Reducing Soil Loss Through Sustainable Trail Routing: Preliminary Findings on Slope Ratio and Trail Slope Alignment

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Impacts to trails:

Widening

Muddiness

Soil Loss

The Agents of Soil Loss

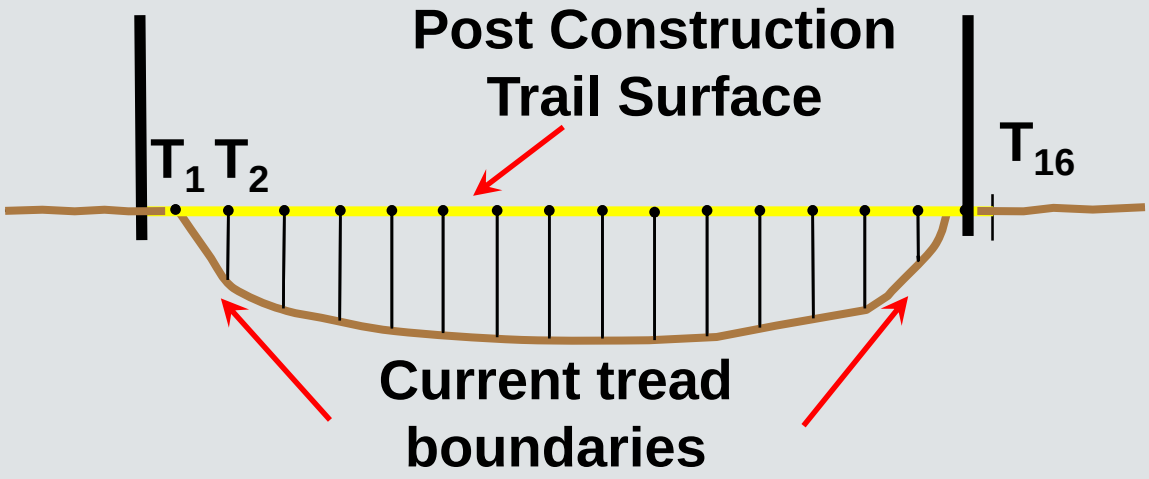
- **Compaction**
- **Displacement**
- **Water driven erosion**
- **Wind Driven Erosion**

Measuring Soil Loss

Max Incision

Mean Trail Depth

Cross Sectional Area (CSA)



