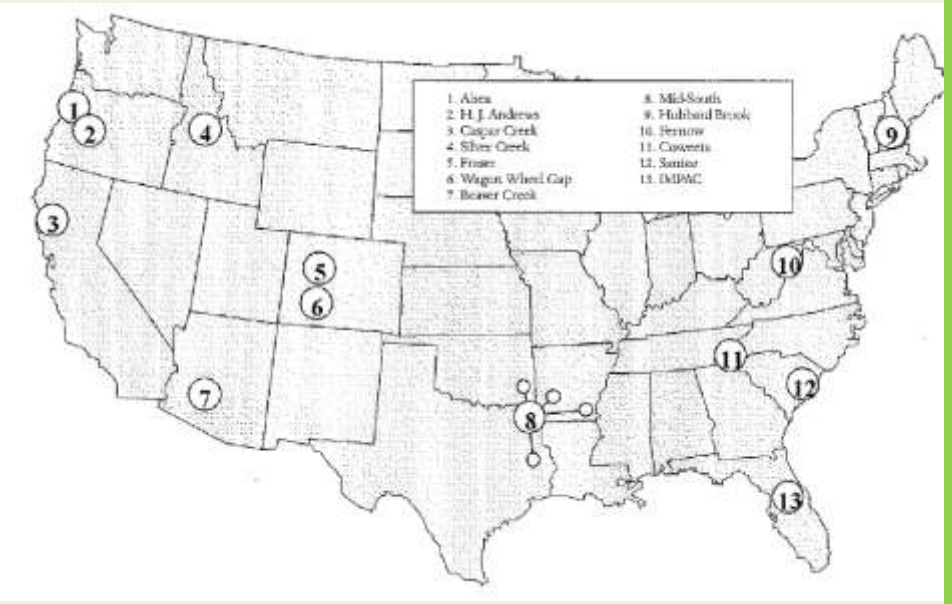
WRC Paired Watershed Studies Overview

Examining the Effects of Contemporary Forest Practices on Aquatic Ecosystems at Multiple Scales

Photo by Kelly James

Liz Dent, ODF Deputy Division Chief, State Forests
Maryanne Reiter, Hydrologist, Weyerhaeuser NR Co.
Presented at WRC Policy Workshop, November 13,2013

Oregon is Not Alone and Watershed Studies are Not New



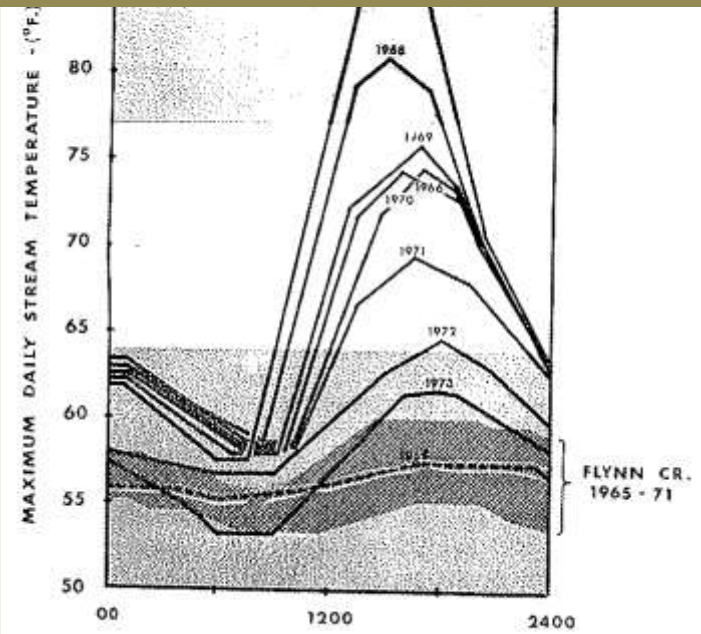
From Ice and Stednick 2004

- Ice and Stednick (2004, *Forest History Today*) chronicle contributions of Paired Watershed Studies
- 13 studies through United States: Wagon Wheel Gap 1910
  - Improved understanding of hydrology
  - Forest management affects on hydrology
  - Establishment and refinement of BMPS to protect watershed functions.

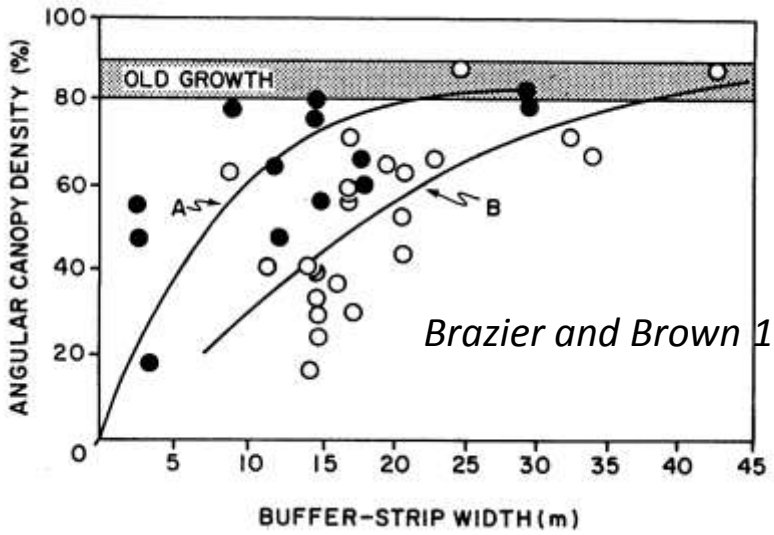
WRC Workshop

Cornerstone Findings and Policy Changes

- Temperatures increase without stream buffers: Leave trees around streams
- Dissolved oxygen decreases with excessive slash accumulation: Keep slash out of streams
- Roads major sources of sediment: BMPs to reduce sediment delivery from roads



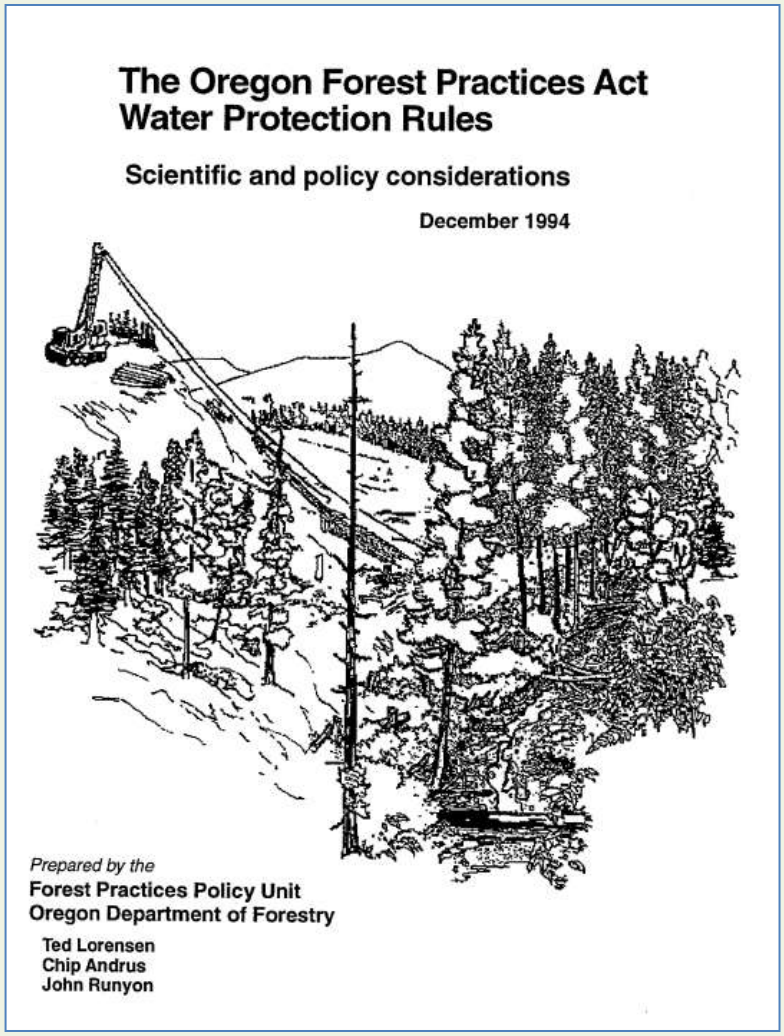
Brown and Krygier 1967



Brazier and Brown 1973

WRC Workshop Science and Policy

- ✓ Studies designed to inform policy decisions
- ✓ Scientific findings are becoming available
- ✓ Need to make sure that findings are making their way to the policy dialogue
- ✓ Need to make sure the science is being framed in a way that supports the policy process



The Oregon Forest Practices Act
Water Protection Rules

Scientific and policy considerations

December 1994

Prepared by the
Forest Practices Policy Unit
Oregon Department of Forestry

Ted Lorensen
Chip Andrus
John Runyon

Background

Why watershed studies are important

- Linking forest management to a range of aquatic responses.
- Further knowledge of ecosystem processes in the context of working forests.

