

Forest road impacts on channels and salmon habitat

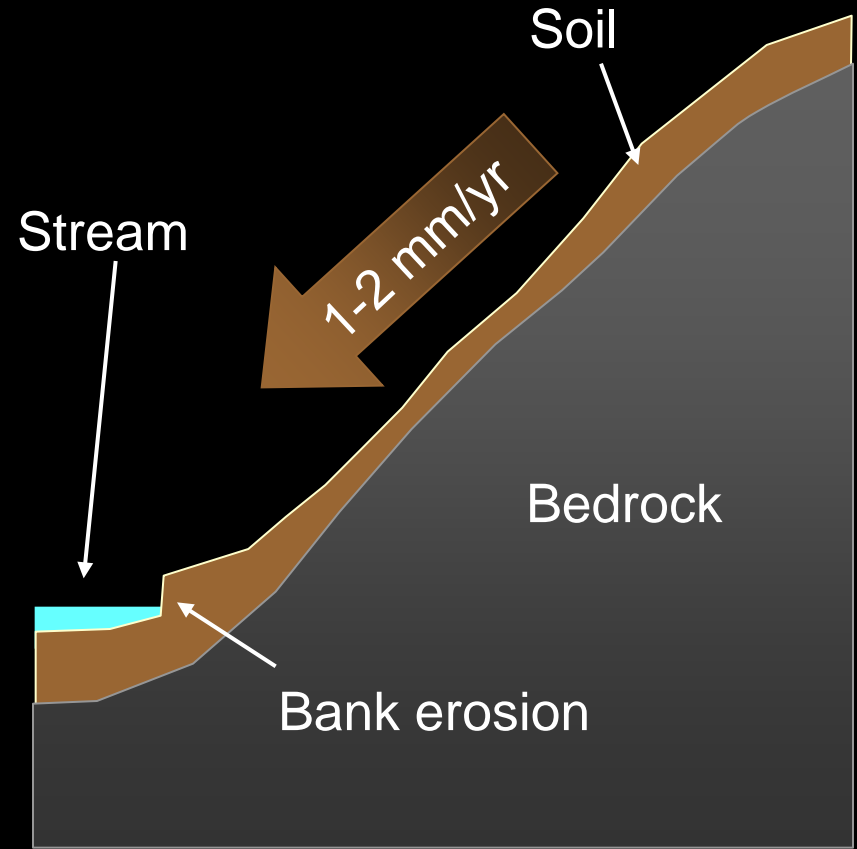


Erosion and sediment supply

- Three main processes
 - Soil creep
 - Surface erosion
 - Mass wasting (landslides)

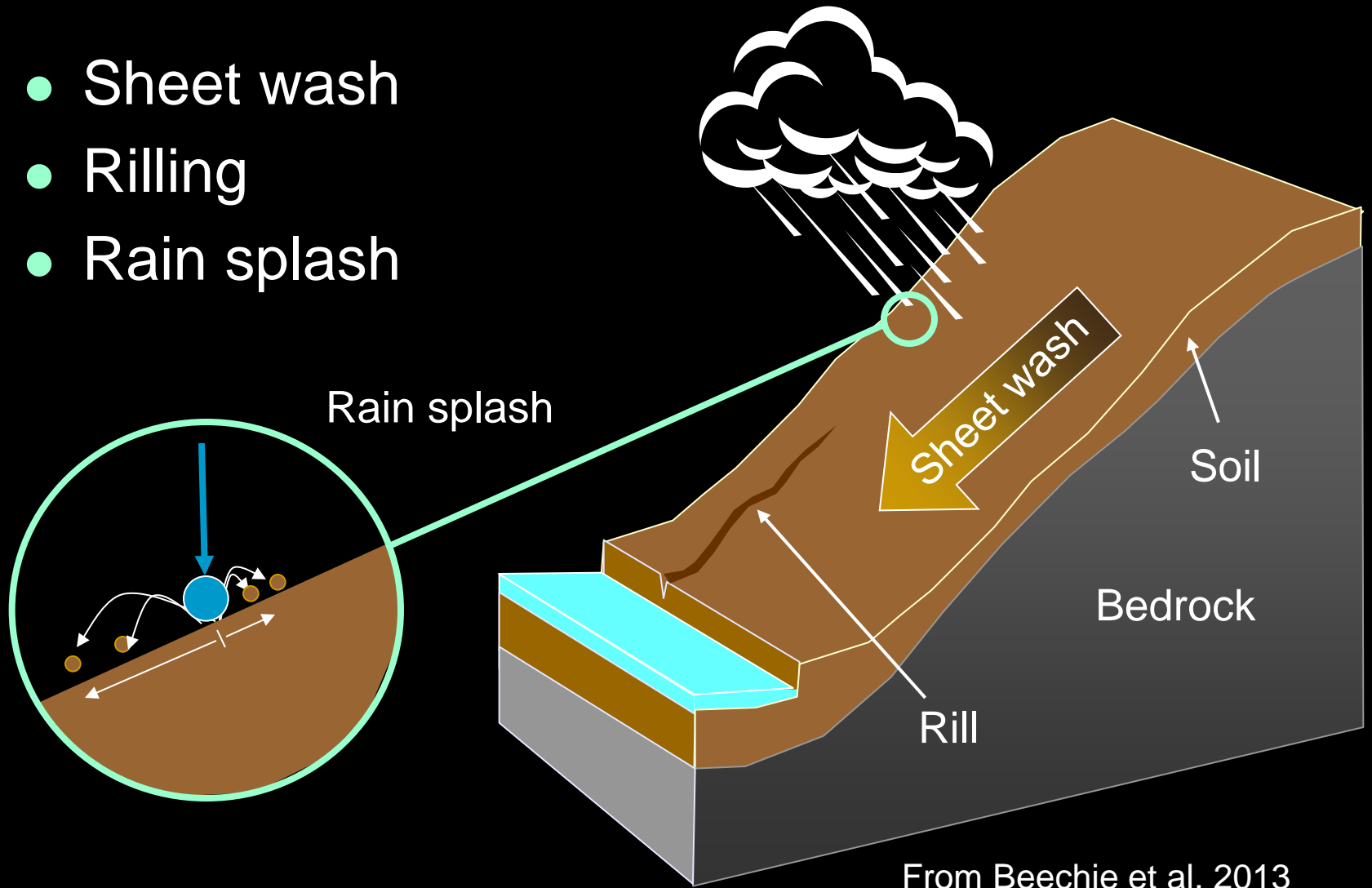
Soil Creep

- Down-slope movement of soil mantle
- Often considered the background erosion rate
- Enters streams via bank erosion