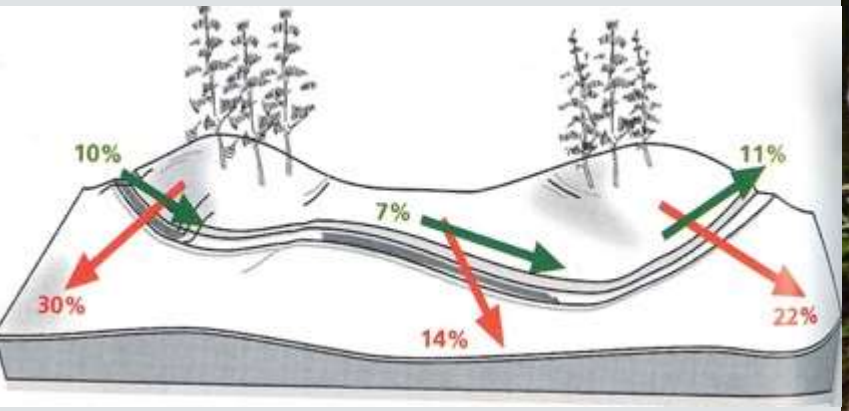
Core Factors that Influence Soil Loss

- Trail Grade
- Tread Substrates
- Soil Type and Texture
- Trail Alignment

Fall Line Trails: routed directly up slopes

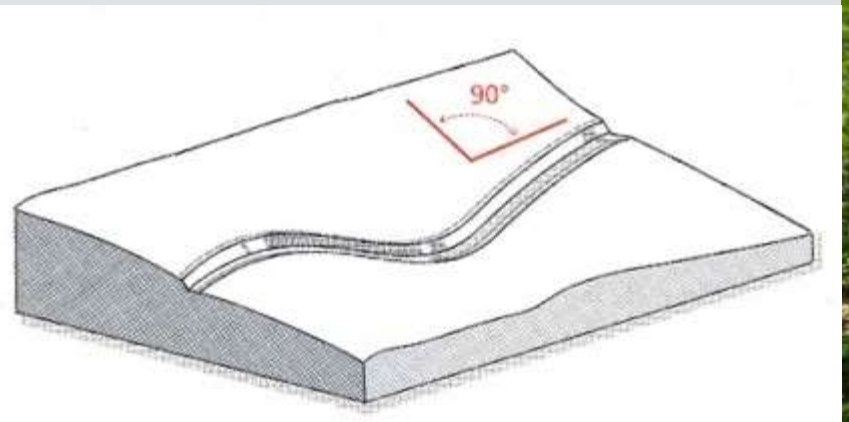
Side-hill Trails: routed across slopes

Slope Ratio



Trail Grade / Landform Grade

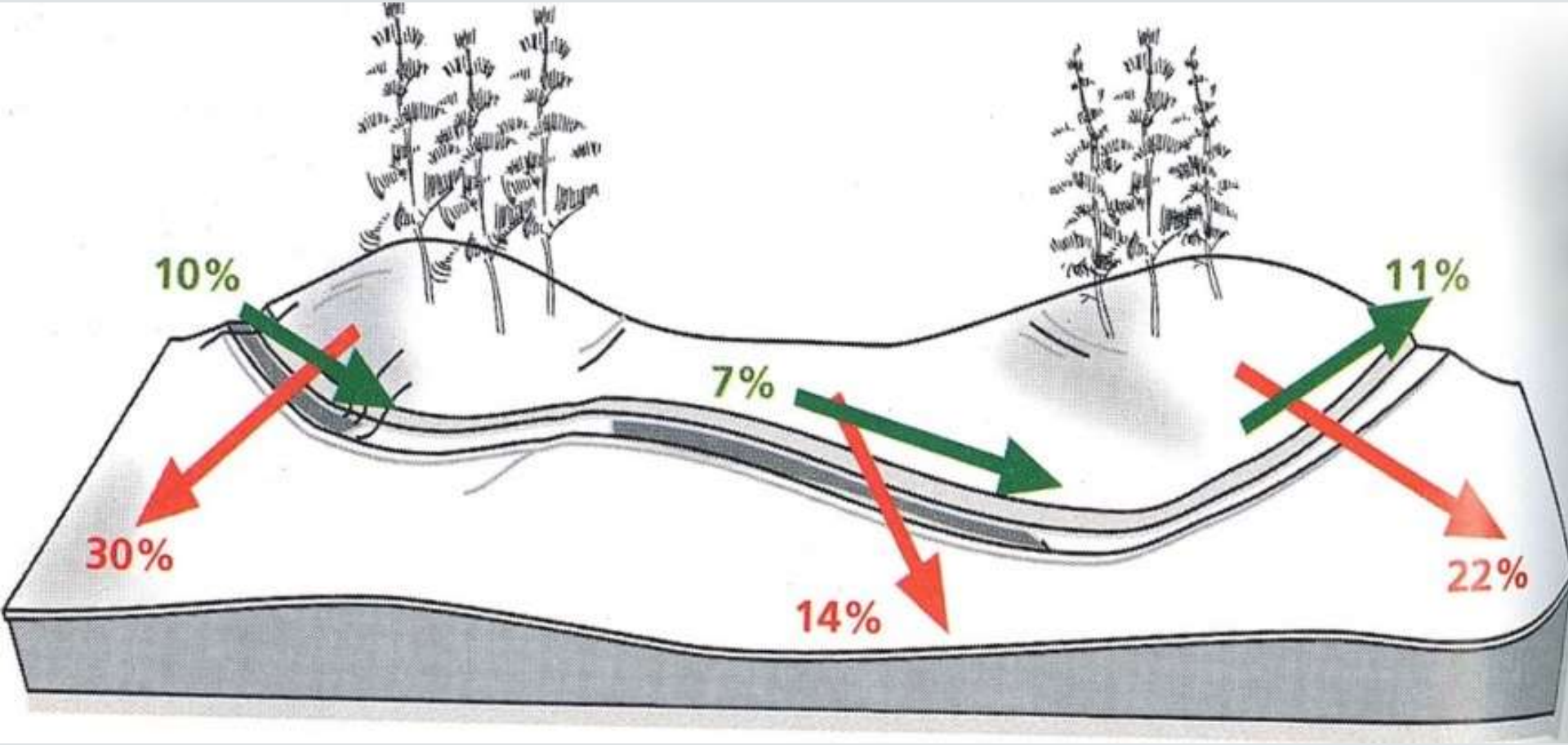
Trail Slope Alignment



Trail Bearing – Fall Line Bearing

(Felton, 2004)

