Suspended sediment concentrations and turbidity responses from contemporary road crossings in the Trask river watershed

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Logging roads and forest harvest as sources of sediments in streams

• Timber harvest and fish (Titcomb 1926, Chapman 1962, Hall & Lantz 1969, many others)

• Logging roads produce the most sediments among forest management practices (Anderson 1971, Cederholm et al. 1981, Furniss et al. 1991)

http://www.ohs.org/education/oregonhistory/index.cfm

Swanson & Dyrness (1975)
New road constructions and old road updates
Contemporary forest practices
Questions

Do contemporary road crossings increase turbidity and suspended sediment concentrations (SSC) in headwater streams?

Does turbidity and SSC respond consistently in magnitude and timing across road crossings?
Within a reach of 100 m along headwater streams we expect minimal differences in SSC and turbidity.

\[ \sum \text{Turbidity or SSC}_B - \text{Turbidity or SSC}_A \approx 0 \]

Within a reach of 100 m downstream from a road crossing we expect differences in SSC and turbidity.

\[ \sum \text{Turbidity or SSC}_B - \text{Turbidity or SSC}_A \neq 0 \]
Study design
Sampling & timeline

- ISCO machines sampled ~400 ml at noon and midnight
  - turbidity (NTU)
  - suspended sediments concentration ≥ 1.5 μm (SSC; mg L⁻¹)
- hourly streamflow and daily precipitation

<table>
<thead>
<tr>
<th>PRE-road intervention</th>
<th>POST-road intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>old or non-existing road</td>
<td>road crossing</td>
</tr>
<tr>
<td>( n_{\text{per site}} = 68 - 100^\Omega )</td>
<td>road crossing + forest harvest + hauling</td>
</tr>
<tr>
<td></td>
<td>Jun 2012 - Mar 2013</td>
</tr>
</tbody>
</table>

\( \Omega = \) includes only pair-samples above/below road crossings
PH2

PH4

PH3

UM2 – 5.3 ha
re-surfaced (lift of rock) and re-constructed in 2007.

PH3 – reference road (36 ha)
pre-existing road with no intervention (no harvest).

UM2 – 10.5 ha
re-surfaced (lift of rock) within a harvest unit.

UM2 – 16.1 ha
rocked (within a harvest unit).

GUS3

Mar/2013
Feb/2012
Preliminary results

<table>
<thead>
<tr>
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<td>road crossing</td>
</tr>
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<td></td>
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</tr>
</tbody>
</table>
Range of turbidity and SSC across sites above road crossings

- Turbidity (NTU)
- SSC (mg/L)

Sites:
- GUS3
- PH2
- PH3
- PH4
- UM2
- GSMACK
- GSW502
- GSW508
- GSW509

5th percentile and 95th percentile indicated on chart.
Paired Wilcoxon signed rank test with continuity correction

PRE-intervention

POST-intervention

Turbidity or SSC

ABOVE

BELOW

10th

25th

75th

90th

median

outliers

mean

Paired Wilcoxon signed rank test with continuity correction

PRE-intervention

POST-intervention

Turbidity or SSC - ABOVE

Turbidity or SSC - BELOW

road crossing

(below)

above

***

Paired Wilcoxon signed rank test with continuity correction

PRE-intervention

POST-intervention

Turbidity or SSC - ABOVE

Turbidity or SSC - BELOW

road crossing

(below)

above
Turbidity and SSC show an overall coherent pattern across sites

<table>
<thead>
<tr>
<th>site</th>
<th>turbidity PRE was higher in ...</th>
<th>SSC PRE was higher in ...</th>
<th>turbidity POST was higher in ...</th>
<th>SSC POST was higher in ...</th>
<th>statistical consistency between turbidity and SSC pre/post</th>
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</thead>
<tbody>
<tr>
<td>GUS3</td>
<td>---</td>
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<td>road crossing</td>
<td>ns</td>
<td>/n</td>
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<tr>
<td>PH2</td>
<td>above</td>
<td>above</td>
<td>road crossing</td>
<td>road crossing</td>
<td>y/y</td>
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<tr>
<td>PH3</td>
<td>ns</td>
<td>ns</td>
<td>road crossing</td>
<td>road crossing</td>
<td>y/y</td>
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<tr>
<td>PH4</td>
<td>above</td>
<td>above</td>
<td>road crossing</td>
<td>ns</td>
<td>y/n</td>
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<tr>
<td>UM2</td>
<td>road crossing</td>
<td>road crossing</td>
<td>road crossing</td>
<td>road crossing</td>
<td>y/y</td>
</tr>
</tbody>
</table>

![Map of Trask Watershed Study Area with sites marked]
Turbidity and SSC may not be interchangeable

- road exports (SSC)
- reference exports (SSC)
- road exports (turbidity)
- reference exports (turbidity)
Take home messages

• There is an overall increase in turbidity and SSC below road crossings

• The timing of delivering and variability of climate may also play a role

• Turbidity and SSC do not respond analogously likely due to site-specific conditions (e.g., road compaction, traffic, erosion)
Future directions

• To include data from the forest harvest and hauling period
• Analysis of the spatial variability (and sources) of sediments within streams using storm events
• To identify the origin of sediments and their impacts downstream
Acknowledgements:

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**Additional database:** Peter James, Amy Simmons & Dave Hockman-Wert

**Discussions:** Tom Dunne & Brooke Penaluna

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SSC and turbidity above during two periods ■ and ○

<table>
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<tr>
<th></th>
<th>r²</th>
<th>slope</th>
<th></th>
<th>r²</th>
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<tr>
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<td>0.45</td>
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<td>26</td>
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<td>4.1</td>
<td>0.12</td>
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