Surface erosion

- Sheet wash
- Rilling
- Rain splash





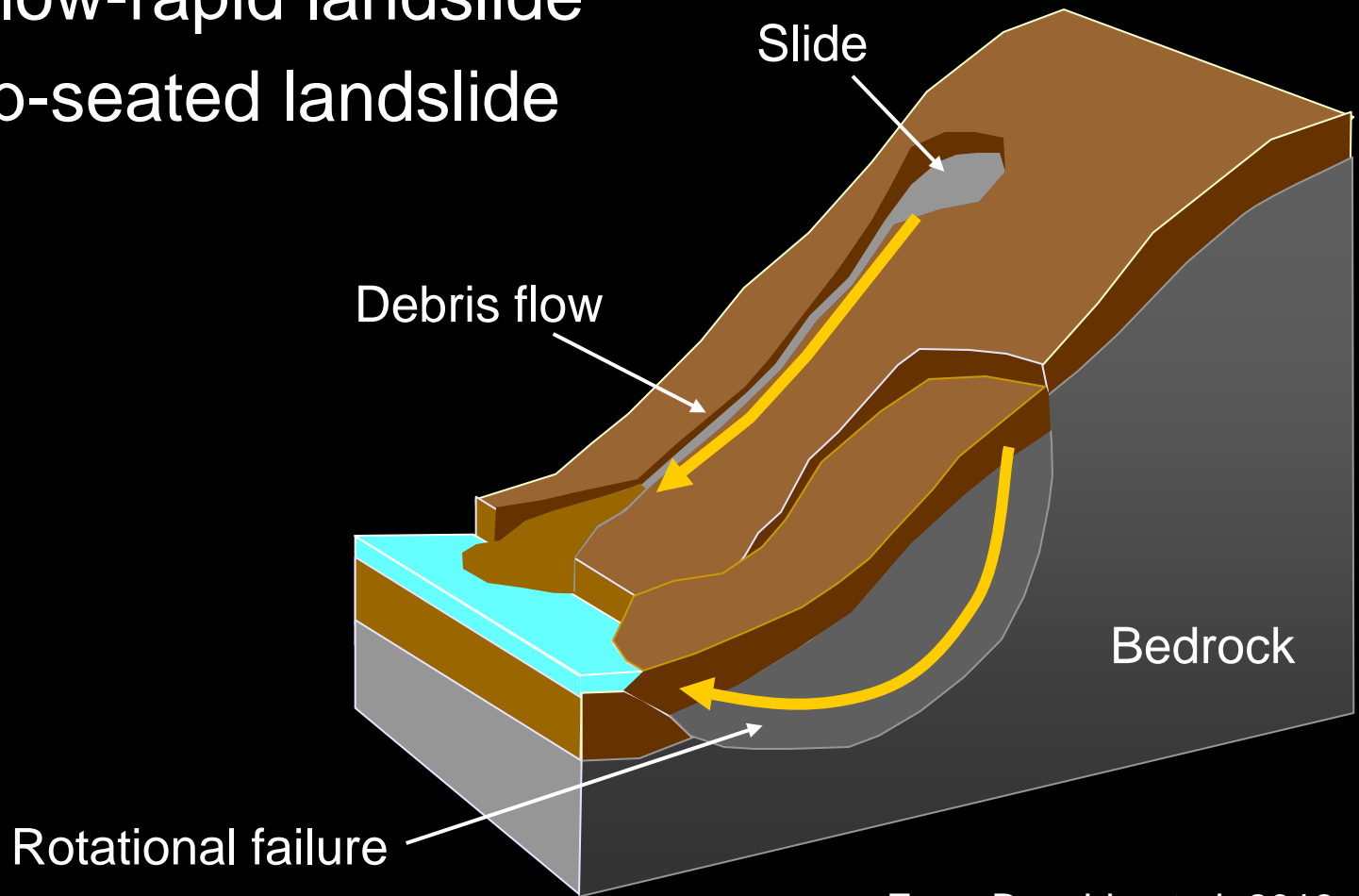
Surface erosion

- What drives surface erosion on roads?
 - Area of road
 - Native material
 - Surface material
 - Traffic level
 - Percent draining to stream