WRC Background

Linking small headwater stream to downstream responses

What are the effects of forest harvest on small streams?
If changes are observed are they also observed downstream?

WRC Background

Linking physical to biological responses

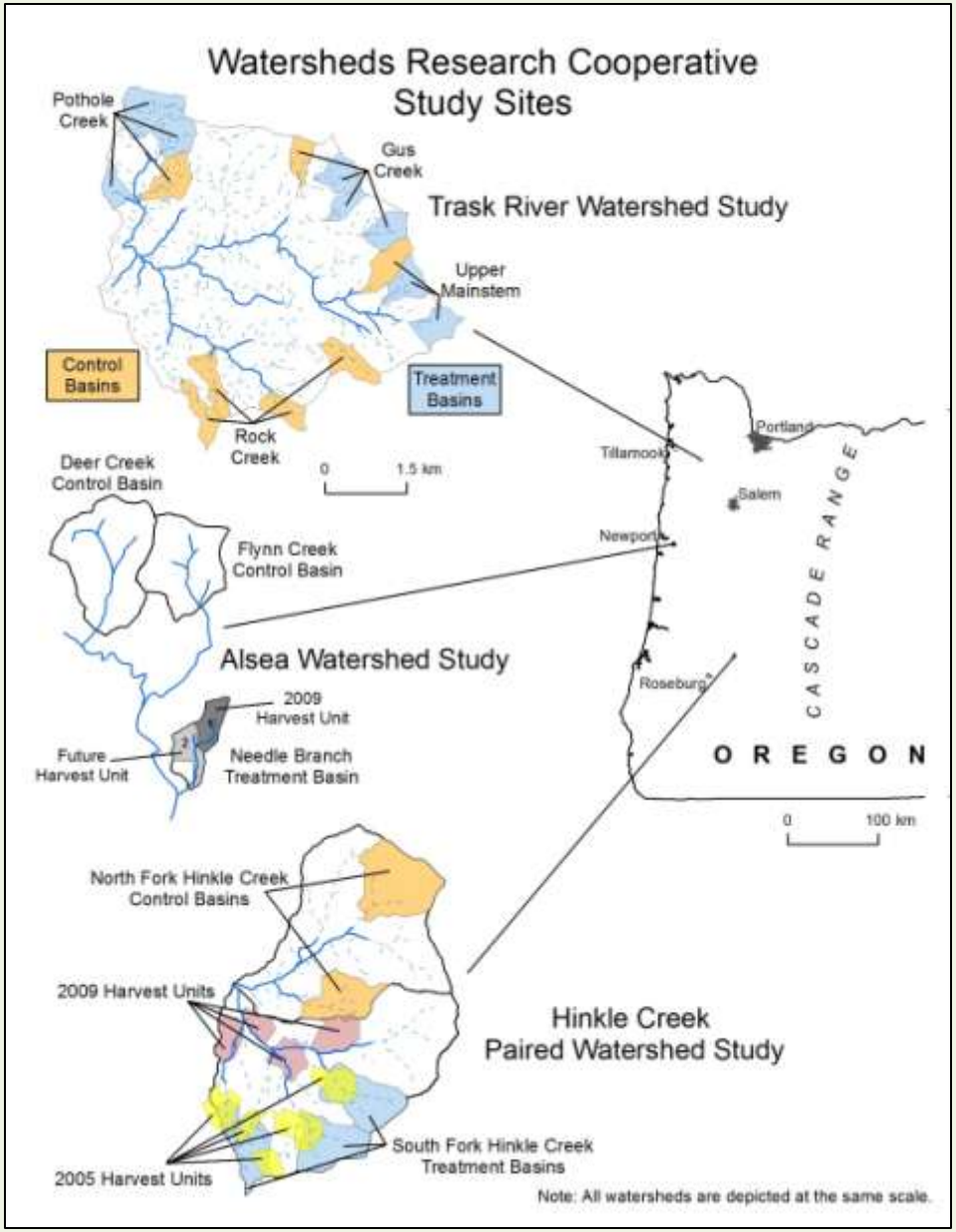
If there are changes in the physical or chemical characteristics of the stream- what does that mean for the biology?

Background

Oregon Watersheds Research Cooperative

Goal: Quantify effects of contemporary forest practices on the physical, chemical and biological characteristics of streams at multiple spatial scales.

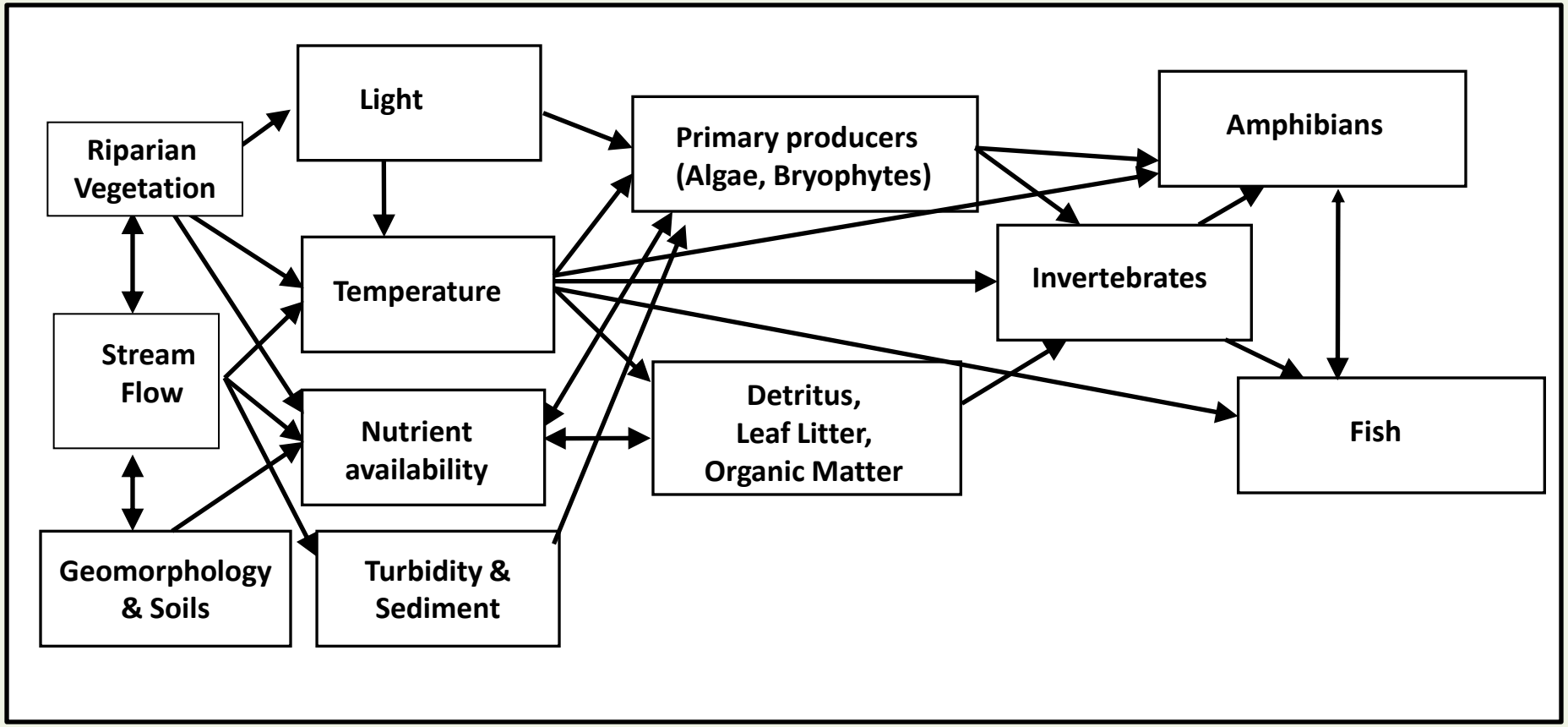
Approach: Cooperative, multi-disciplinary and long-term.



