The Trask River Watershed Study

Responses of Aquatic Ecosystems to Contemporary Forest Management

Photo by Kelly James

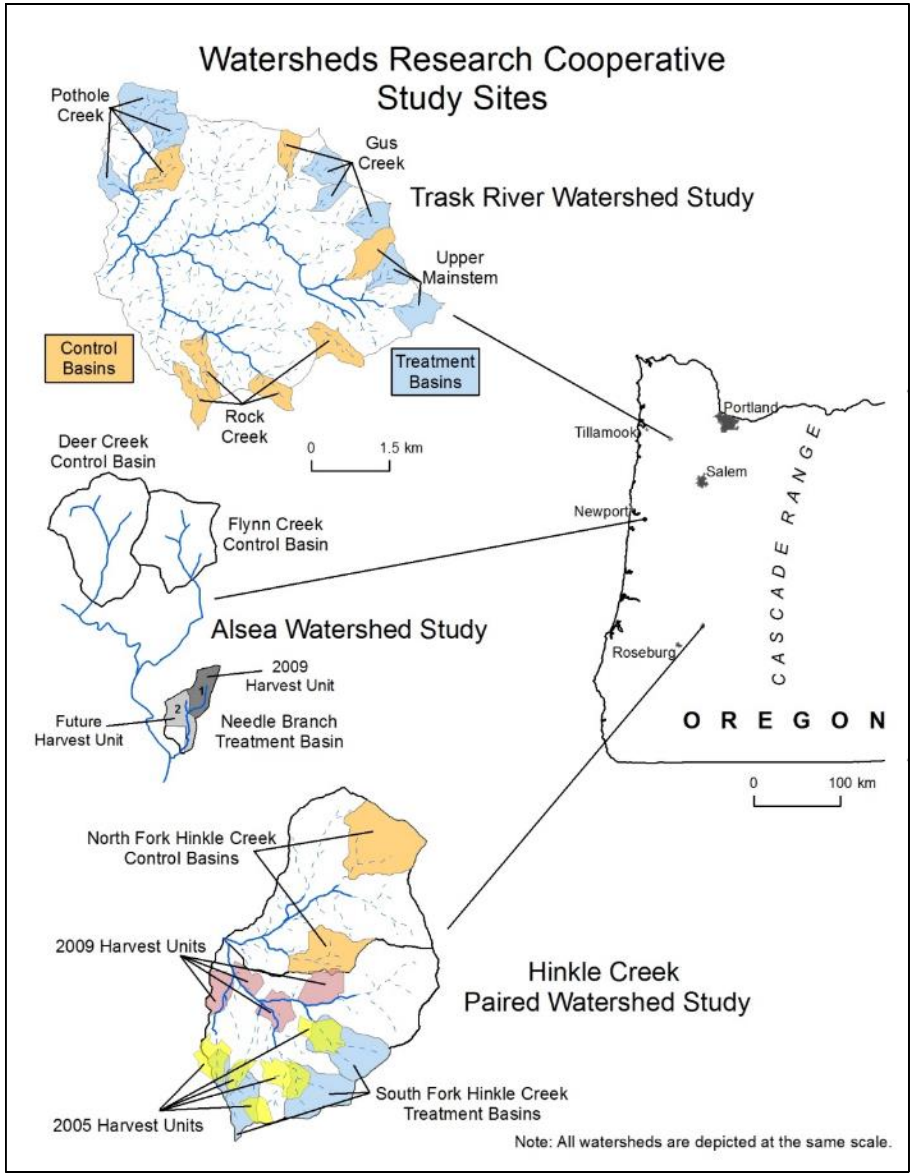
Trask River Watershed Study	Watershed Research Cooperative

Coop established in 2006 by OSU College of Forestry

Agency, industry and academic organizations participated

Goal: Quantify effects of current OR forest practices on streams

Approach: Watershed-scale experimental studies; cooperative, multi-disciplinary and long-term (decade).



