Long-term Studies of Macroinvertebrate Responses to Harvest in Hinkle, Alsea and Trask watersheds

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## Differences between Study Watersheds

<table>
<thead>
<tr>
<th>Site Characteristics</th>
<th>Hinkle</th>
<th>Trask</th>
<th>Alsea</th>
</tr>
</thead>
<tbody>
<tr>
<td># invertebrate sites</td>
<td>24</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>WS area (sq. km) Geology</td>
<td>0.21—10.57 Basalt</td>
<td>0.26—6.68 Mixed</td>
<td>0.26—1.67 Sandstone</td>
</tr>
<tr>
<td>Elevation (m)</td>
<td>448—695</td>
<td>324—729</td>
<td>135—222</td>
</tr>
<tr>
<td>Percent slope</td>
<td>3.9—21.5</td>
<td>2.7—18.8</td>
<td>2.5—6.0</td>
</tr>
<tr>
<td>Avg. Annual precip (in)</td>
<td>81.1</td>
<td>121.7</td>
<td>84.8</td>
</tr>
<tr>
<td><strong>Aug</strong> avg daily max temp</td>
<td>27.5 °C</td>
<td>24.6 °C</td>
<td>25.0 °C</td>
</tr>
<tr>
<td><strong>Jan</strong> avg daily min temp</td>
<td>1.1 °C</td>
<td>0.4 °C</td>
<td>2.3 °C</td>
</tr>
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<td>Trask</td>
<td>Alsea</td>
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<td>WS area (sq. km)</td>
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<td>small TyeeSandstone</td>
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<td>Geology</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elevation (m)</td>
<td>Some sites steepest</td>
<td>Greatest range, highest</td>
<td>lowest</td>
</tr>
<tr>
<td>Percent slope</td>
<td>least</td>
<td>greatest</td>
<td>Least gradient</td>
</tr>
<tr>
<td>Avg. Annual precip (in)</td>
<td>27.5 °C warmest</td>
<td>24.6 °C cooler</td>
<td>25.0 °C</td>
</tr>
<tr>
<td>Jan avg daily min temp</td>
<td>1.1 °C</td>
<td>0.4 °C coldest</td>
<td>2.3 °C warmest</td>
</tr>
</tbody>
</table>
How do patterns of benthic invertebrates in these watersheds compare?

How will they respond to harvest?
Characteristics of Stream Invertebrates

1. High Variation in Densities & Composition
   Samples with many taxa

2. Variation in Life Histories
   Local Longevity v. Colonizers

3. Variation in Sensitivities
   Tolerant v.s. Sensitive
Using Diversity & Variation in Study Design

Evaluating:

**Abundance**  Densities, Biomass

**Composition**  Taxa at each site (Taxa richness)  Relative abundances of taxa

**Life Histories**  Emergence of adults

**Sensitivities**  Proportions of tolerant taxa (Chironomids)
WRC Sites Study Approach
Control, Unlogged v. Logged Sites
Before and After Harvest

Trask: 4 sub-basins
1 control/subasin
7 treated headwaters
4 mainstem

Hinkle: 7 North Fk control: 3 headwater + 1, 3 mainstem
10 South Fk treated: 4 headwater, (3 dwntm tribs), 6 mainstem
4 yrs after headwater harvest, 1 yr post-mainstem harvest

Alsea: 1 control tributary
1 upstream logged trib
2 yrs postharvest
Hinkle
Seasonal & Annual Variation in Benthic Densities

Benthic invertebrates per square meter (log scale)

Unlogged Hinkle headwaters

- Spring
- Summer
- Fall
Hinkle: Fish Diet

Aquatic prey are important in Spring & Fall
Terrestrial prey most of Summer diet
A Comparison of Spring Benthic Samples, Unlogged Sites

Distinctive Invertebrate Assemblages at Each Watershed

(NMS Ordination; each symbol = collection at one site)
Benthic densities at Hinkle headwaters were lower and more variable at Trask.
Among Non-Rare Invertebrates (≥ 1% at a Site) Few Found *In Common* at All 3 WRC watersheds

**Benthics:**
- 3 Mayflies
- 1 Stonefly
- 1 Chironomid tribe
- Oligochaete (worms)

**Emergent Adults:**
- 3 Mayflies
- 3 Caddisflies
Differences between *Headwaters and Mainstems* at Hinkle & Trask (preharvest):