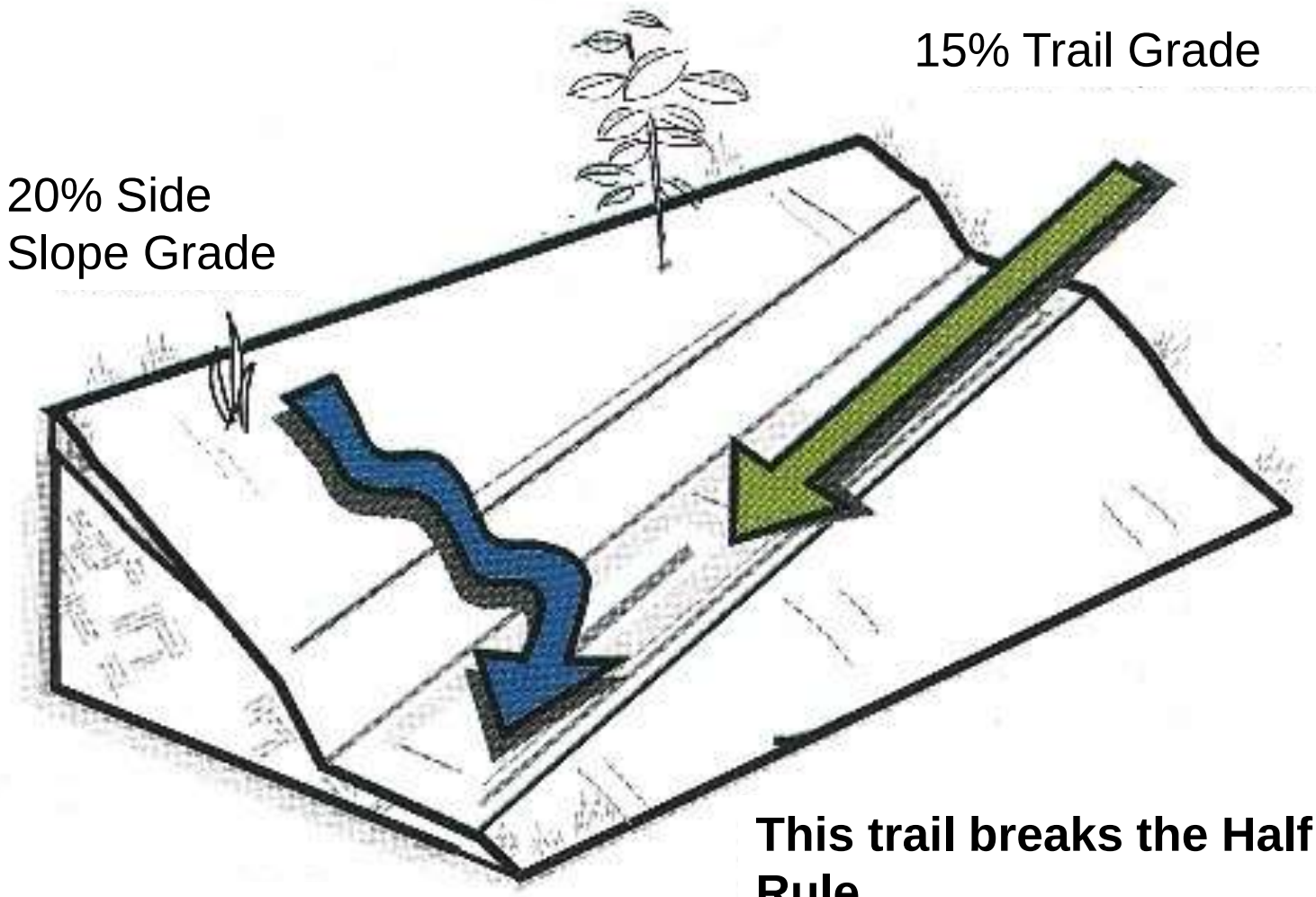
Slope Ratio



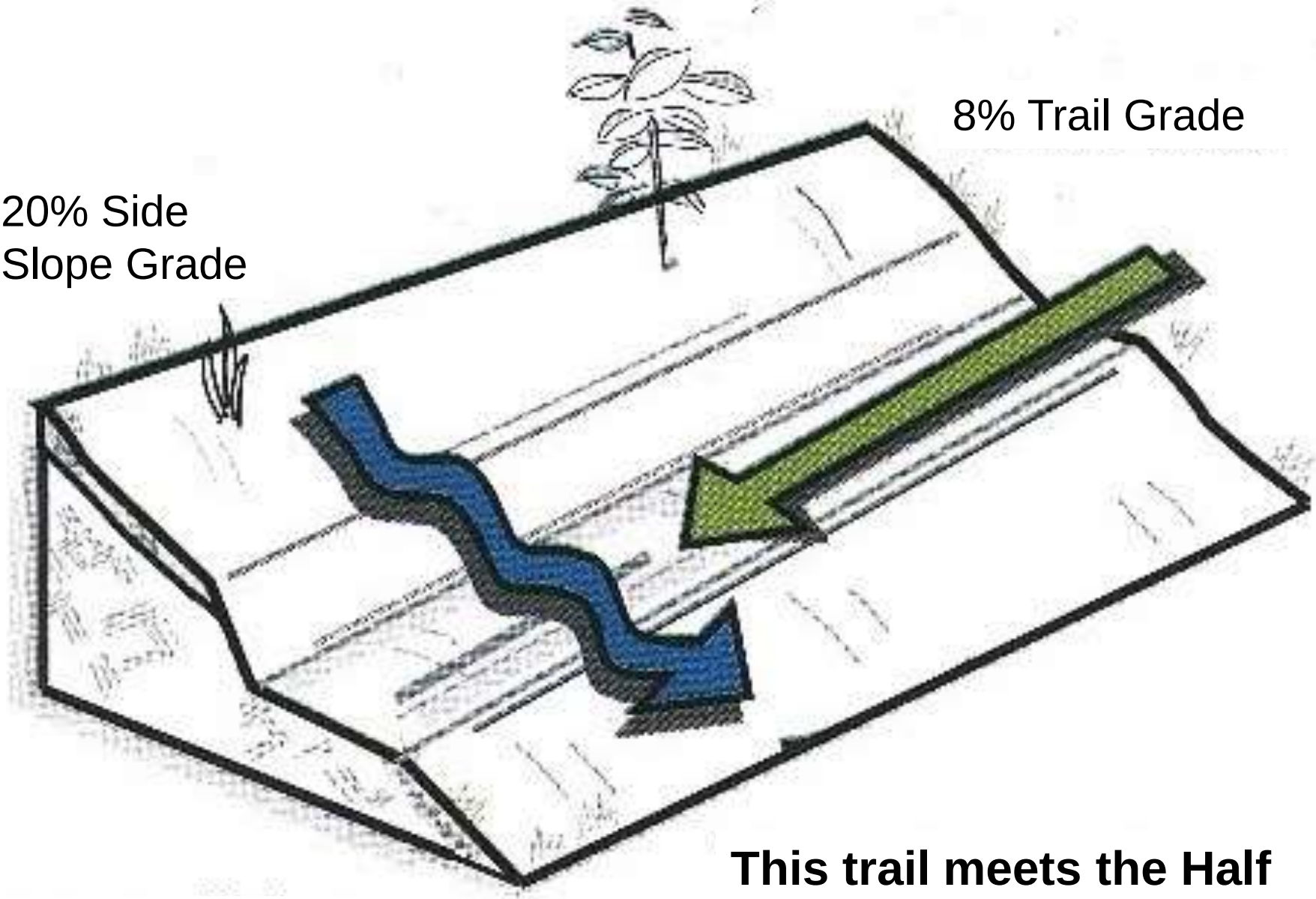
Slope Ratio = Trail Grade / Side Slope Grade
Range: 0 to 1

(Felton, 2004)

The IMBA Half Rule: A trail's grade shouldn't exceed half the grade of the side slope.



(Felton, 2004)

