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

From Beechie et al. 2013
Surface erosion

- Sheet wash
- Rilling
- Rain splash

From Beechie et al. 2013
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

From Cederholm and Reid 1987
Fine sediment and egg survival

From Jensen et al. 2009
Lane’s balance for bedload

- Sediment load
- Sediment size
- Degradation
- Stream slope
- Aggradation
- Stream discharge

Lane 1955
Increased sediment: pool filling

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

From Beechie et al. 2005
Increased sediment: aggradation

- Bed fining (spawning)
- Aggradation (rearing pools)
- Turbidity (feeding)
Increased sediment: channel widening

From Beechie et al. 2005
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

<table>
<thead>
<tr>
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<th>Mature forest</th>
<th>Clear-cut</th>
<th>Road</th>
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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

M. Madej, USFS photos
Road treatments

M. Madej, USFS photos
Road treatments

M. Madej, USFS photos
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