Background

Conceptual Model of Linkages

"Simple" connections within the forested aquatic ecosystems.
Basis for predicting system responses to forest management.



Hinkle Creek

Hinkle Creek Study

Hinkle Creek

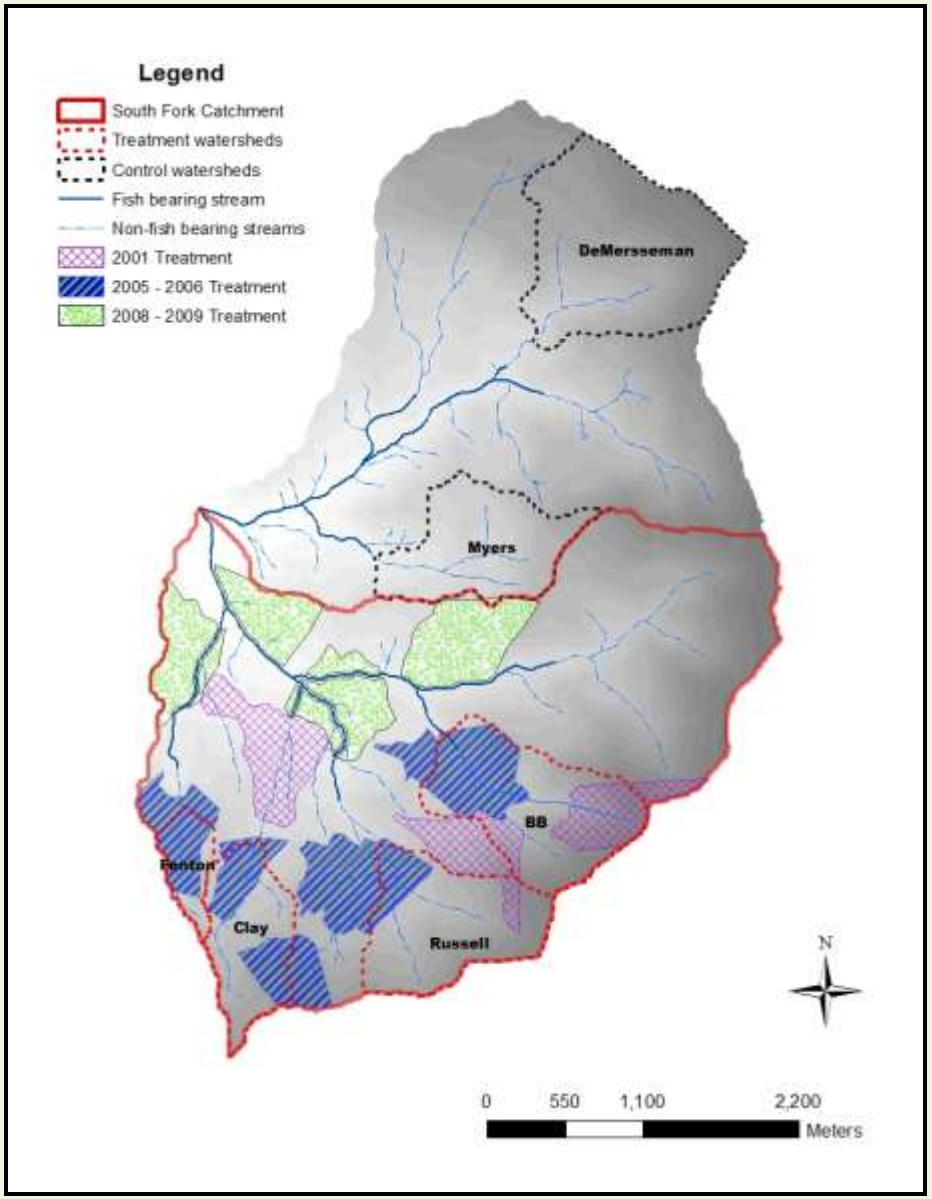
Watershed Study Design

Design: Nested, Paired
Watershed area: 4796 acres
Control watershed: 2117 acres
Treatment watershed: 2679 acres

Treatments: First harvest: 5 clearcuts adjacent to non-fish bearing streams (2005).

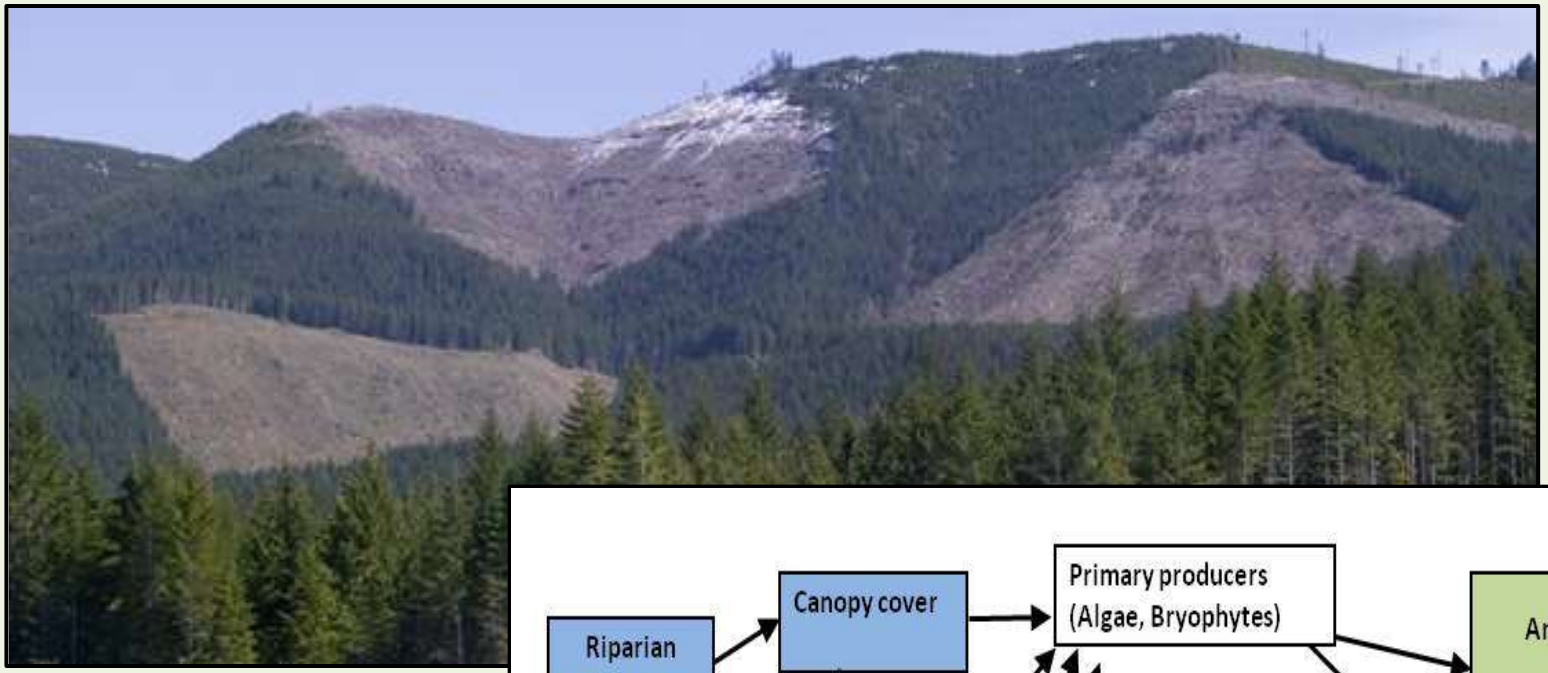
Second harvest: 4 clearcuts adjacent tributary and mainstem fish bearing streams (2008).