Landslides

- Shallow-rapid landslide
- Deep-seated landslide



From Beechie et al. 2013

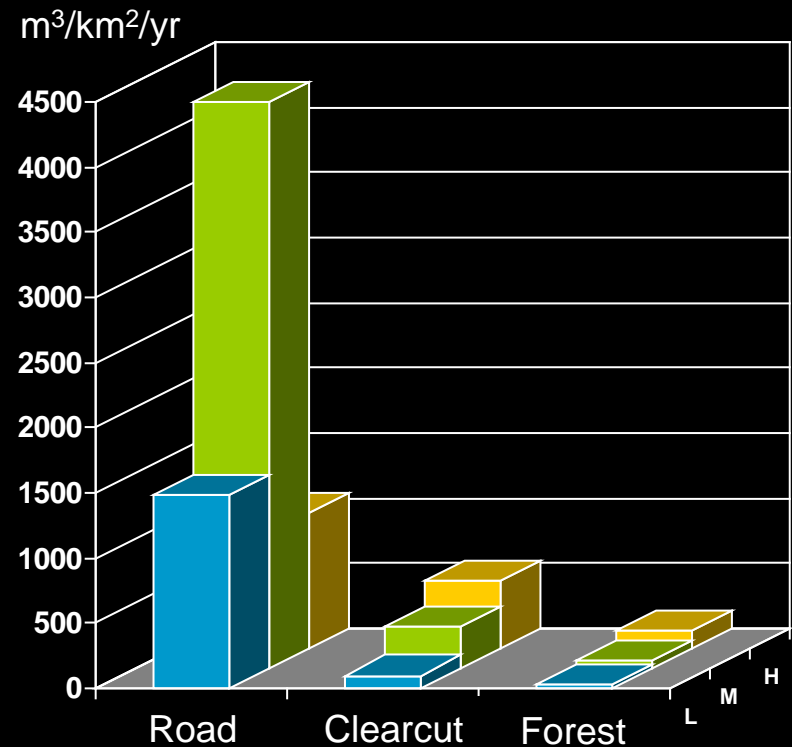






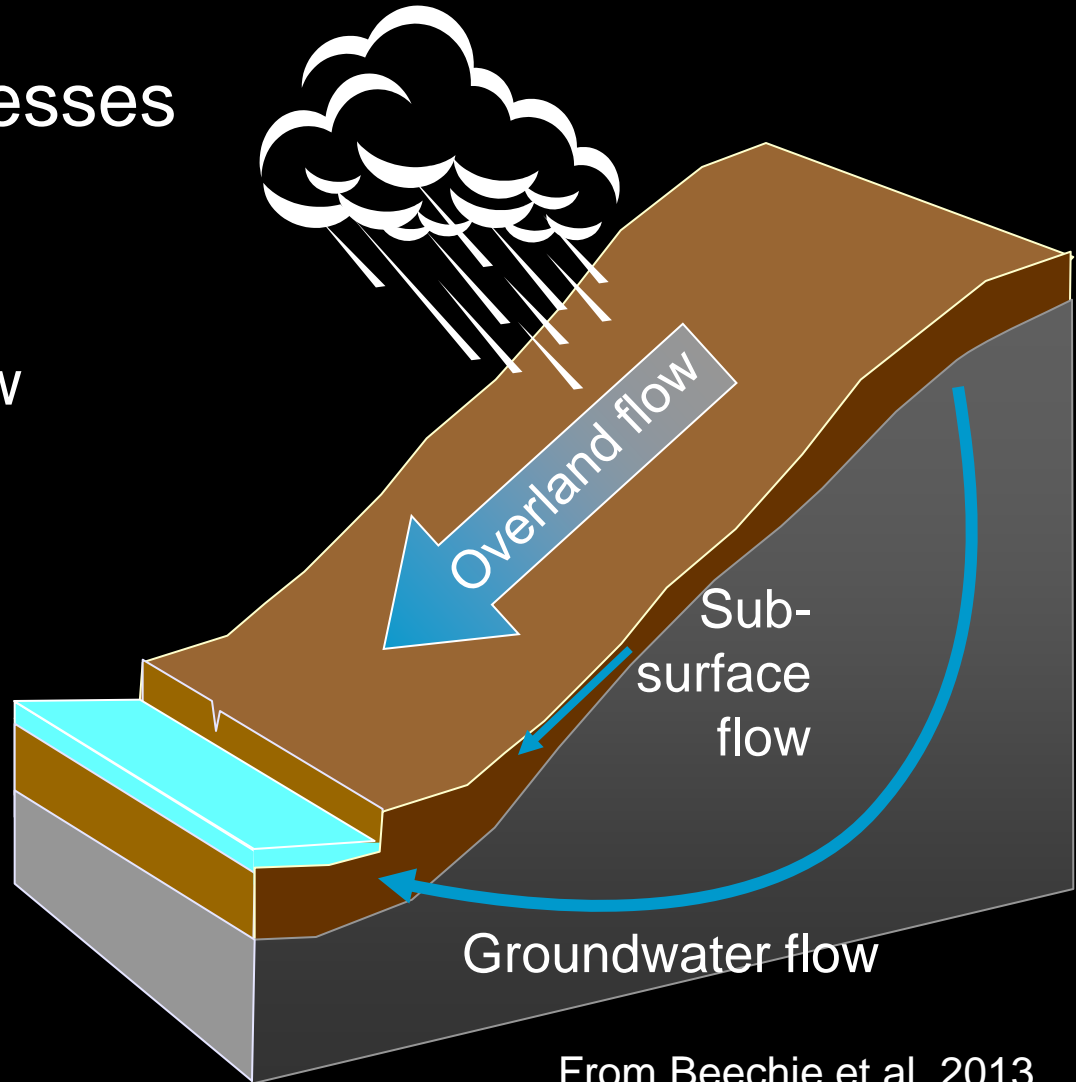
Road effects on landslides

- Increased rates
 - Roads: 10x higher
 - Clearcuts: 4x higher
- Cumulative sediment increase
 - Area of roads and clearcuts is small
 - Cumulative increase often around 2x



Runoff processes

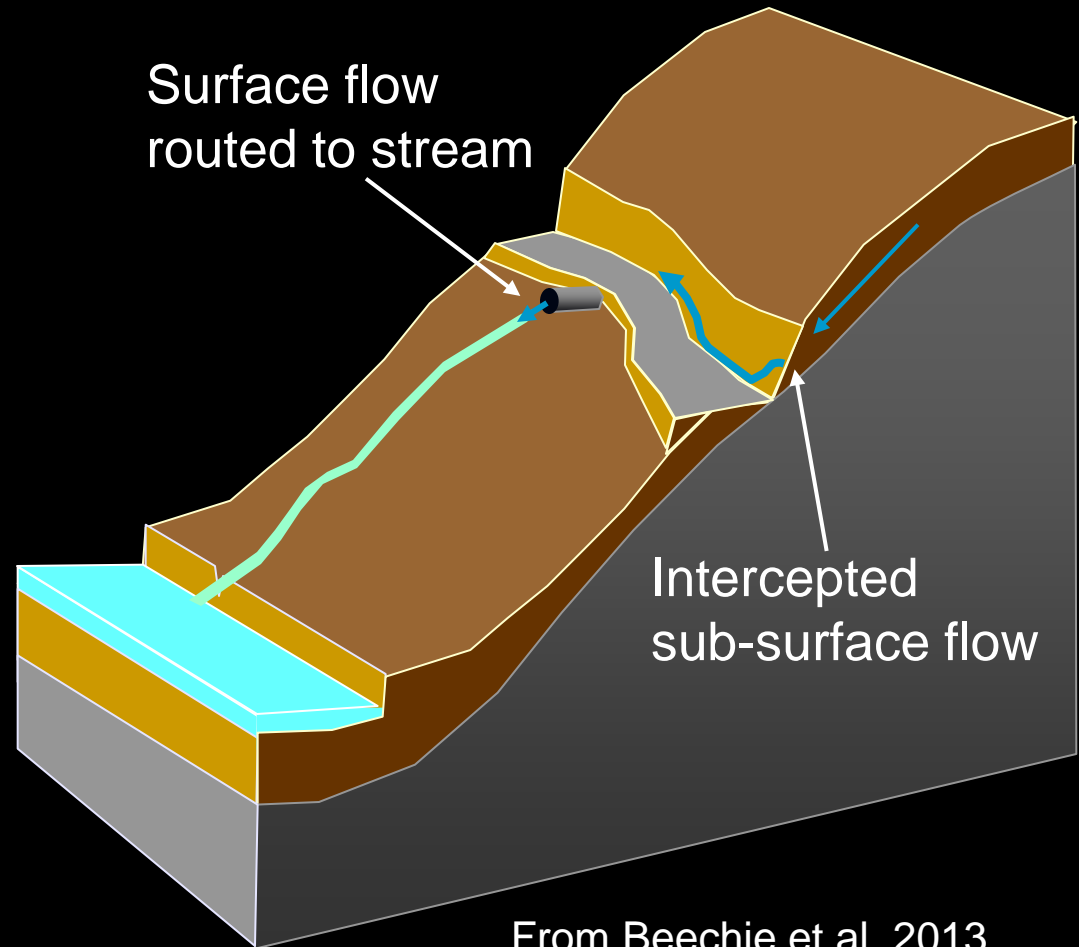
- Three main processes
 - Overland flow
 - Subsurface flow
 - Groundwater flow



