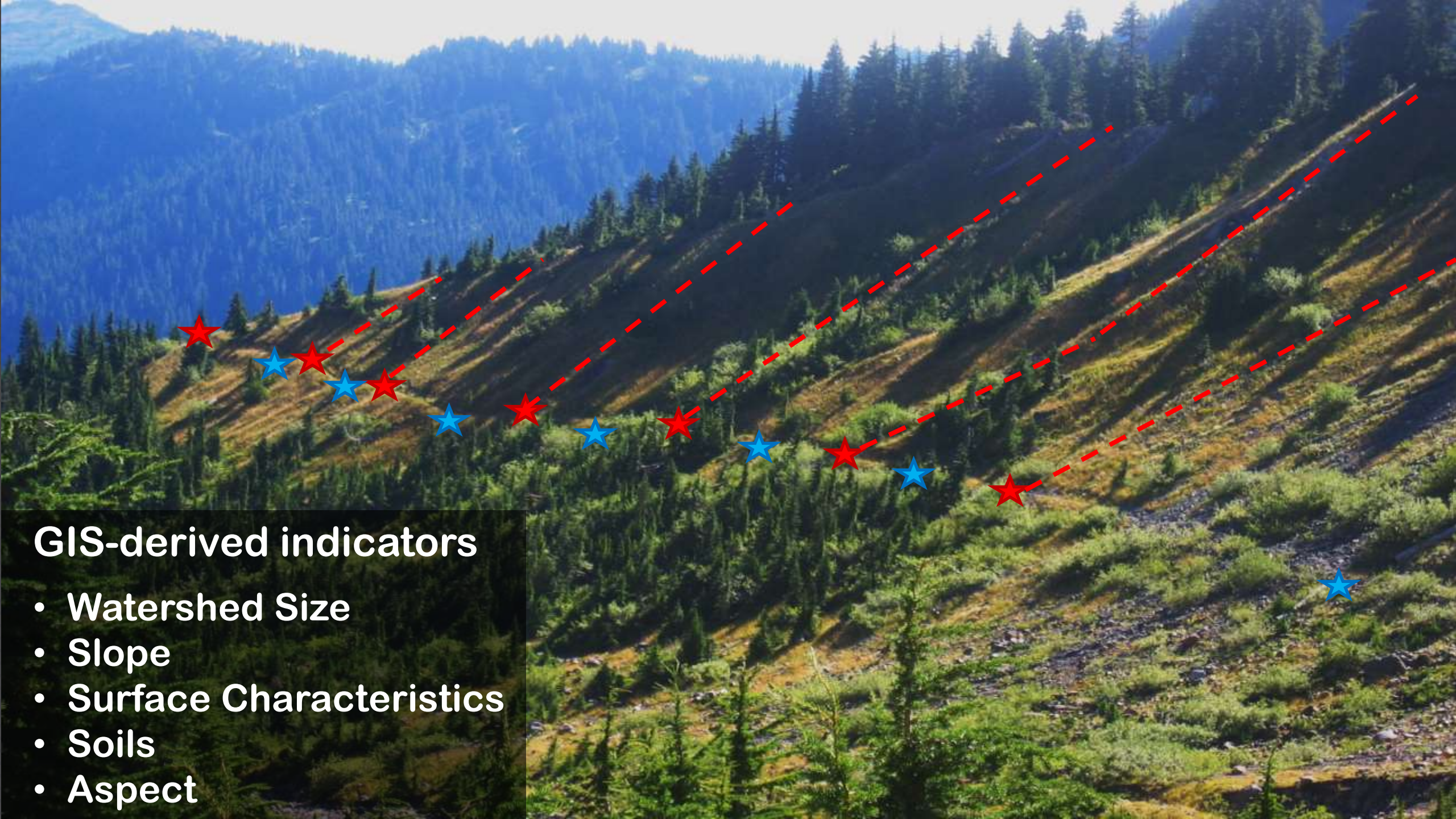
Surface Model vs. Bare Earth



Digital Surface Model DSM

highest-hit elevation for each 1m cell