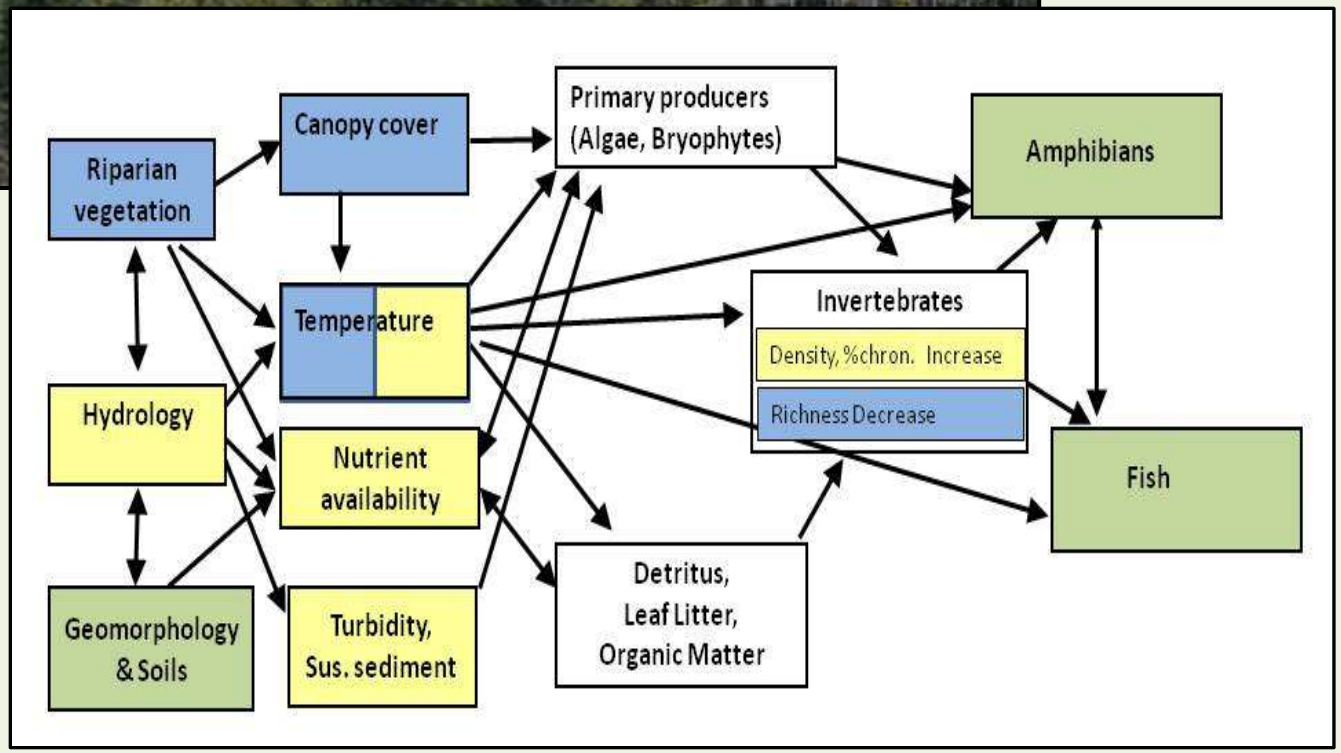
Status: Study ran from 2001-2011



Hinkle Creek

First Harvest in Small, Headwater Streams

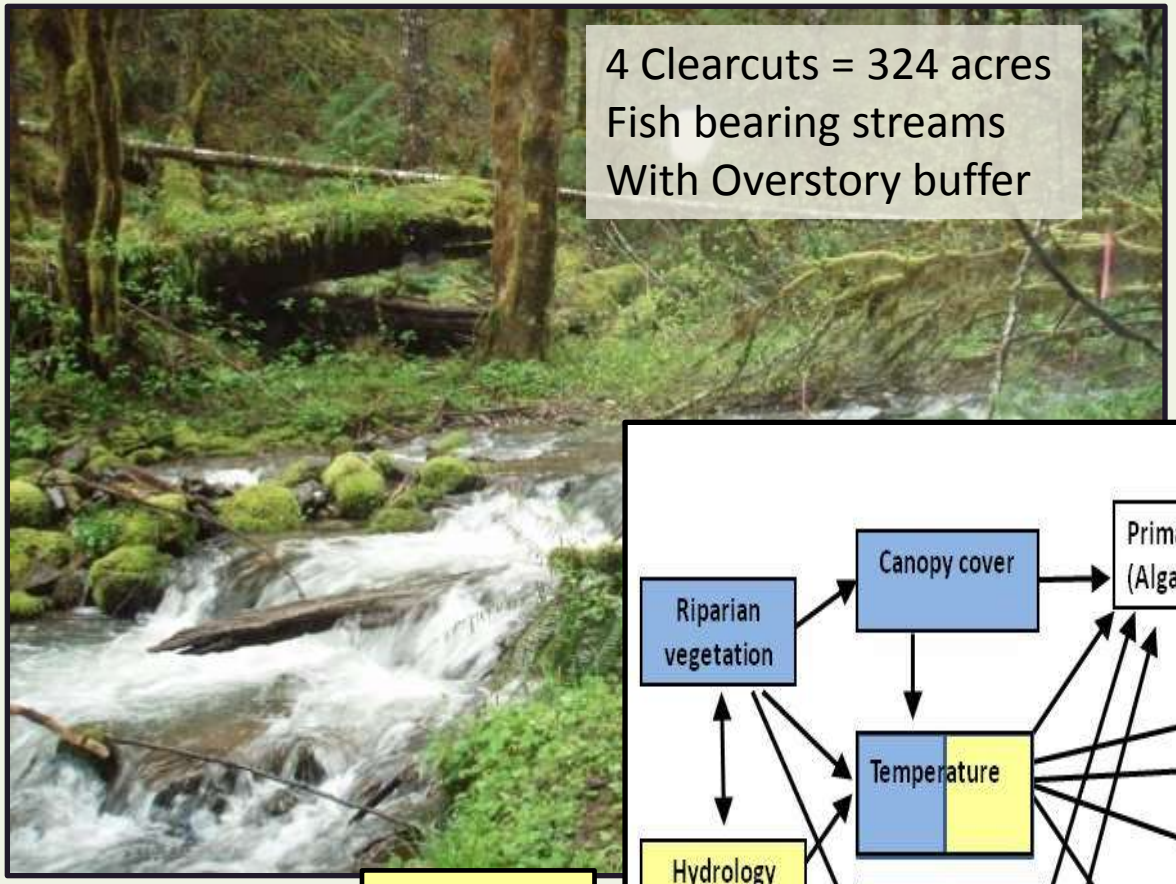


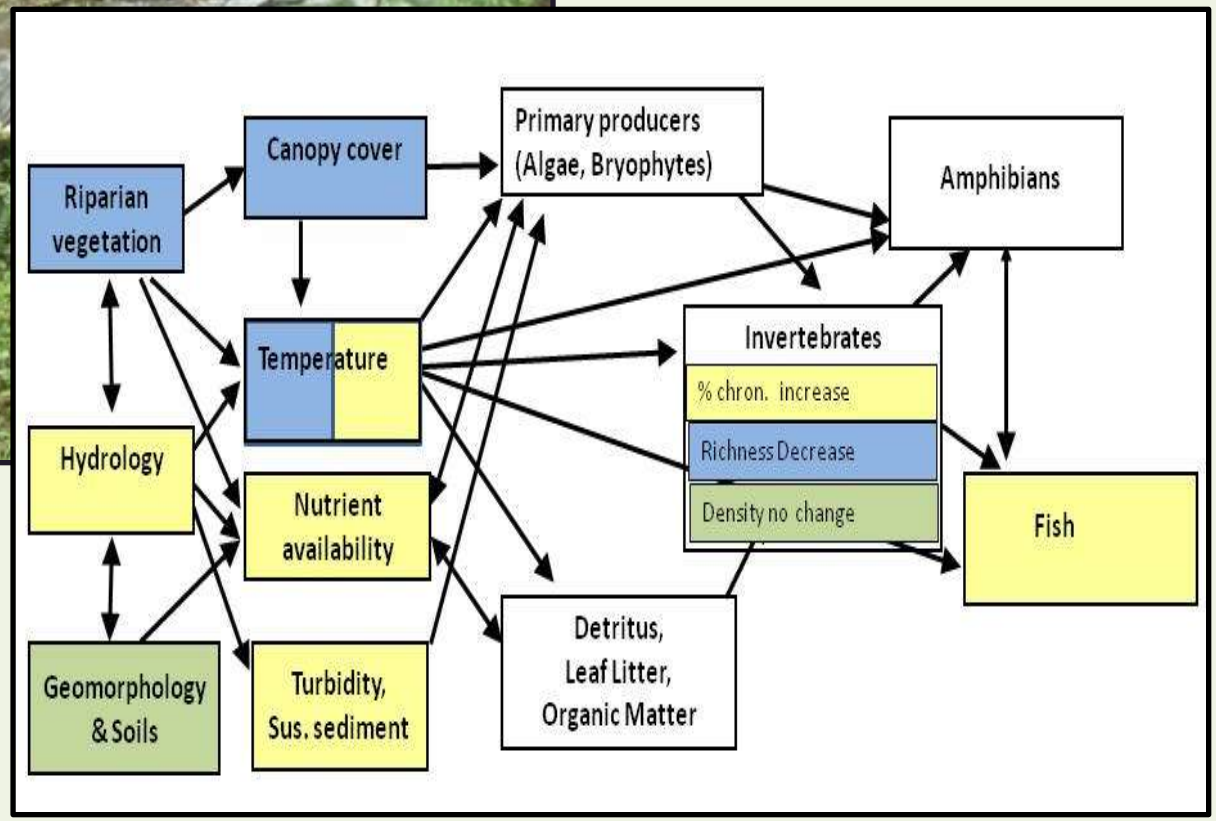


Increase
Decrease
No change
Didn't measure

Hinkle Creek

Second Harvest Along Fish-Bearing Streams





Increase

Decrease

No change

Didn't measure

Alsea Revisited

Alsea Watershed Study: Then and Now

Alsea Watershed Study (1966):

- Entire watershed harvested