From Beechie et al. 2013

Road effects

- Groundwater emerges from road-cut, enters ditch
- Ditch flow routes rapidly to stream

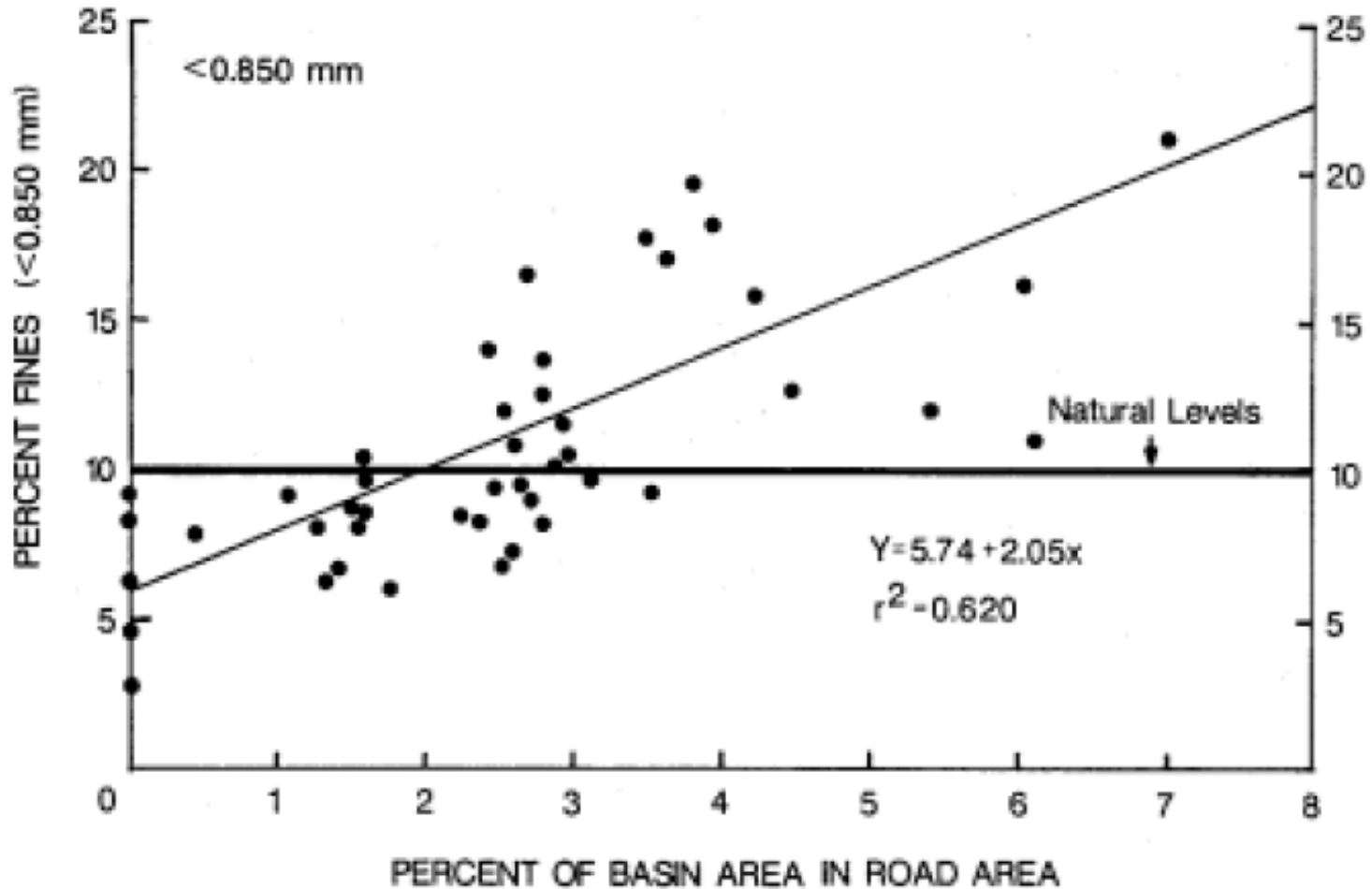


From Beechie et al. 2013

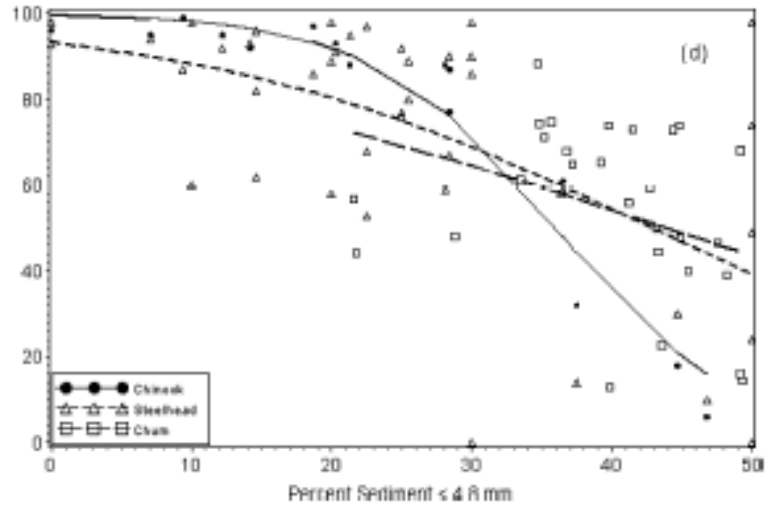
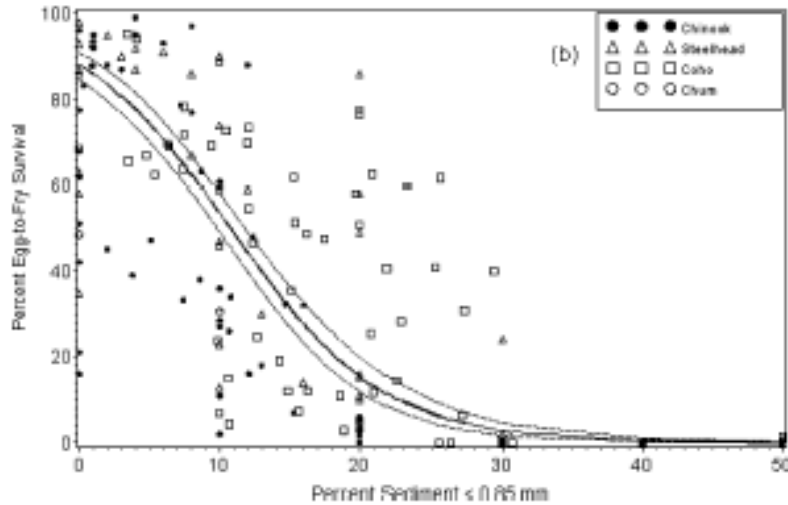
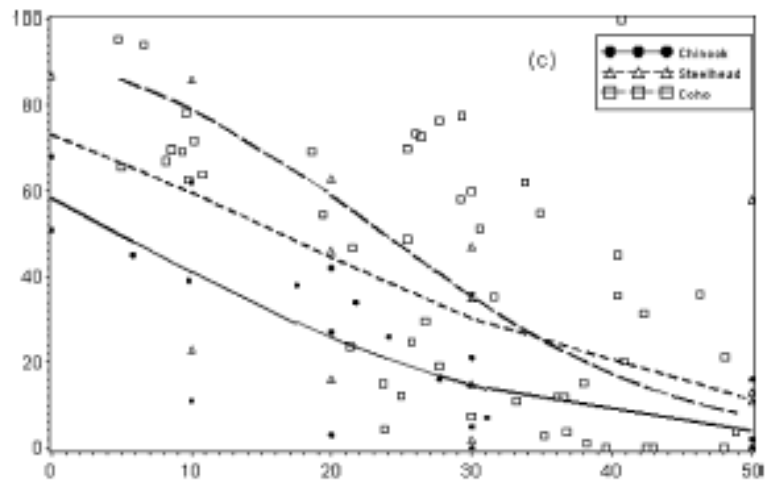
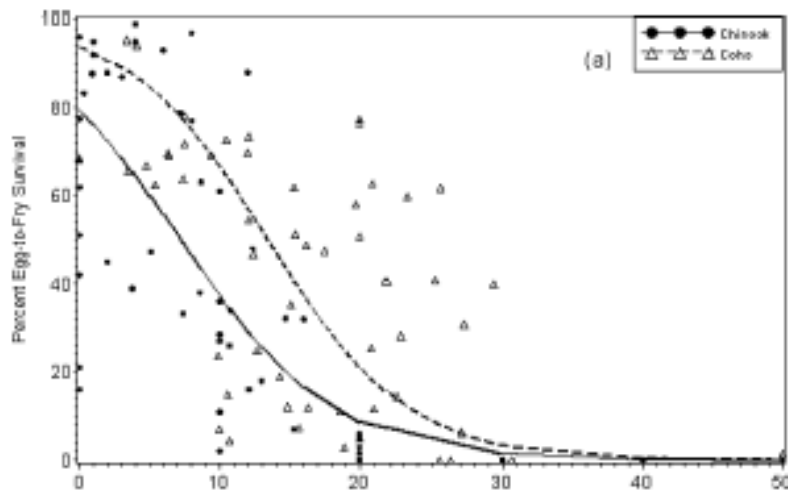
Channel and habitat response