Trask River Watershed Study

Funding/Research Team

- Collaborative effort-involved scientists from multiple organizations; state, federal, private

- Funding from multiple sources
  - Base funding: ODF, Weyerhaeuser
  - Infrastructure funding – OWEB
  - Fish, amphibians, birds – USGS
  - Other support – counties, OSU, USFS, BLM, NCASI

Dr. Sherri Johnson, *PNW Research, USFS*
Dr. Bob Bilby, *Weyerhaeuser Company*
Liz Dent, *Oregon Dept. of Forestry*
Dr. Jason Dunham, *USGS FRESC*
Dr. Michael Adams, *USGS FRESC*
Dr. Arne Skaugset, *OSU College of Forestry*
Maryanne Reiter, *Weyerhaeuser Company*
Dr. Judy Li, *OSU Fisheries and Wildlife*
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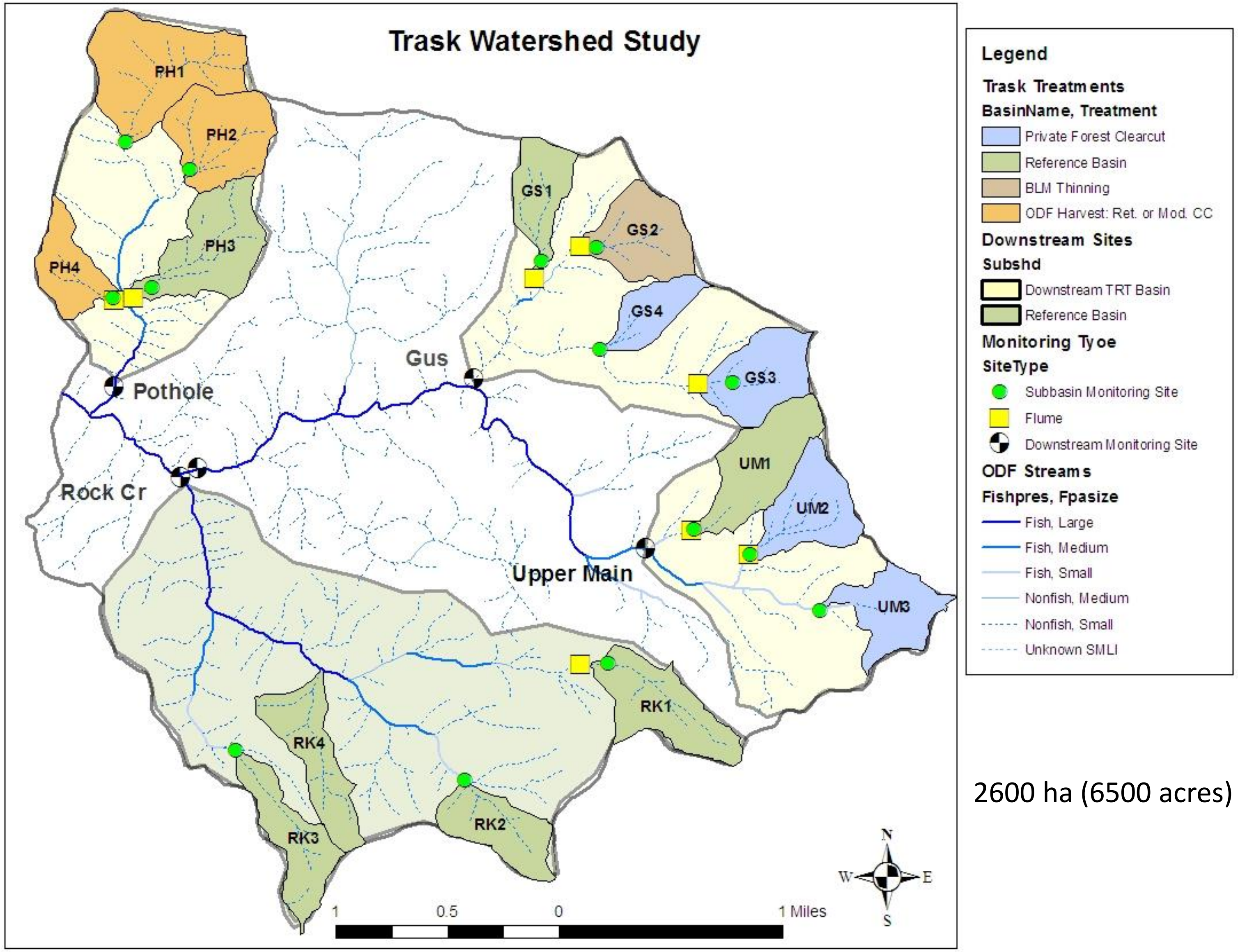
Dr. Alba Argerich, *OSU College of Forestry*
Dr. Mark Meleason, *Oregon Dept. of Forestry*