Density, Percent Chironomidae & Taxa Composition

NMS Summer Trask 2006-10

- **Headwater**
- **Downstream**

Differences between Headwaters and Mainstems at Hinkle & Trask (preharvest):

Density, Percent Chironomidae & Taxa Composition

**Axis 1** ($R^2=0.428$) vs. **Axis 3** ($R^2=0.209$)

- Tanypodinae
- Ostracoda
- Yoraperla
- Malenka, Epeorus, Rhyacophila
- Cinygmula
- Baetis
Assessing Effects of Harvesting in Hinkle Creek

2005 in Tributaries
- North Fork: 4 Control reaches
- South Fork: 4 Headwaters harvested

2008 Harvest in Mainstem
- North Fork: 3 Control reaches
- South Fork: 6 Harvested reaches
Hinkle: Effects of Harvest on Taxa Composition

Axis 1

Axis 3

harvest
harvested
not harvested
Invertebrate Response in Hinkle Headwaters: Densities Increased

Preharvest: No difference

Benthic invertebrates per square meter

2004 2005 2006 2007 2008 2009

control

treatment
Invertebrate Response in Hinkle Headwaters:
Percent Chironomids Increased, Taxa Richness Decreased
Hinkle Tributaries with Fish:
No downstream effects on invertebrates after harvest in headwaters

Benthic densities (in this graph), percent chironomids and taxa richness did not differ significantly from controls.
Hinkle Mainstem Invertebrate Responses: Percent Chironomids Increased

Benthic percent chironomids

2004 2005 2006 2007 2008 2009

control treatment

Taxa Richness Decreased

Benthic taxa richness

2004 2005 2006 2007 2008 2009

control treatment
Fish at Hinkle Mainstem:
Diet responded to Increase in chironomids

![Graph showing the relationship between benthic percent chironomids and fish gut content percent chironomids over the years 2004 to 2009. The graph indicates that the diet of fish at Hinkle Mainstem responded to an increase in chironomids following headwater logging and dam-break floods.](image-url)
Mainstem Responses:
Benthic Densities DID NOT Increase

Benthic invertebrates per square meter

- control
- treatment

headwater logging

MS logging and dam-break flood
South Fork Hinkle: No Detected Change in Benthic Density
May be Explained by Increase in Fish Biomass

![Graph showing benthic invertebrate density and fish biomass over time.](image)
Invertebrate Mainstem Responses: Adult Aquatic Emergence Increased

Aquatic insect emergence rate number/square meter/day

2005 2006 2007 2008 2009

headwater logging
MS logging and dam-break flood

control

- headwater logging
- MS logging and dam-break flood
Hinkle & Alsea Aquatic Emergence 2009

Higher Emergence at Logged Sites

Individuals/m²/day

Hinkle Unlogged  Hinkle Logged  Flynn  Needle Branch
Alsea: Few detectable differences postharvest at Needlebranch
High variation between sites, fewer replicates
Alsea: Cutthroat diet after harvest

Average fish diet composition

- **Flynn**
  - 2007 - 2009
  - 2010 - 2011

- **NB**
  - 2007 - 2009
  - 2010 - 2011

- **Unknown**
- **Terrestrial**
- **Adult Aquatic**
- **Aquatic**
Trask: Seasonal & Annual Variation in Emergence Detecting Changes in Life Histories

Emergence of Aquatic Insects Trask 2008-2010

Individuals/m²/day

2008

2009

2010
**Trask: Measuring Benthic Biomass Contributions to Stream Productivity**

Trask Biomass 2009-2011

- **April**: Headwater = 0.8, Downstream = 1.0
- **June**: Headwater = 0.8, Downstream = 0.9
- **Aug/Sept**: Headwater = 0.5, Downstream = 0.5

**Measuring Benthic Biomass Contributions to Stream Productivity**
WRC Sites Study Designs:  
*Key to Detecting Differences*

**Hinkle:** High replication in space & time  
Significant differences adjacent to harvest  
Coordinated sampling suggest connections to fish consumption

**Alsea:** limited samples  
More years,  
WRC context important

**Trask:** Controls within sub-basin  
Expanded measurements  
life histories, productivity
Thanks to many

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Alsea Watershed

Preharvest study: 2007-2009
Small tributaries with fish

Flynn Creek
3 reaches no harvest

Needlebranch
3 reaches
Harvest in 2009 upstream of study reaches
Upper Trask Watershed

4 Subbasins, 3 ownerships
2006-2011 Preharvest Sampling

Harvest 2012 in modified plan

11 Headwater 4 Mainstem Reaches