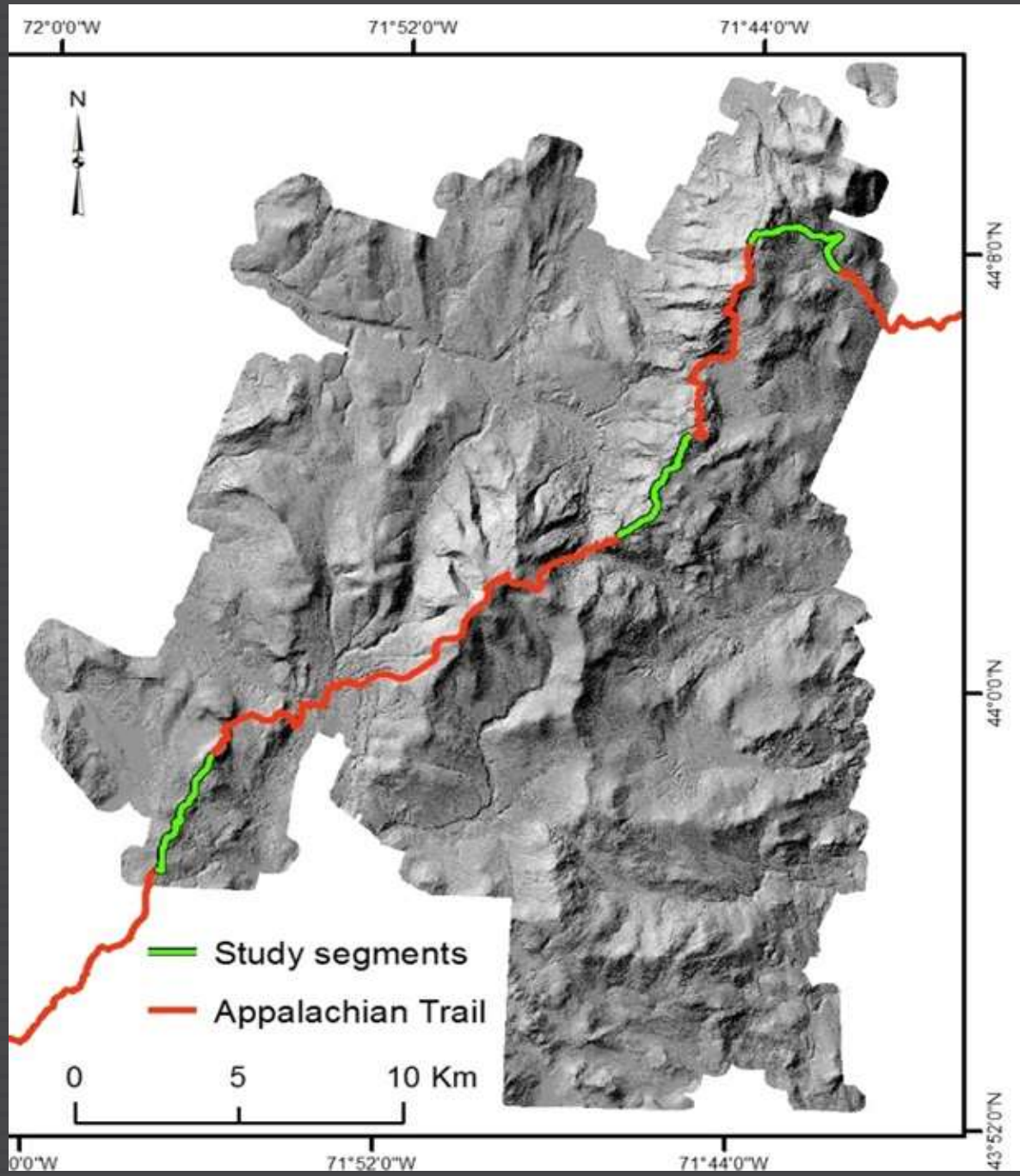


GIS-derived indicators

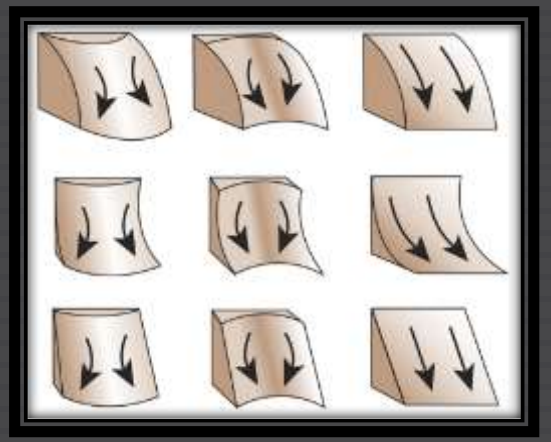
- Watershed Size
- Slope
- Surface Characteristics
- Soils
- Aspect