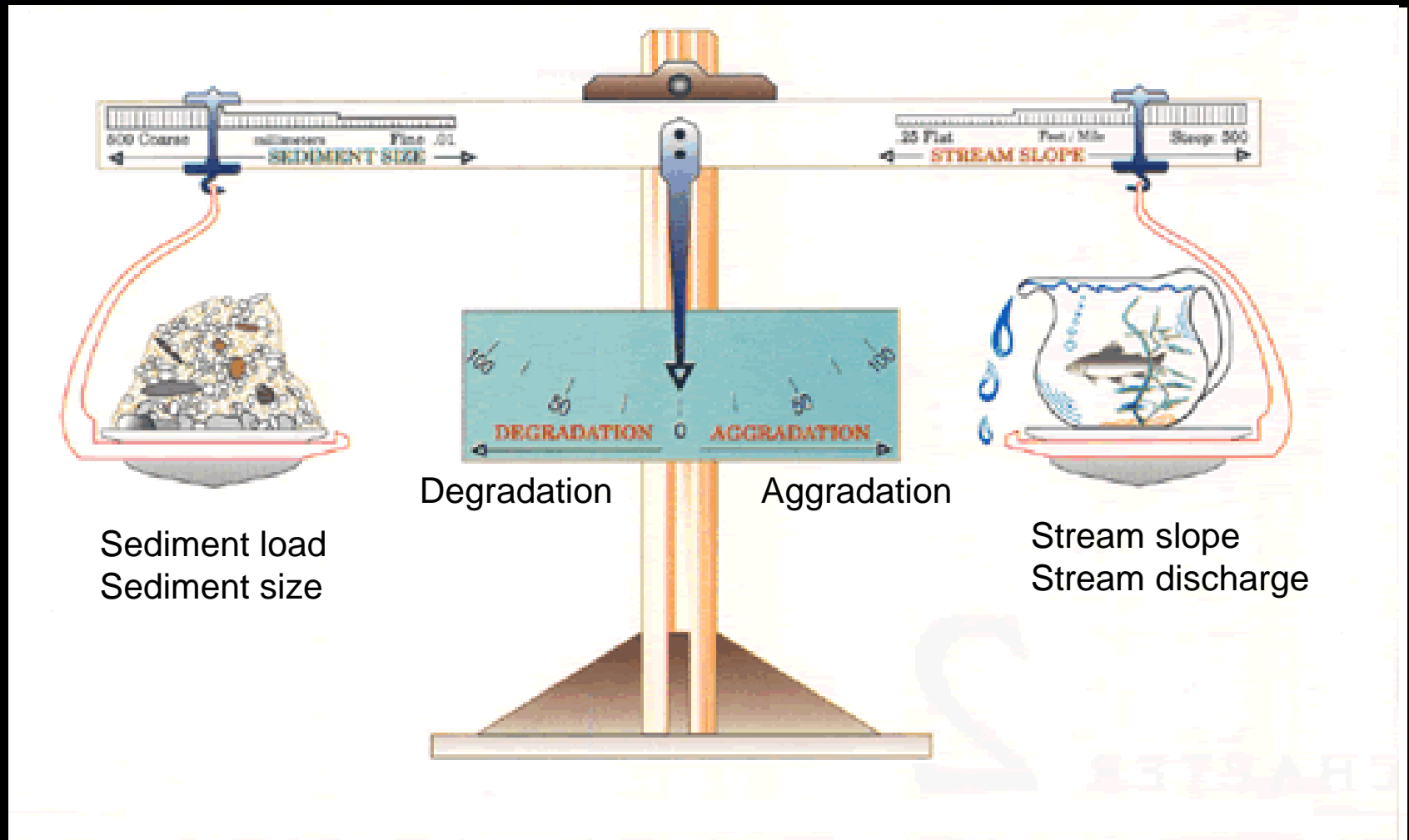
Roads and fine sediment



Fine sediment and egg survival

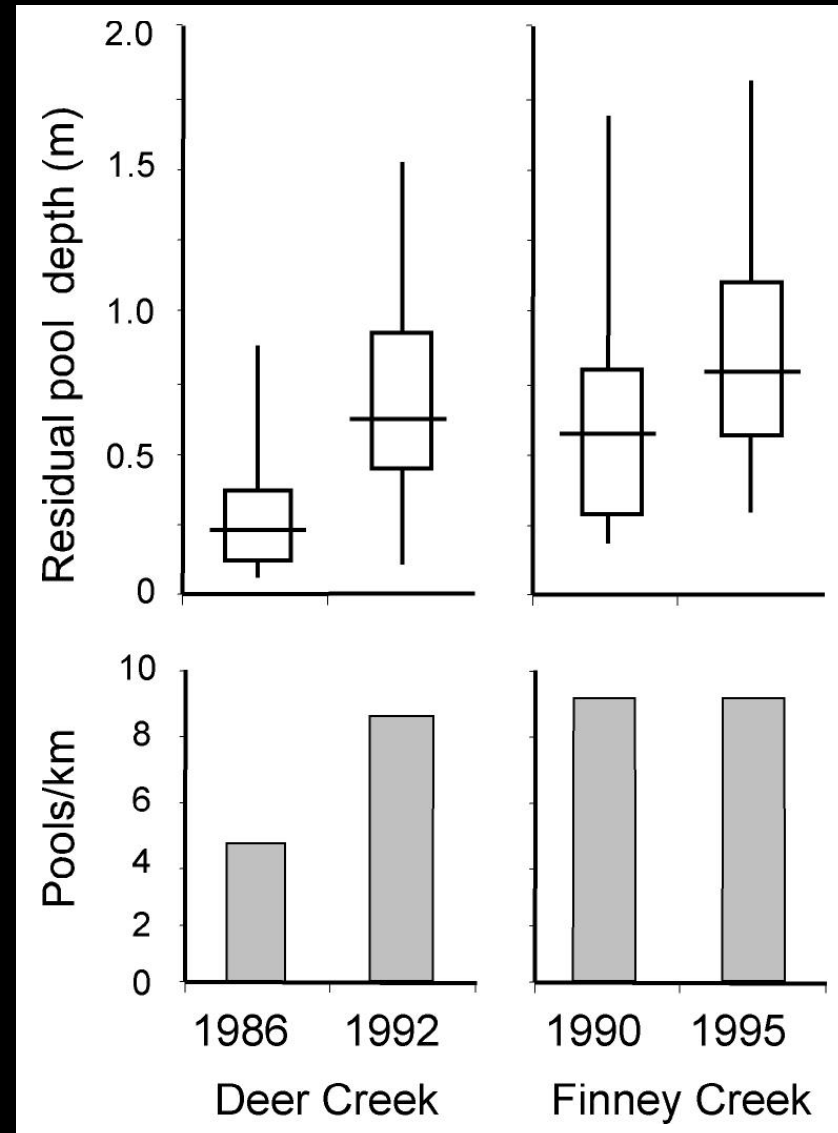


Lane's balance for bedload



Increased sediment: pool filling