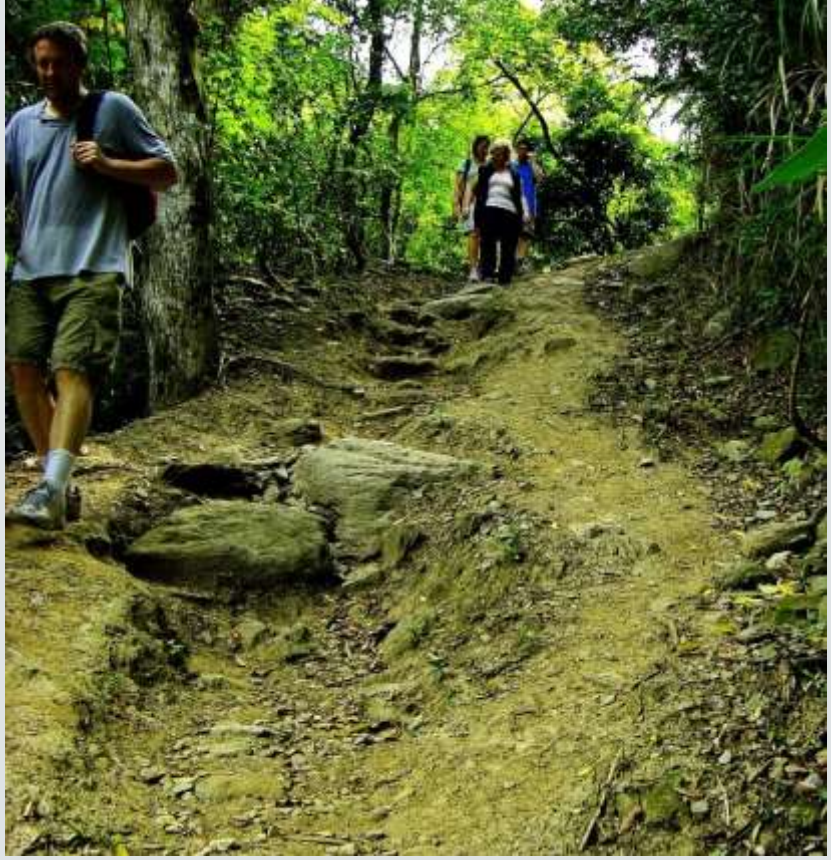


This trail meets the Half Rule.

Water will sheet across the trail

(Felton, 2004)


Why 50%?
Why not 40%
Why not 60%



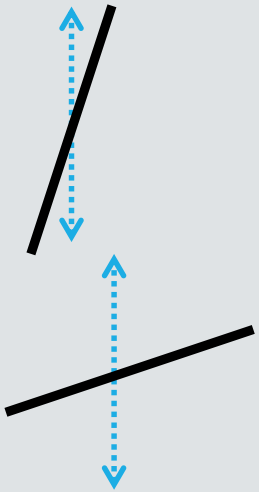
Trail Slope Alignment Angle

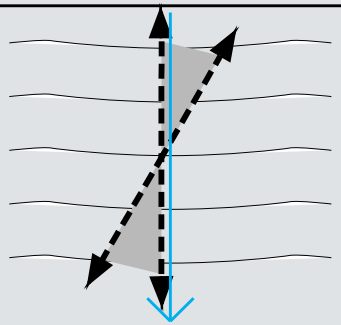
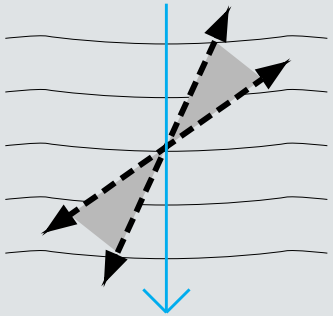
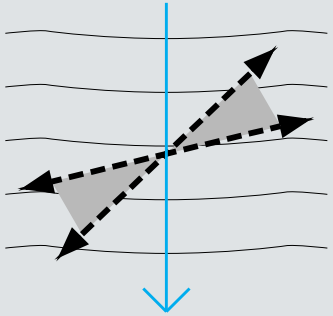
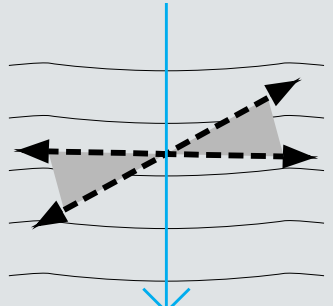
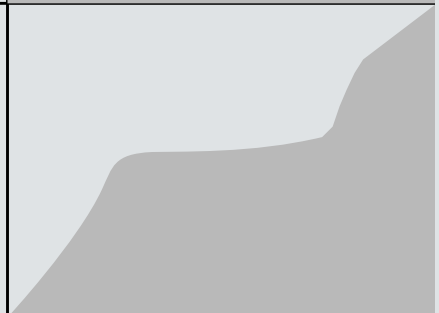
Trail Alignment Angle to the Prevailing Landform Slope, Irrespective of Trail Grade