- Burned with no stream buffers.

Current forest practice rules:

- Minimize clearcut to 120 acres
- Buffers on fish-bearing streams
- Prohibit excessive slash in streams.

Alsea Revisited Hydrology Response to Harvest

Hydrology 1966

- Increases in low flows
- Small increases in peak flows

Hydrology 2009

- Increase during transition months

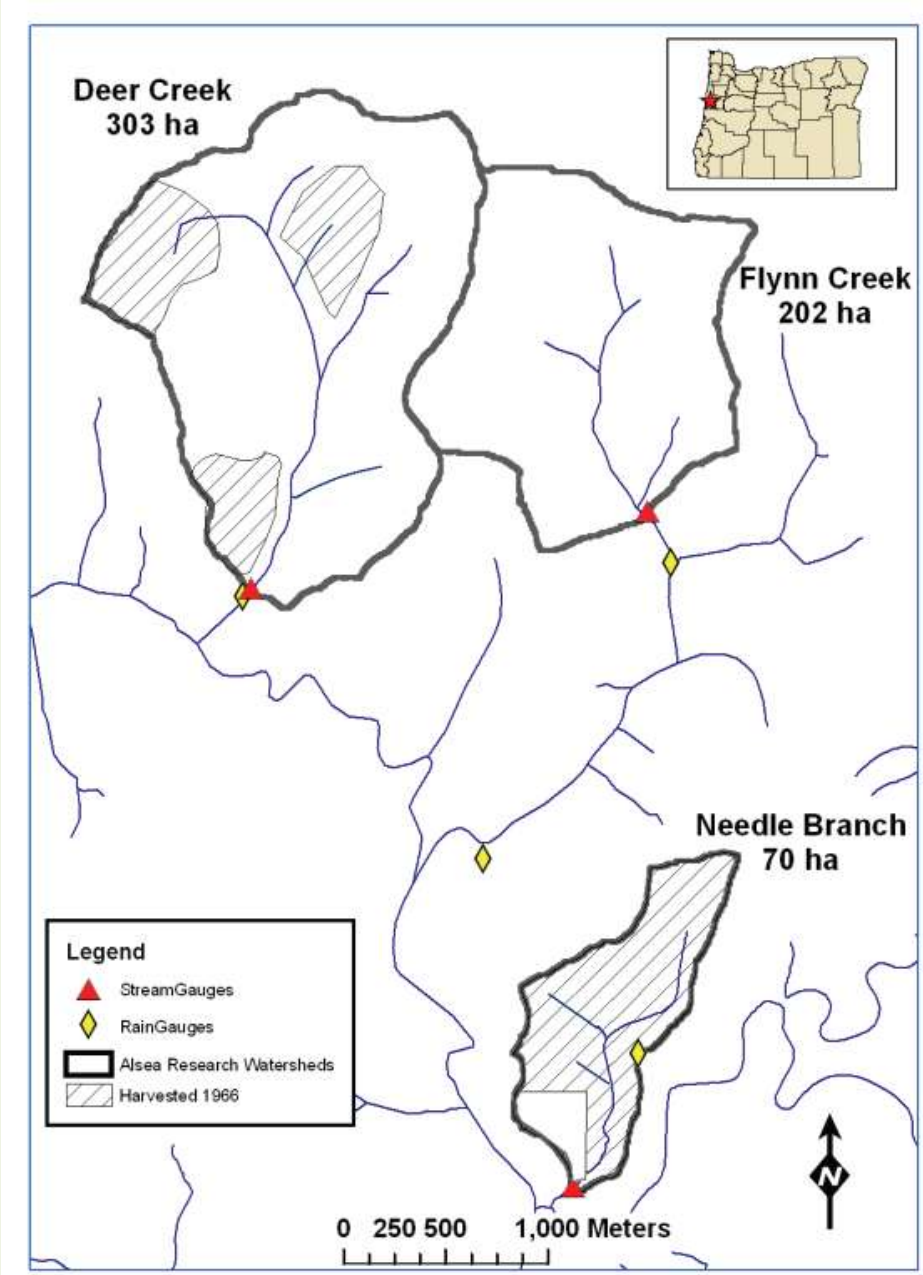
Alsea Revisited Sediment Response to Harvest

1966

- Sediment increased (hot prescribed fire and channel disturbance)