Trask River Watershed Study | Study Design

Objectives

- Quantify effects of forest harvest on the physical, chemical and biological characteristics of small, headwater streams

- Examine extent to which harvest in headwaters influences the physical, chemical and biological characteristics in downstream fish-bearing reaches



2600 ha (6500 acres)

Trask River Watershed Study | Treatment Types

Treatment Types

- Private Lands – clear-cut with no buffer (leave trees at some sites)
- State Lands – modified clear-cut or retention cut with 25ft buffers
- BLM Lands – thinning with 50ft buffers

Trask River Watershed Study Timeline

2006-11
Baseline
data collection

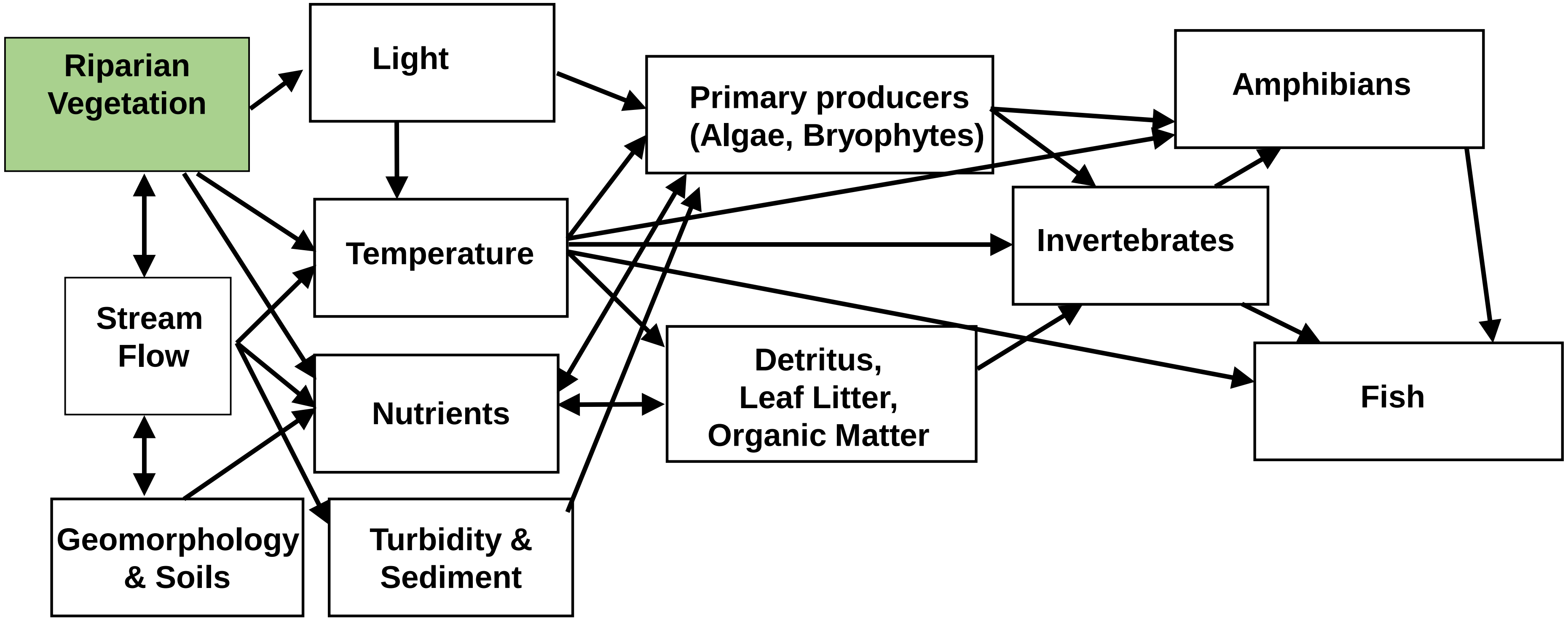
2011
Road
upgrades

2012
Headwater
harvest in
8 basins

2013-16
Post-treatment
data collection

Trask River Watershed Study

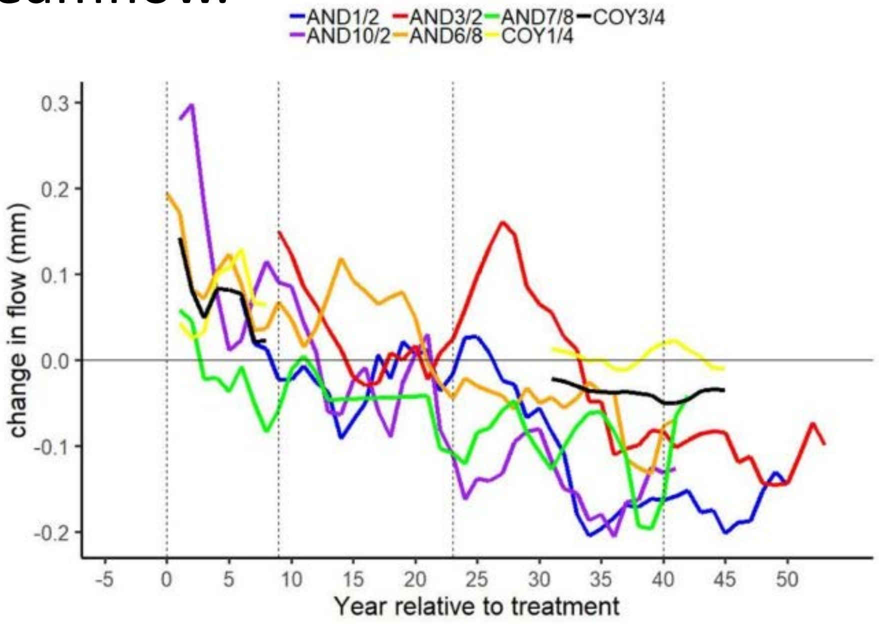
Study compartments and linkages



Streamflow

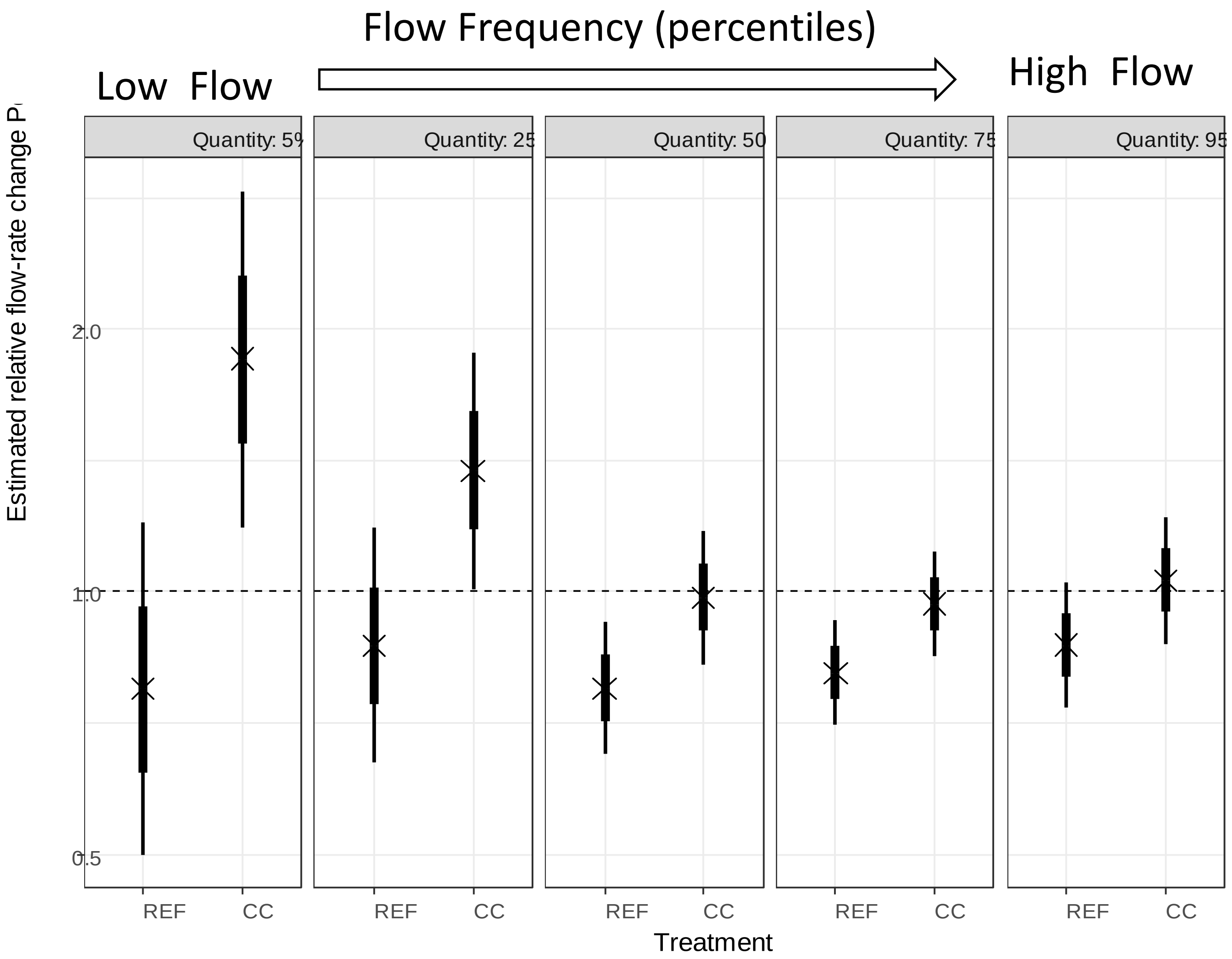
Initially after harvest, multiple studies have show that stream flows increase.