Range: 0 – 90º

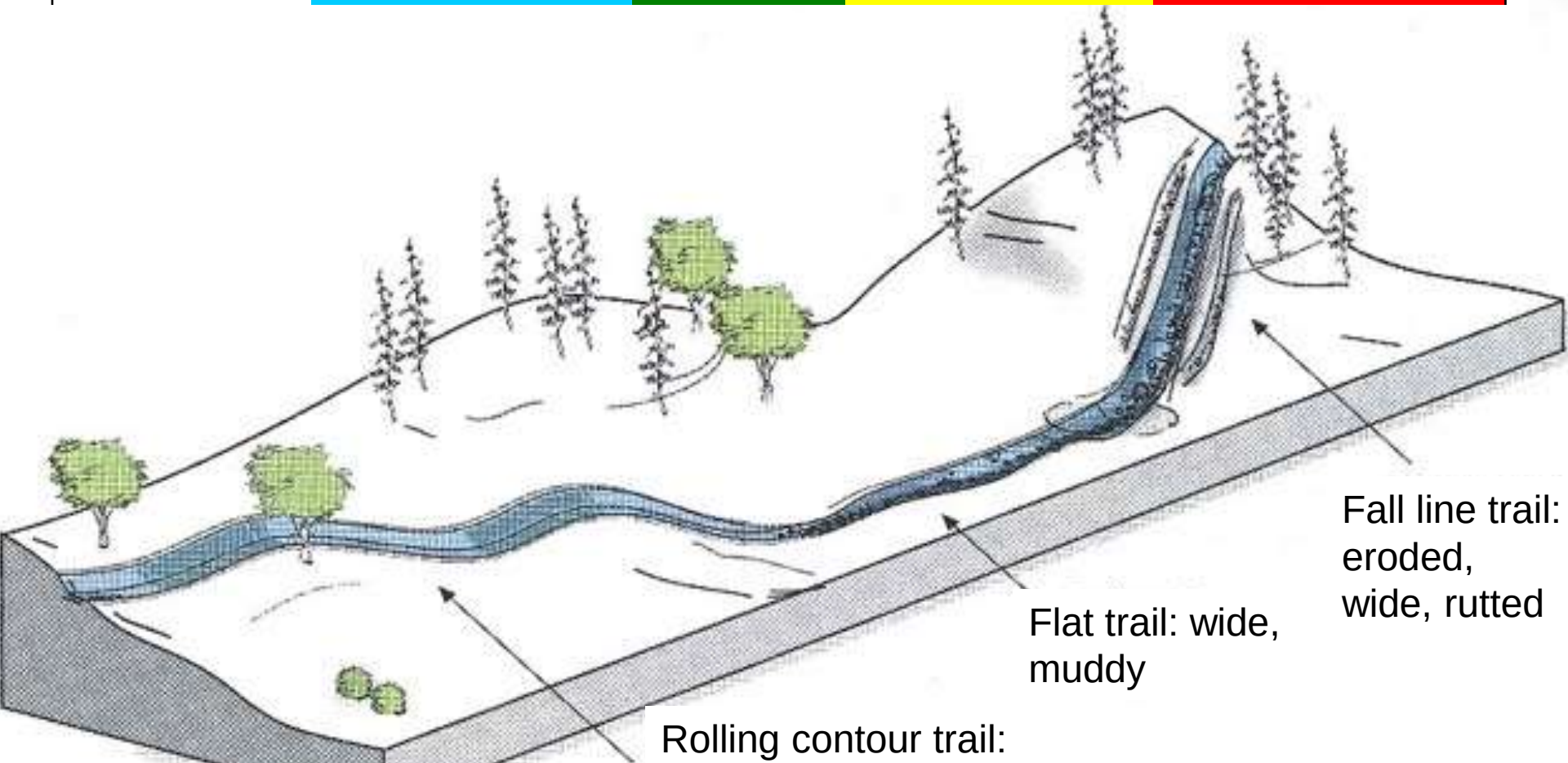
Low Alignment Angle (fall line)

High Alignment Angle (side-hill)