- Pools can be filled by large increases in coarse sediment supply
- Recovery is often less than 10 years

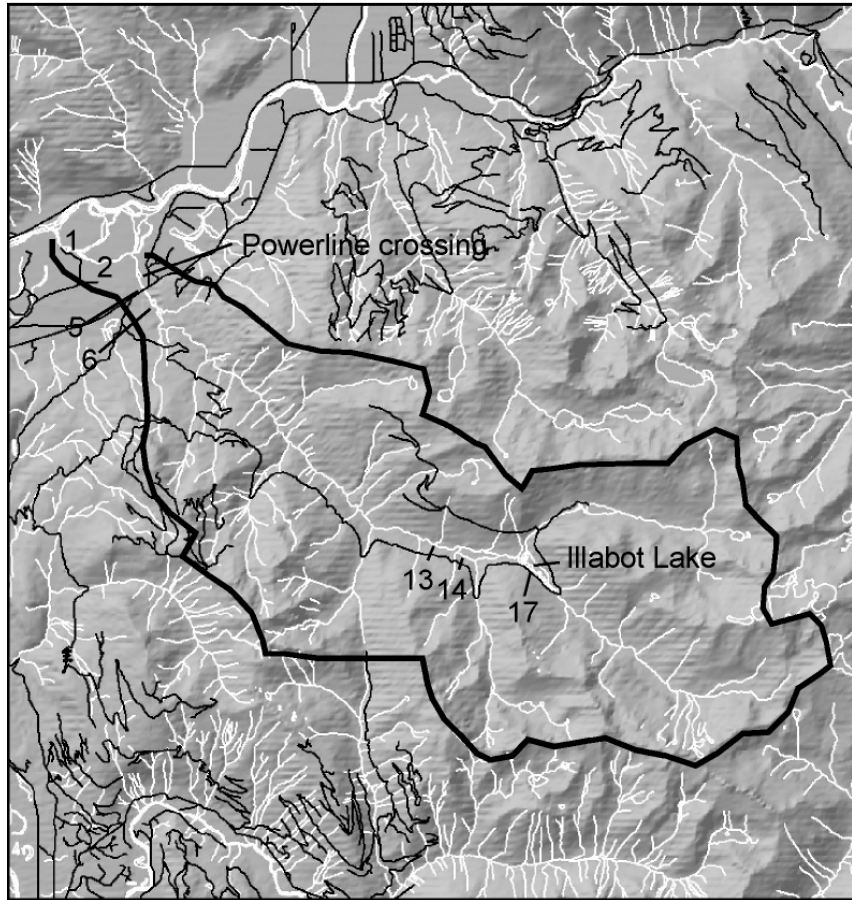


Increased sediment: aggradation

- Bed fining (spawning)
- Aggradation (rearing pools)
- Turbidity (feeding)