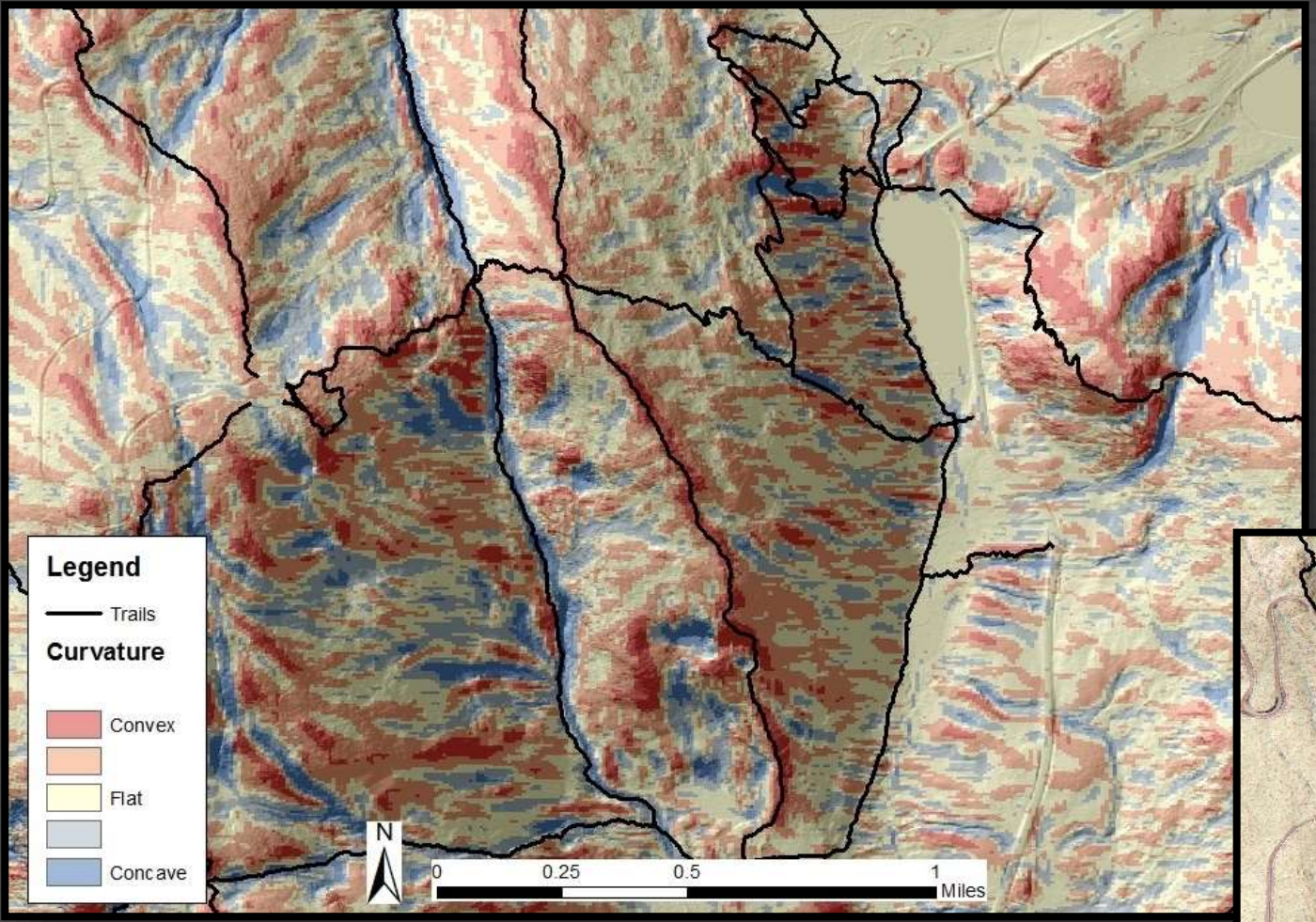
Sampling Strategy

- Regression modeling for factors that influence tread soil loss
- 135 transects measured at three 5-km sections of trail in the White Mountains NF with LiDAR coverage