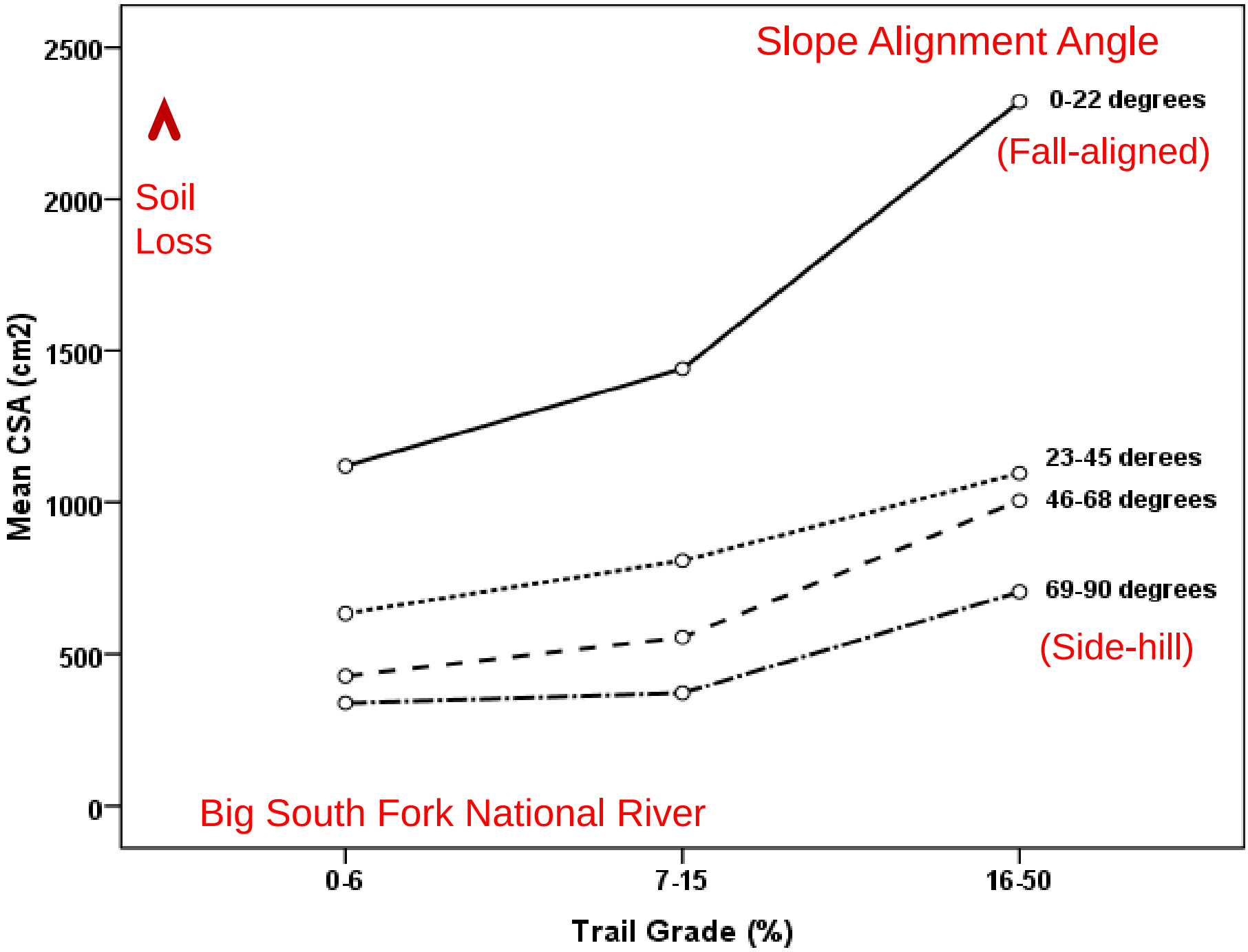


Trail Slope Alignment	Diagram (Trail, Topography Lines, Fall Line)	Degradation Potential	Cross Sectional Trail Profile
0 – 22 degrees Fall Line		**Very High-** tread drainage rarely possible; erosion, widening and muddiness are probable	
23 - 45 degrees Fall Line		**High**- tread drainage is difficult; erosion, widening, and muddiness are likely	
45 - 67 degrees Side-hill		**Low-** tread drainage is possible; low potential for problems	
68 - 90 degrees Side-hill		**Very Low-** tread drainage is easy; very low potential for problems	