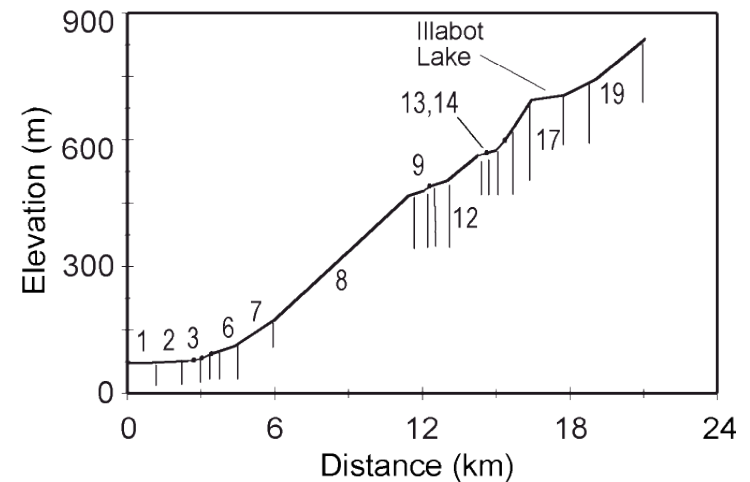
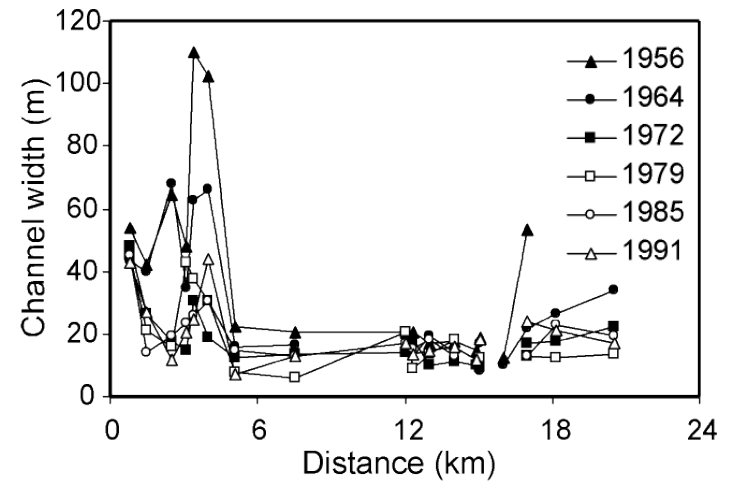


Increased sediment: channel widening



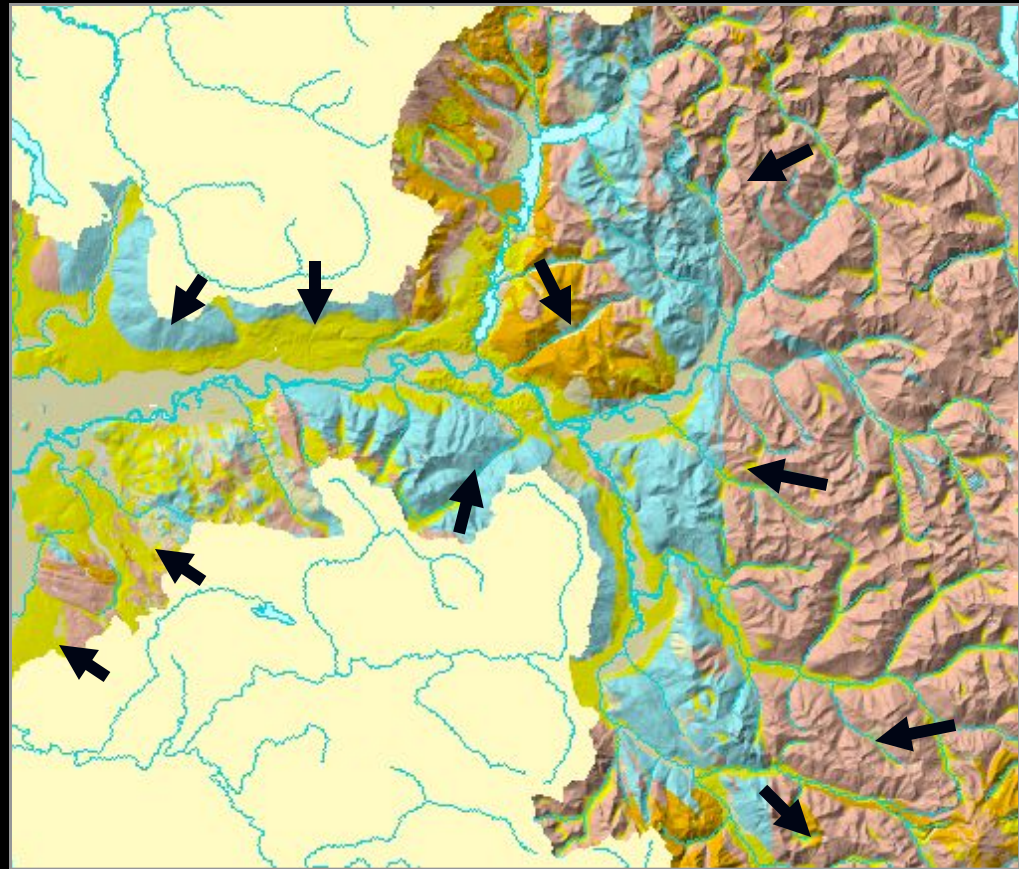
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Scale = 1:230,000



Planning road treatment/removal

- The sediment budget
 - Soil creep
 - Surface erosion
 - Landslides
- Quantify change in erosion rates
 - Background
 - With land use effects



Sediment budget result (Skagit)

- 10 sediment budgets
- Natural rates related to geology
- Clear cut and road erosion rates are 4 and 45 times higher