2009

- Preliminary results indicate no major increases in sediment



Alsea Revisited

Stream Temperature Response to Harvest

Temperature 1966

- Increased >10 deg C

Temperature 2009

- Increased < 1.0 deg C in the buffered and un-buffered portion

Dissolved Oxygen Response to Harvest

Dissolved Oxygen 1966

- Decreases in DO concentrations

Dissolved Oxygen 2009

- Little to no change in DO

Fish Response to Harvest

Fish 1966

- Long-term depression of cutthroat trout population

Fish 2009

- Increased cutthroat trout biomass and abundance post harvest

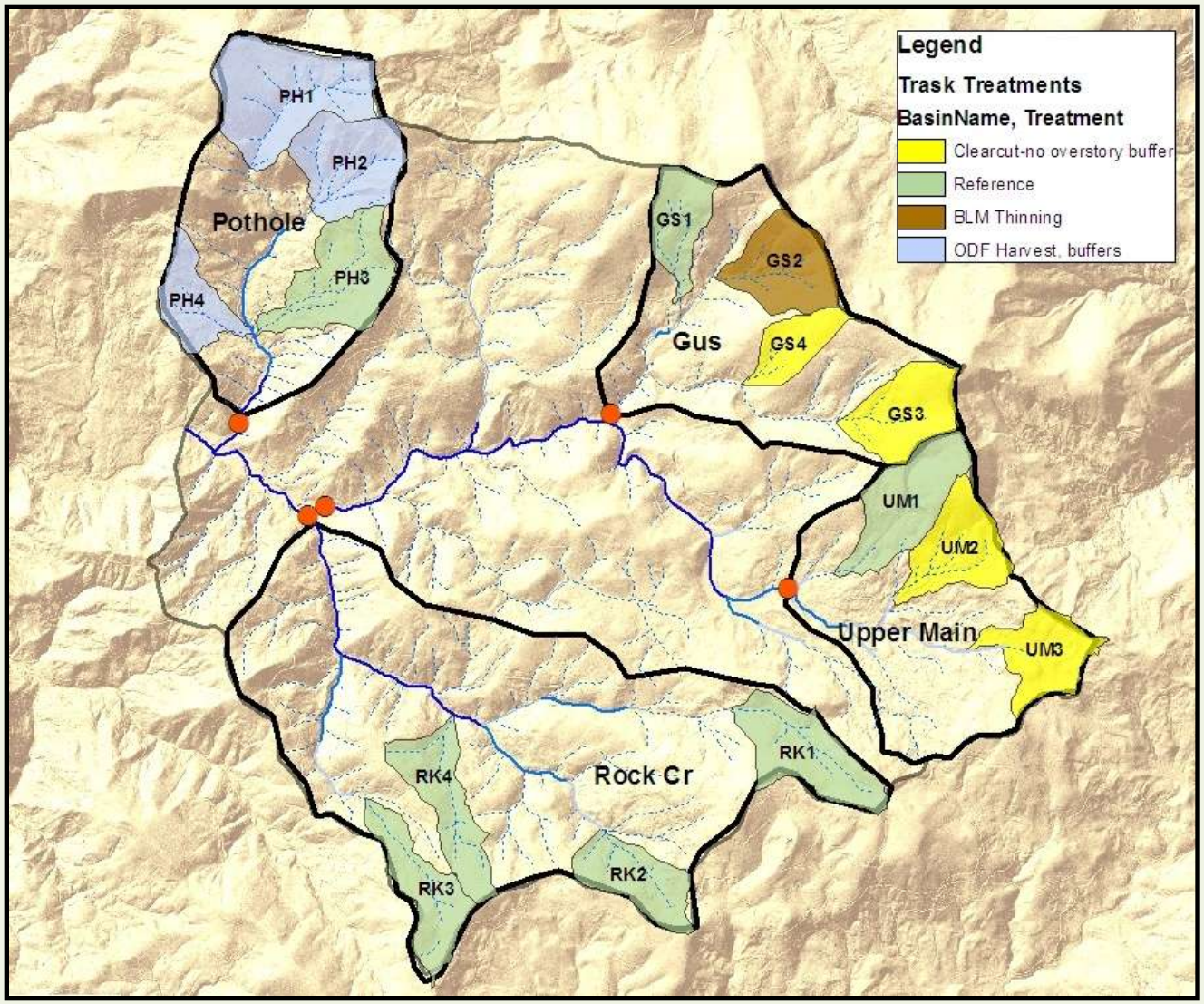
Trask River

Trask Watershed Study Introduction

- The 6500 acres
- Headwaters of the Trask River
- West side of Oregon Coast Range Crest

Mostly State and Private ownership with some Federal lands
Numerous cooperators

Trask Study Design



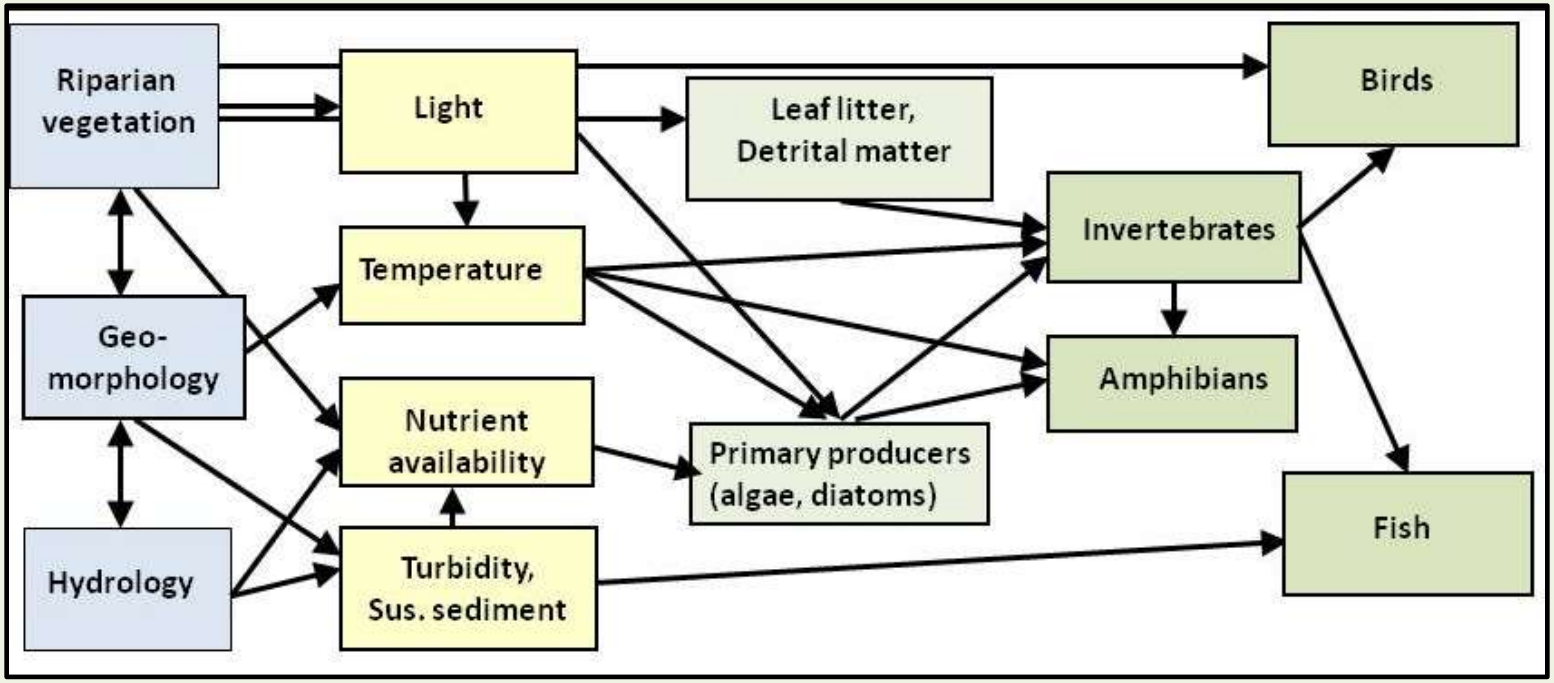
Nested design : local and downstream sites

Size: 6500 acres
Treatment: Small headwater catchments (average of 93 acres)

Extensive pre- and post-harvest study:
4+ years of pre-harvest and 4 year post-harvest data collection.

Trask River

Conceptual Model of Linkages



- Effects of forest harvest on the physical, chemical and biological characteristics of small headwater streams
- Extent to which harvest influences the physical, chemical and biological characteristics in downstream fish reaches.
- Increase understanding of major processes that influence aquatic ecosystems through forest-stream interactions.