And with forest regrowth, there can be later periods of decreased late summer streamflow.



Trask River Watershed Study

Flow

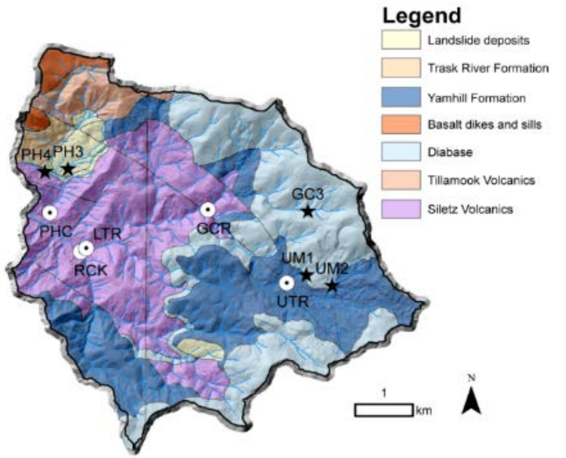


During first 4 years after harvest:

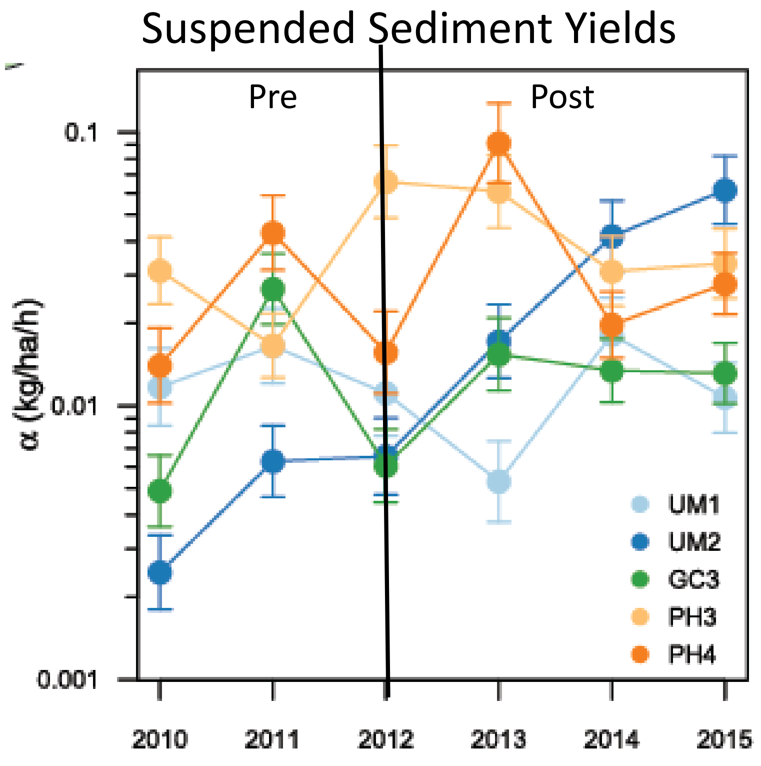
- Flow at reference sites decreased – dry years
- Low flow at harvested sites increased ; little change at higher flows