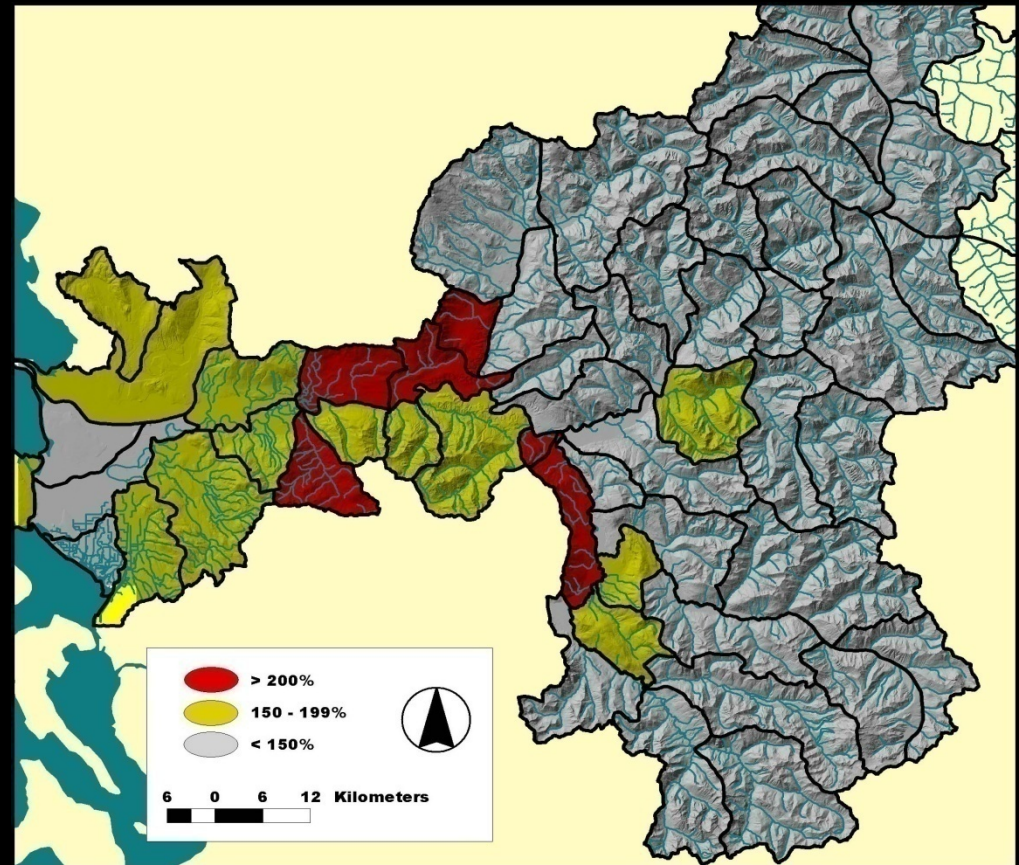
	Mature forest	Clear-cut	Road
Low-grade metamorphic	130	520	1040
High-grade metamorphic	53	318	4346
Glacial sediments	33	99	1485
Alluvium	0	0	0

Units: m³/km²/yr

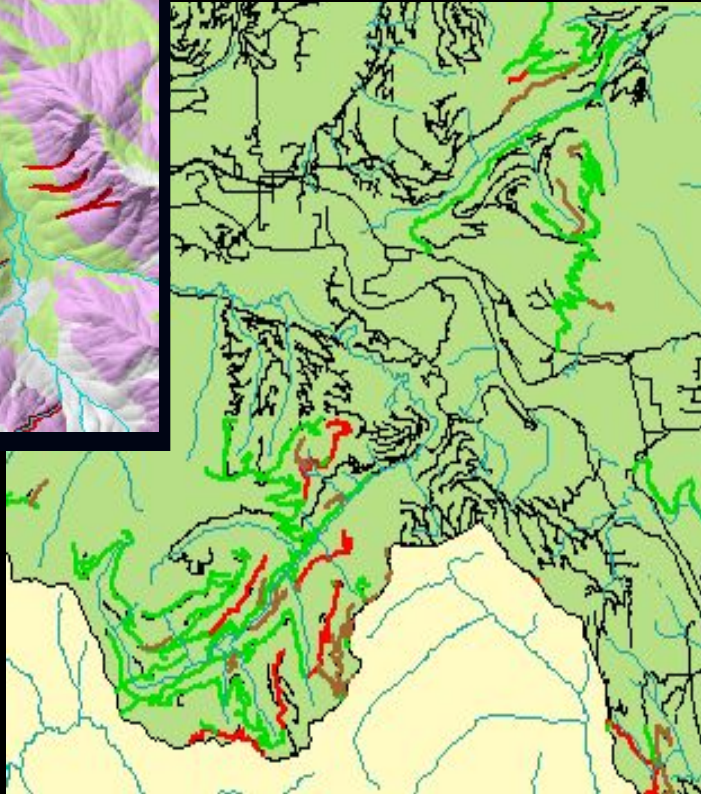
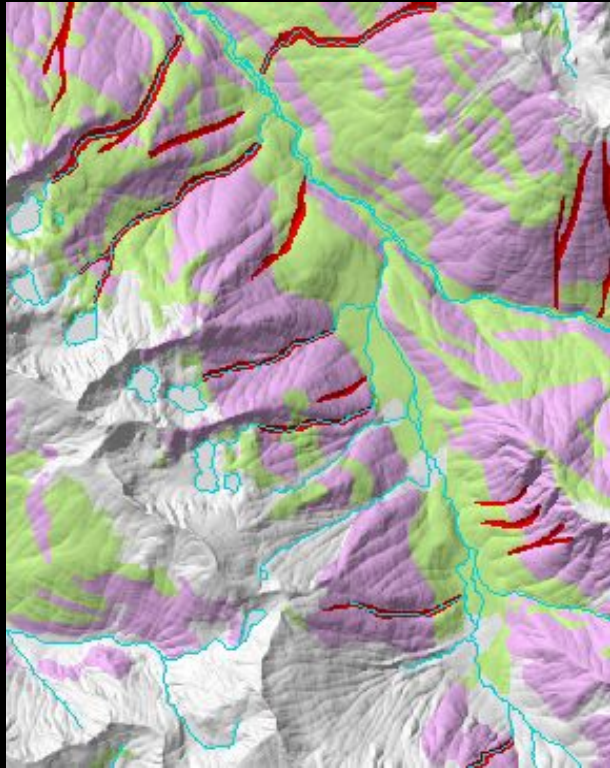
Based on Paulson (1997)

Sediment supply map

- Identify sub-basins with elevated sediment supply



Landscape strategies



- Landform mapping indicates hazard areas for passive restoration
- Road mapping identifies at-risk sites for active restoration

Road treatments

- Road removal/abandonment
- Sidecast removal or reduction
- Surface thickness/hardness
- Traffic reduction
- Drainage improvement



Road treatments



Road treatments



Road treatments







Summary points

- Road effects
 - Increased surface erosion
 - Increased mass wasting
- Channel response
 - Fine sediment affects egg survival
 - Coarse sediment affects channel structure and rearing habitat

Citations

- Beechie, T., J. Richardson, A. Gurnell, J. Negishi. 2013. Chapter 2: Watershed processes, human impacts, and process-based restoration. Pages 11-49 In Roni, P. and Beechie, T. (eds.) Stream and watershed Restoration: A Guide to Restoring Riverine Processes and Habitats. Wiley-Blackwell, Chichester, UK.
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- Lane, E.W., 1955. The importance of fluvial morphology in hydraulic engineering. *Proceedings American Society of Civil Engineers* 81(745): 1-17.
- Paulson, K. 1997. Estimating changes in sediment supply due to forest practices: a sediment budget approach applied to the Skagit River basin, Washington. MS Thesis, College of Forest Resources, University of Washington, Seattle, Washington.