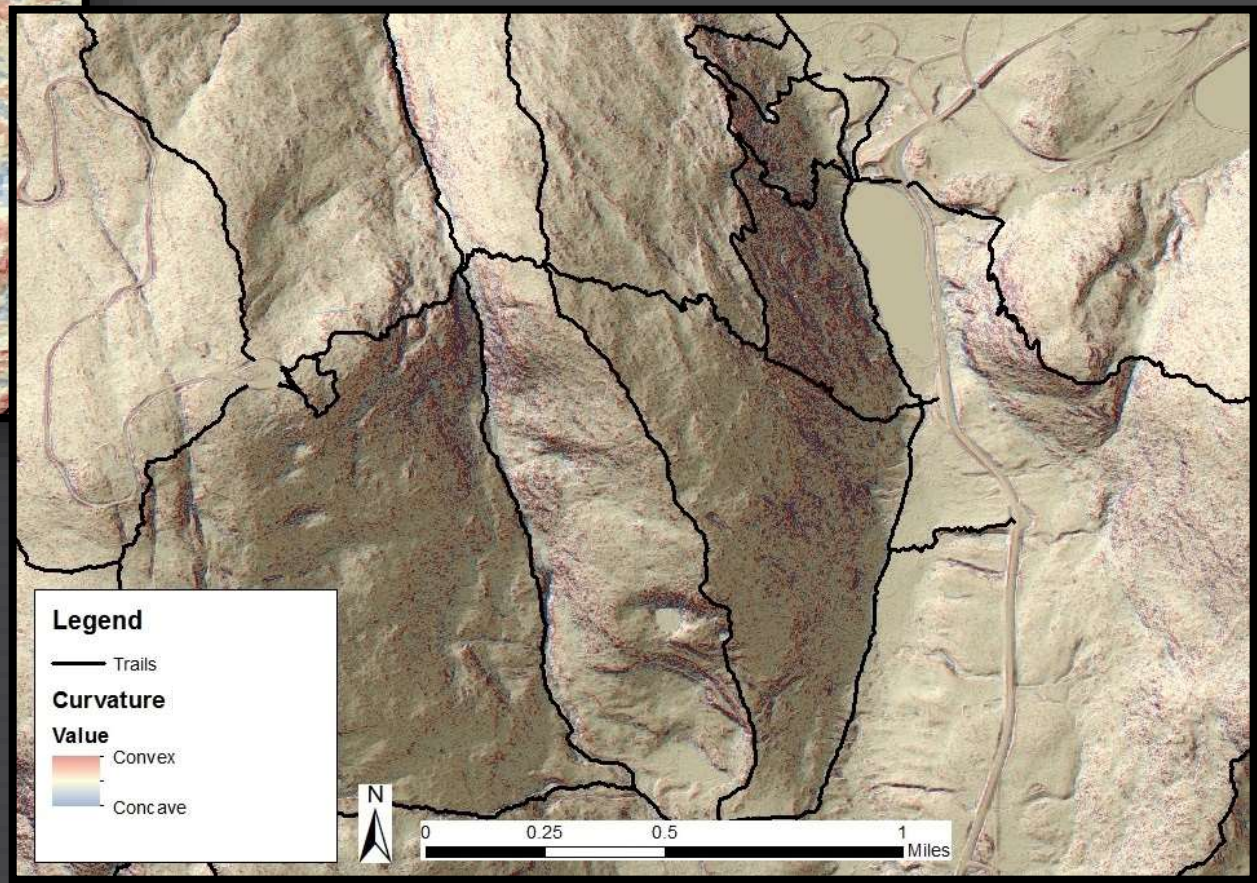


Curvature





Smoothed to 30m



At 1m, shows microtopography

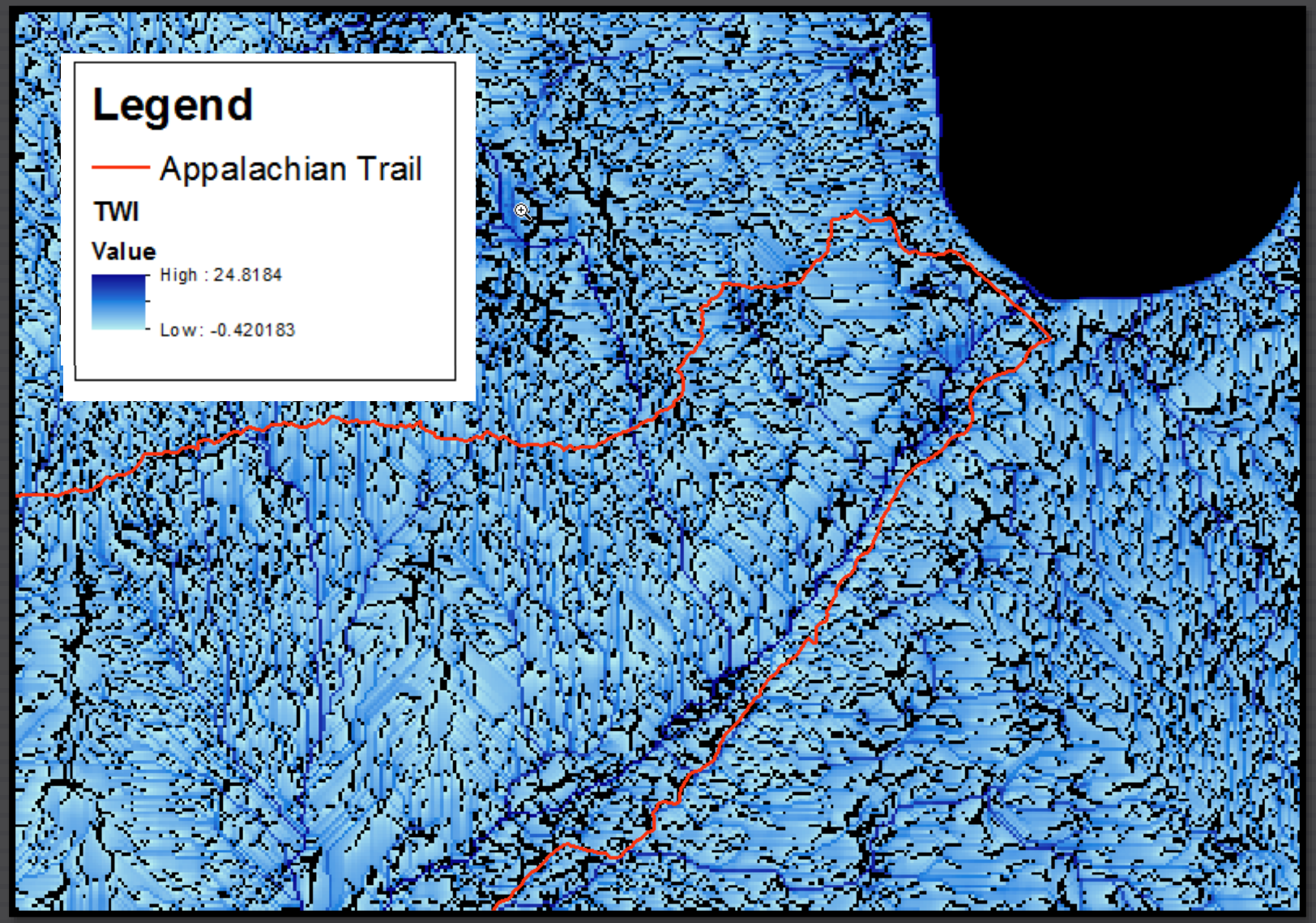
Topographic Wetness Index

$$TWI = \ln(A_s / \tan \beta)$$

(Beven and Kirkby 1979)

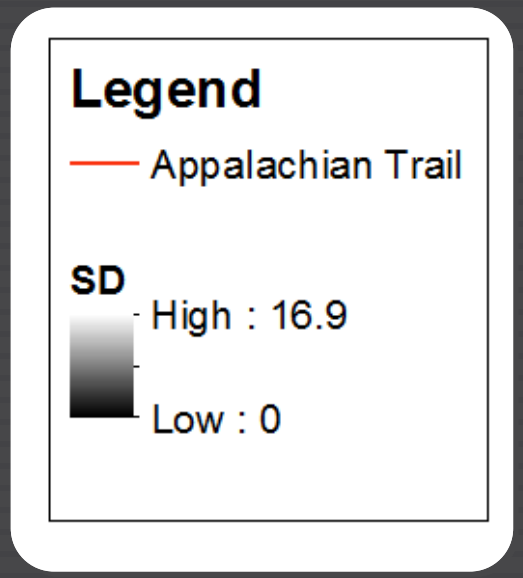
A_s is the upstream area (number of upstream elements multiplied by the area of each grid cell)