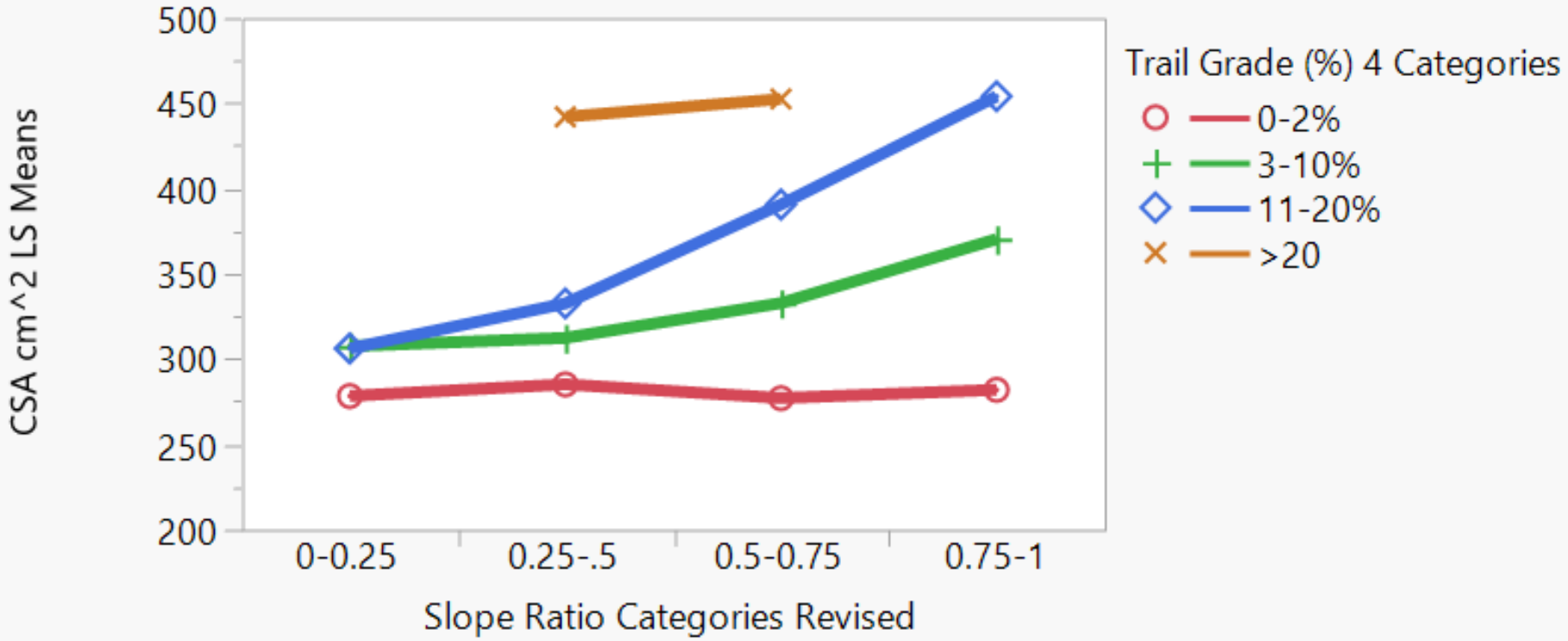
Trail Slope Alignment	Trail Grade			
	0-2%	3-10%	11-20%	>20%
0-30º	Unfavorable	Poor	Very Poor	Very Poor
31-60º	Unfavorable	Good	Poor	Very Poor
61-90º	Unfavorable	Good	Poor	Very Poor



Title	Avoid Fall Lines	Slope Ratio	TSA
Sustainable Mountain Trails Sketchbook	X	1/4	
Managing the Impacts of Recreation on Vegetation and Soils	X		
Off-highway motorcycle and ATV trails: Guidelines for Design, Construction, Maintenance, and User Satisfaction			
Appalachian Trail Fieldbook: Maintenance and Rehabilitation Guidelines for Volunteers	X		
Trail Solutions: IMBA's Guide to Building Sweet Singletrack	X	1/2	
Managing Mountain Biking: IMBA's Guide to Providing Great Riding	X	1/2	X
Recreational Horse Trails in Rural and Wildland Areas: Design, Construction, and Maintenance	X	1/2	
A Comprehensive Framework for Off-Highway Vehicle Trail Management	X	1/2	X
The Complete Guide to Trail Building and Maintenance			
Appalachian Trail Design, Construction, and Maintenance	X		
Equestrian Design Guidebook for Trails, Trailheads, and Campgrounds			
Trail Planning, Design, and Development Guidelines	X	1/4 or 1/3	
(USFS) Trail Construction and Maintenance Notebook	X	1/2	


Slope Alignment Angle
0-22 degrees
(Fall-aligned)
Soil
Loss
23-45 derees
46-68 degrees
69-90 degrees
(Side-hill)
Big South Fork National River
Mean CSA (cm2)
2500
2000
1500
1000
500
0
0-6
7-15
16-50
Trail Grade (%)

Preliminary Results from the Southern 1/3 of the Appalachian Trail



Should the ½ Rule be the 1/3 Rule?


Questions?