Trask River

Study Timeline

2006-11
Baseline data collection

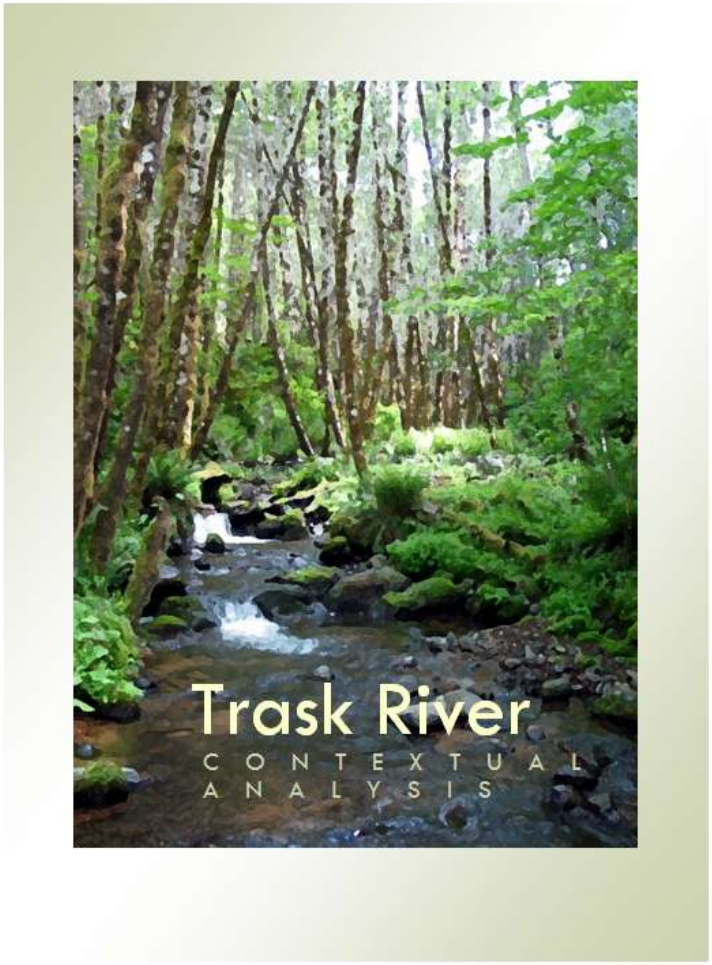
2011
Road upgrades

2012
Headwater harvest in 8 basins

2012-16
Post-treatment data collection

Understanding The Landscape

- Landscape key to understanding pattern and process,
- Physical and biological context as an early phase of research

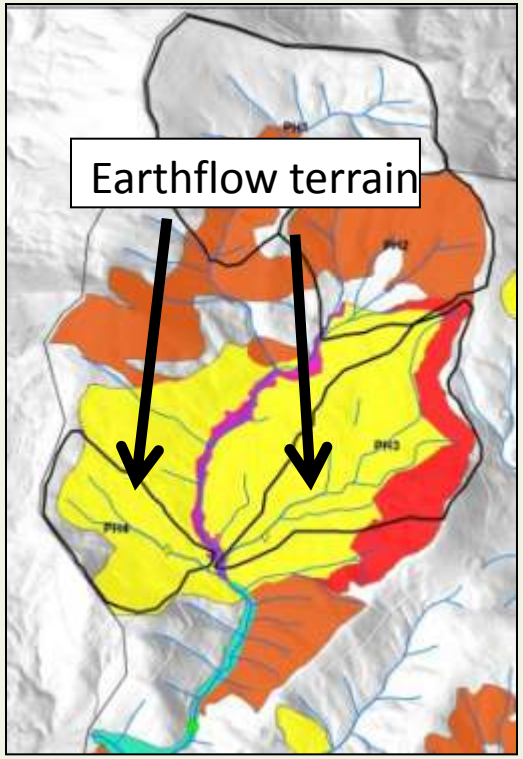


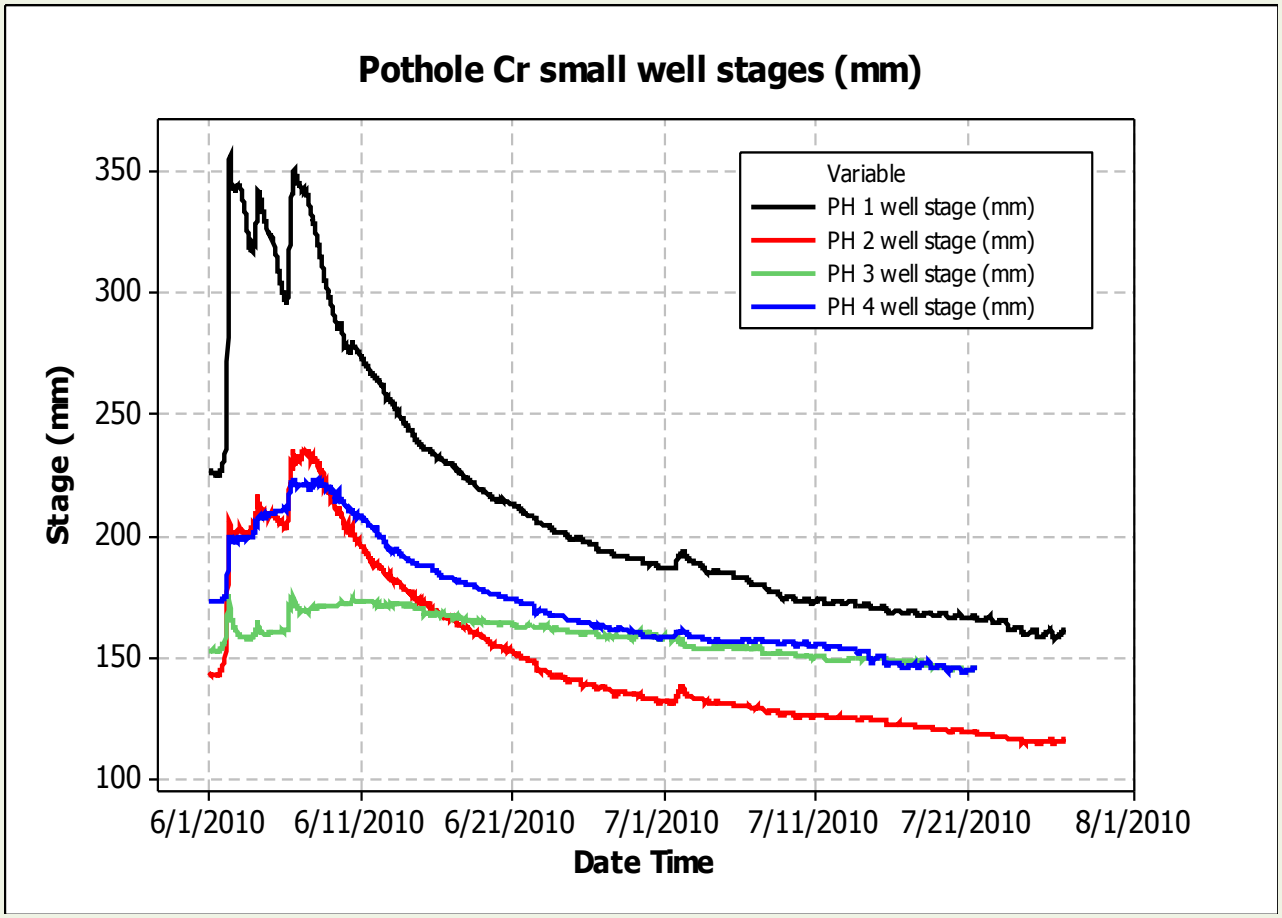
- *Trask Landscape Setting*
- *Physical Setting*
- *Fire History and Vegetation*
- *Recent Management*
- *The Aquatic Environment*

Tillamook Burn, burned and cut - Oreg. State Univ. Archives, Agr. Exp. Sta. Photo. Collec., Wildfire Risk Explorer, P029:Acc 87:6