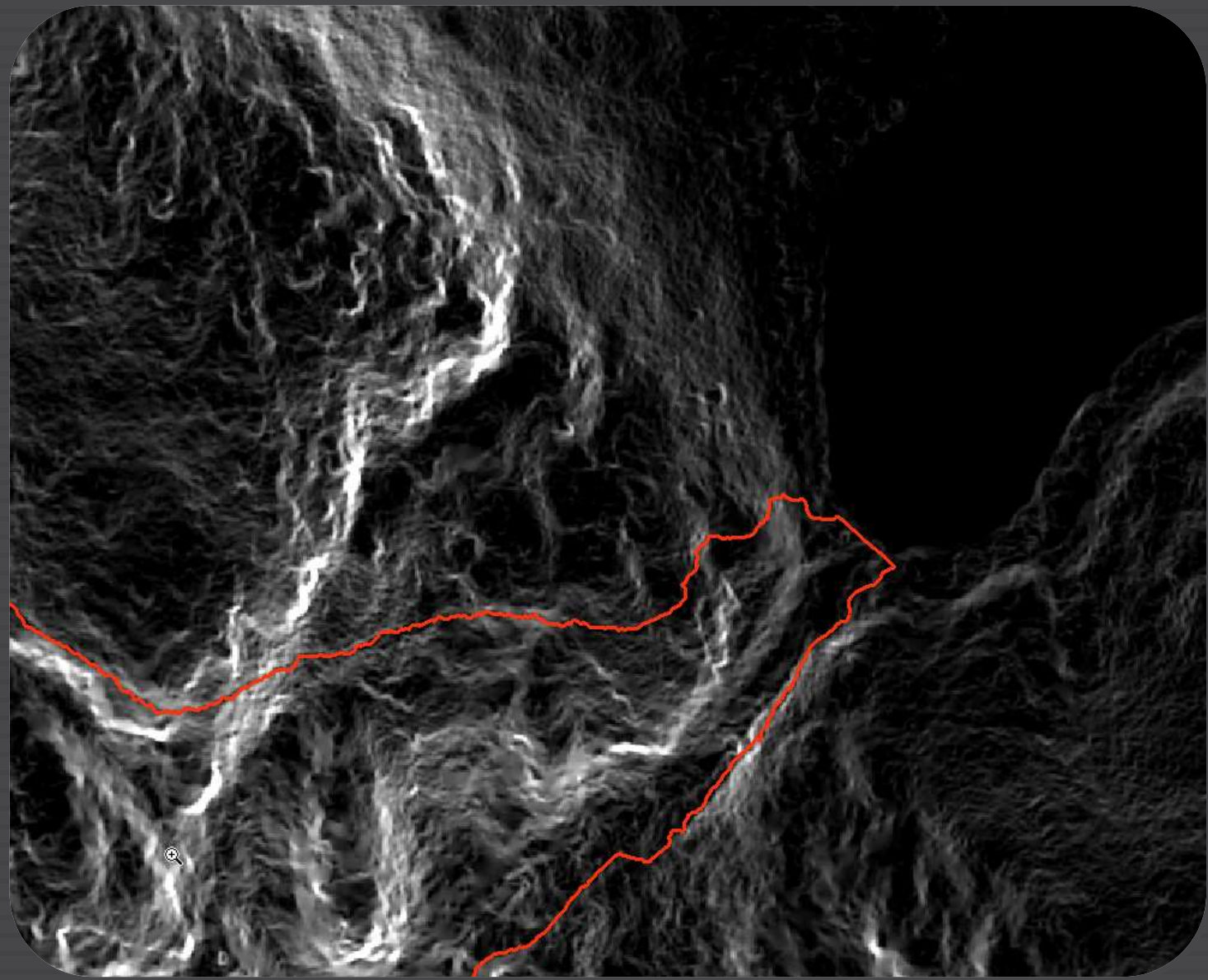
β is the slope at a given cell



Topographic Roughness (Rugosity)

Standard deviation of elevation within cell neighborhood

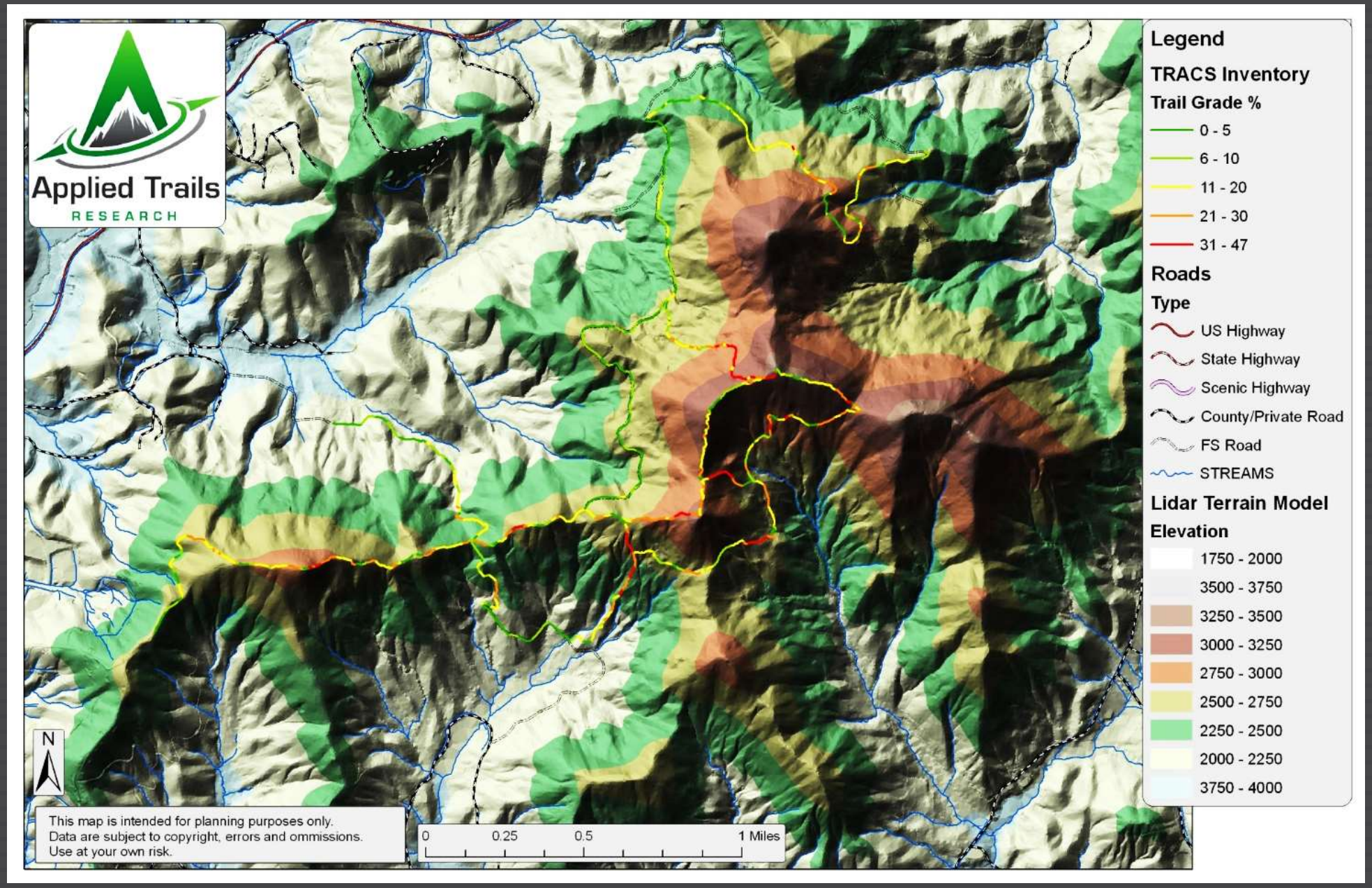




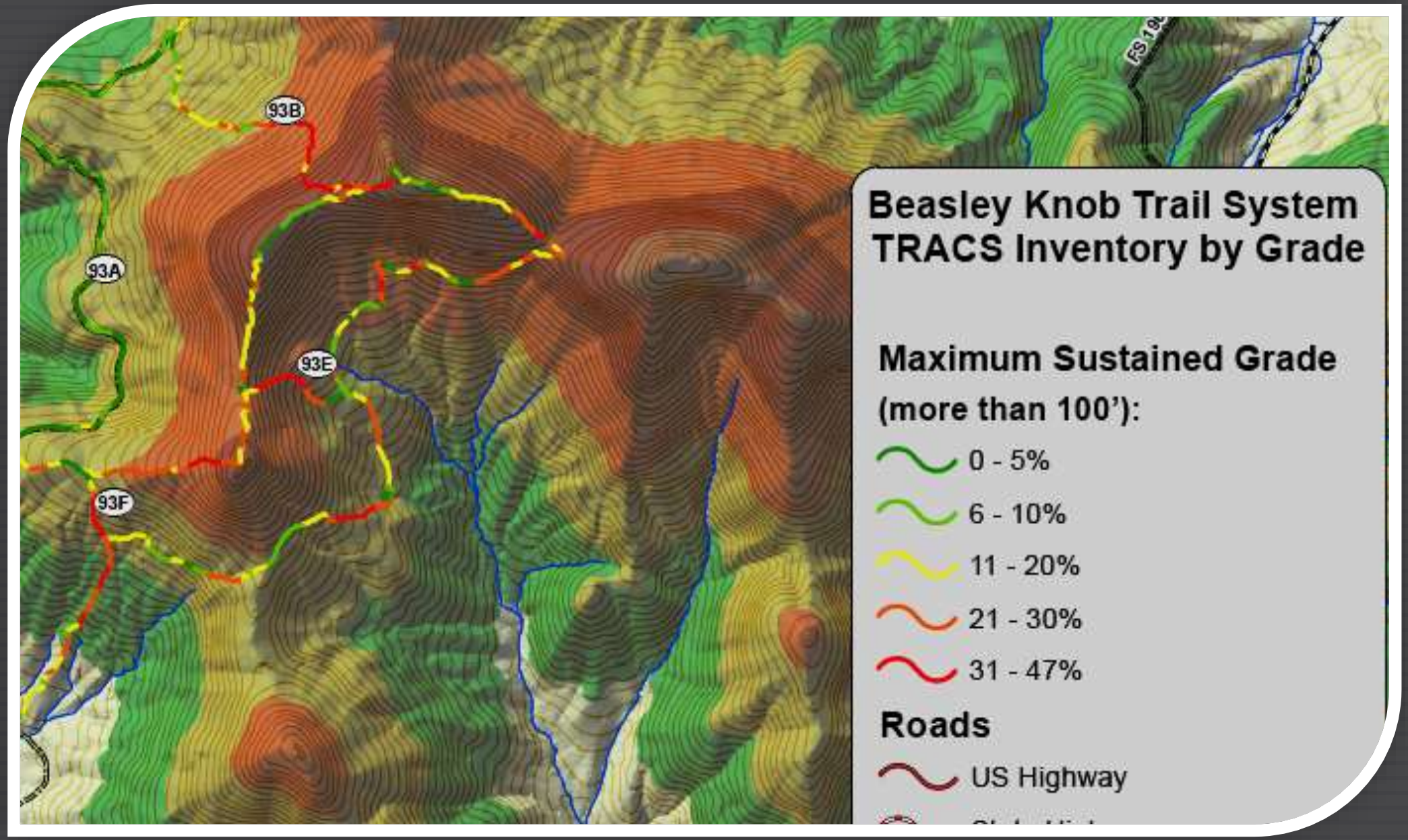
Multiple Regression Modeling

Variables	Regression Model
Precipitation	2.8 (<.001)
Landform Slope	1.6 (.004)
Tread Corridor Mean Grade	3.6 (.003)
Mean Substrate Type: % Soil	-0.4 (0.048)
Mean Landform Slope along Trail Corridor	-1.2 (.018)
Watershed Flow Length	0.3 (.005)
Constant	-34.6
Adjusted R^2	0.57
F-stat	14.96