Trask River

Low Flow Hydrology





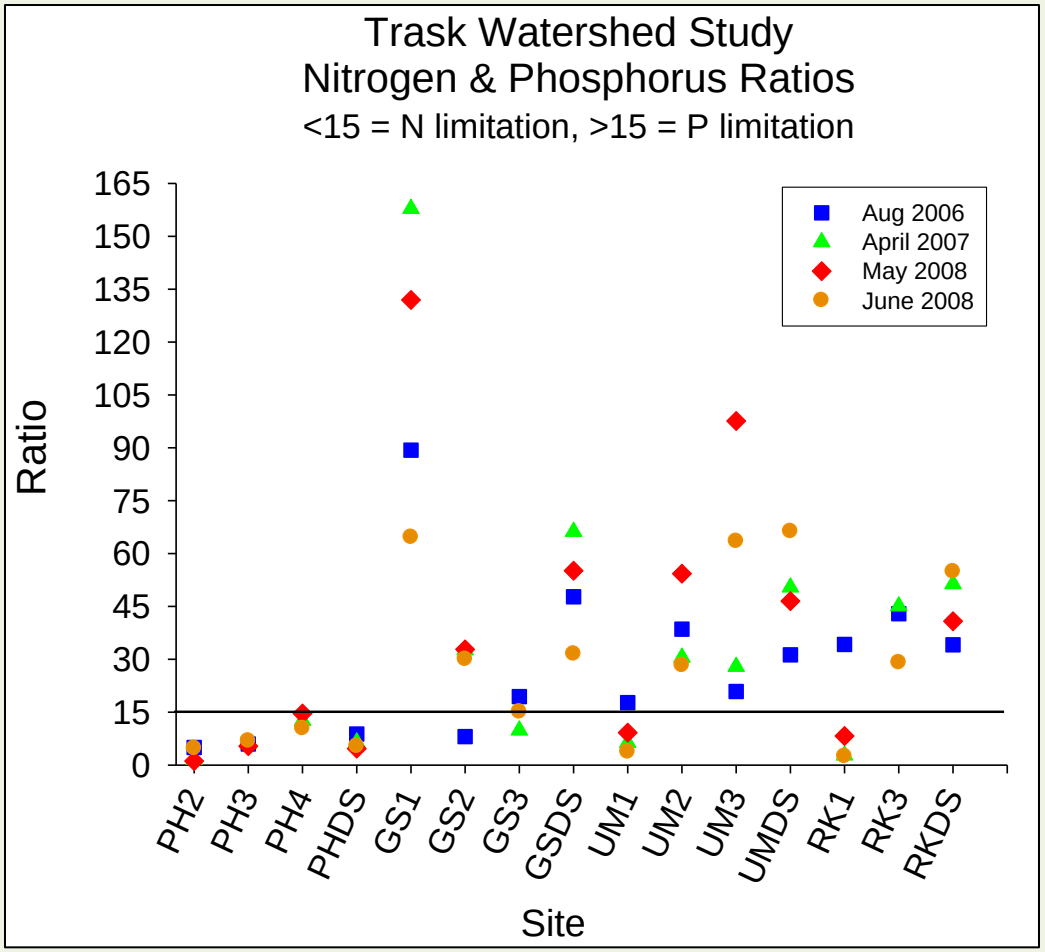
The small watersheds with more earthflow terrain:

- Less responsive to rainfall
- Moderated drop in summer flow.

Trask River

Water Chemistry

- N:P ratios indicate biological activity
- Most sites Phosphorus limited
- Pothole cluster is Nitrogen limited
- Some sites (example: Gus1) highly variable over time while some are more consistent
- Will pattern change after harvest and how does it affect aquatic biota?



Amphibian Abundance and Movement

Initial Results

- Tailed frog larvae:
  - Greater downstream movement than Pacific Giant Salamanders
- Tailed frog abundance:
  - Increases in a downstream direction
  - Higher abundance below downstream boundary of treatment areas (prior to harvest)
- Downstream sites:
  - Maintain mass during advanced development stages better than headwater sites

Trask River Linking Physical and Biological Responses: Fish

- Fish Growth: Fastest for small salmon and trout, and minimal for larger coastal cutthroat trout.

- Movement: Restricted for coastal cutthroat trout.

- Overlap between seasonal patterns of diet and food limitation for salmonids and sculpins.

Trask River

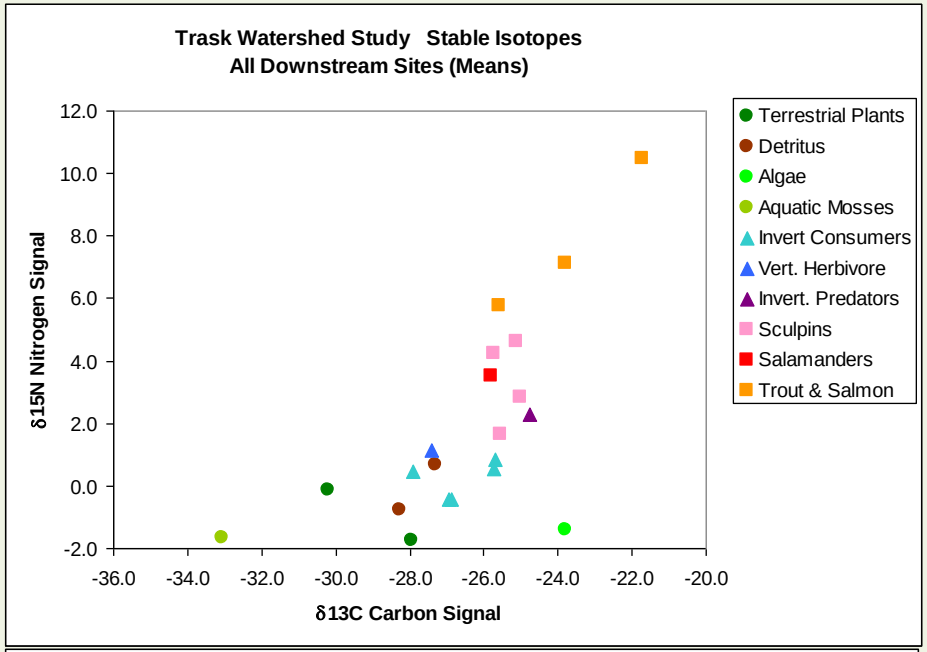
Trask Food Web

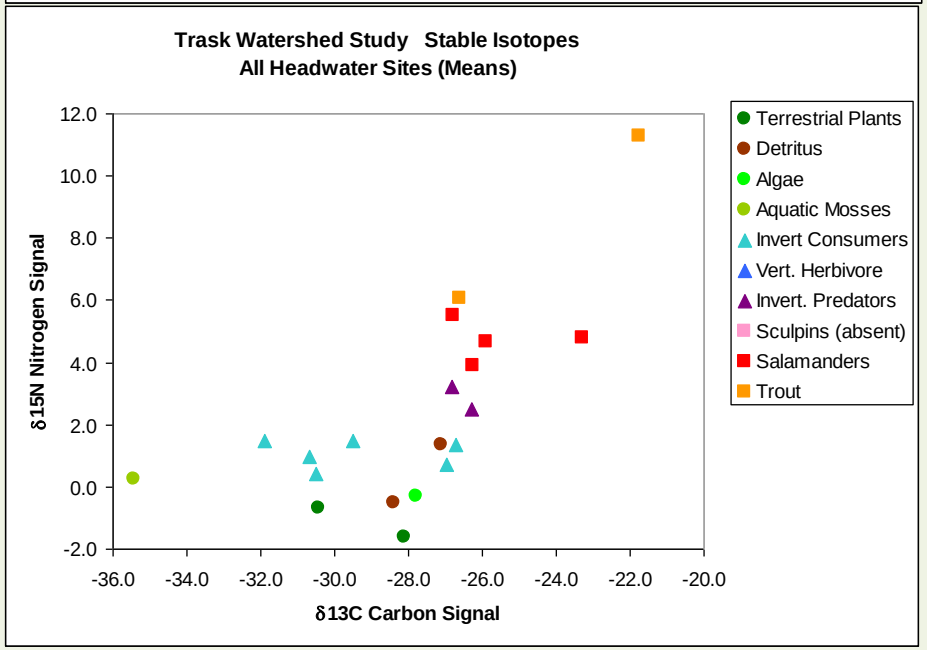
Stable isotopes: Connections between elements of the food web

Nitrogen: Relative position

Carbon: Energy source

Will forest management shift this balance?





Summary

Contemporary Forest Watershed Studies

Hinkle Creek

- Designed Contemporary forest practices resulted in detectable changes (both increases and decreases).
- Changes were often difficult to detect and were within observed variability of watershed.

Alsea

- Magnitude of changes far less than earlier forest practices.

Trask Watershed Study

- Builds on previous studies
- Designed to measure differences in patterns and processes underlying those patterns
- Understanding process allow inferences to other settings
- Managed forests within ecosystem context

Summary: Science Findings and Policy Decisions

- Oregon has a long history of research informing forest policy and management
- Important that we continue to ask the hard questions
- Use scientific methods to provide insights
- How do science findings help inform your policy decisions?

WRC Overview: Questions?

The aim of science is not to open the door to infinite wisdom, but to set a limit to infinite error.

Bertolt Brecht