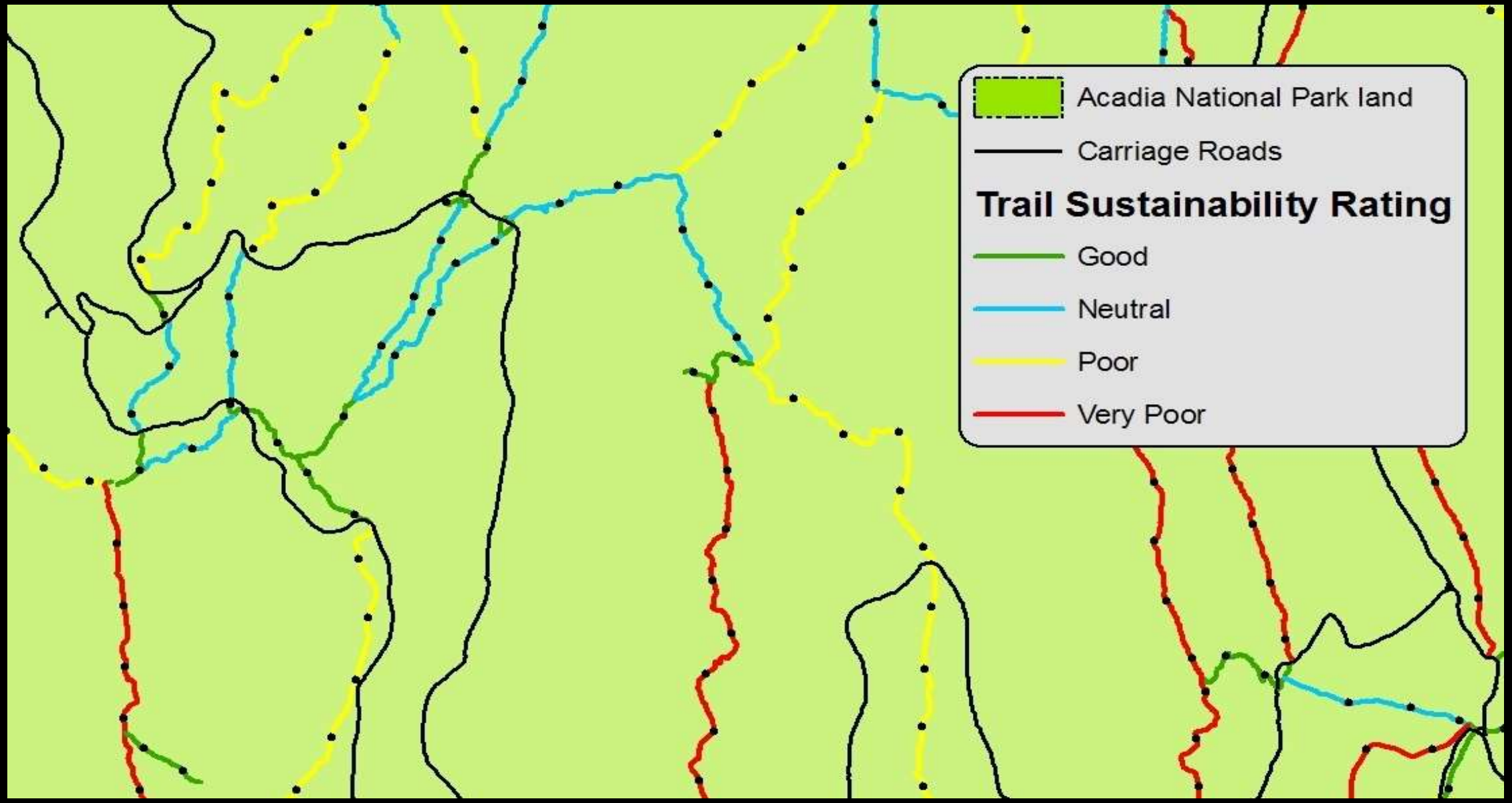
LiDAR Based Trail Grade Assessment



LiDAR Based Trail Grade Assessment



Trail Sustainability Ratings based on grade and TSA



Summary

Advances include:

Tools

- GIS and computing advances
- Data collection tools (e.g., aerial and ground-based LiDAR)

Technology & datasets

- High resolution terrain and watershed models
- Improved GPS accuracy (sub-meter)