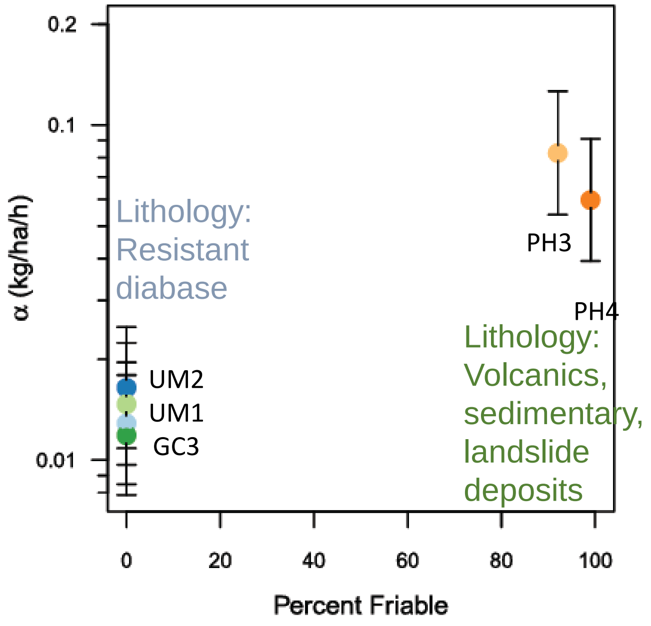
Trask River Watershed Study

Suspended sediment yields



Variability in geology dominates background levels of sediment yields



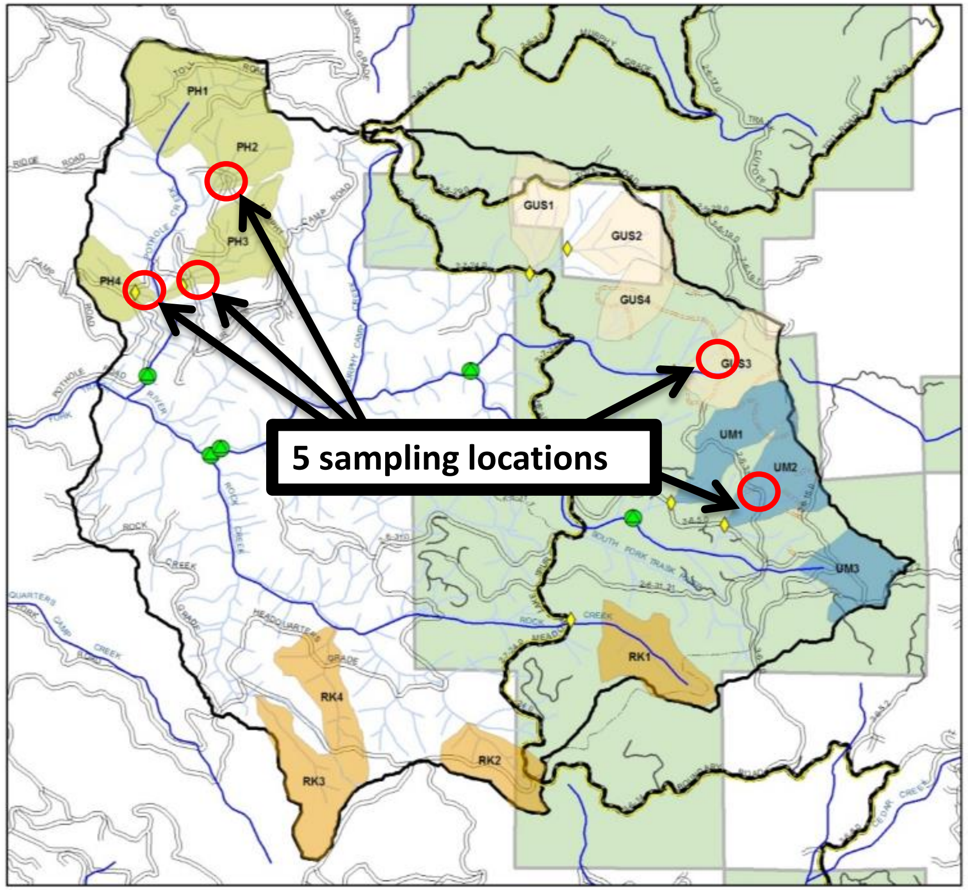


Bywater-Res et al. 2017, *Journal of Hydrology*

Trask River Watershed Study

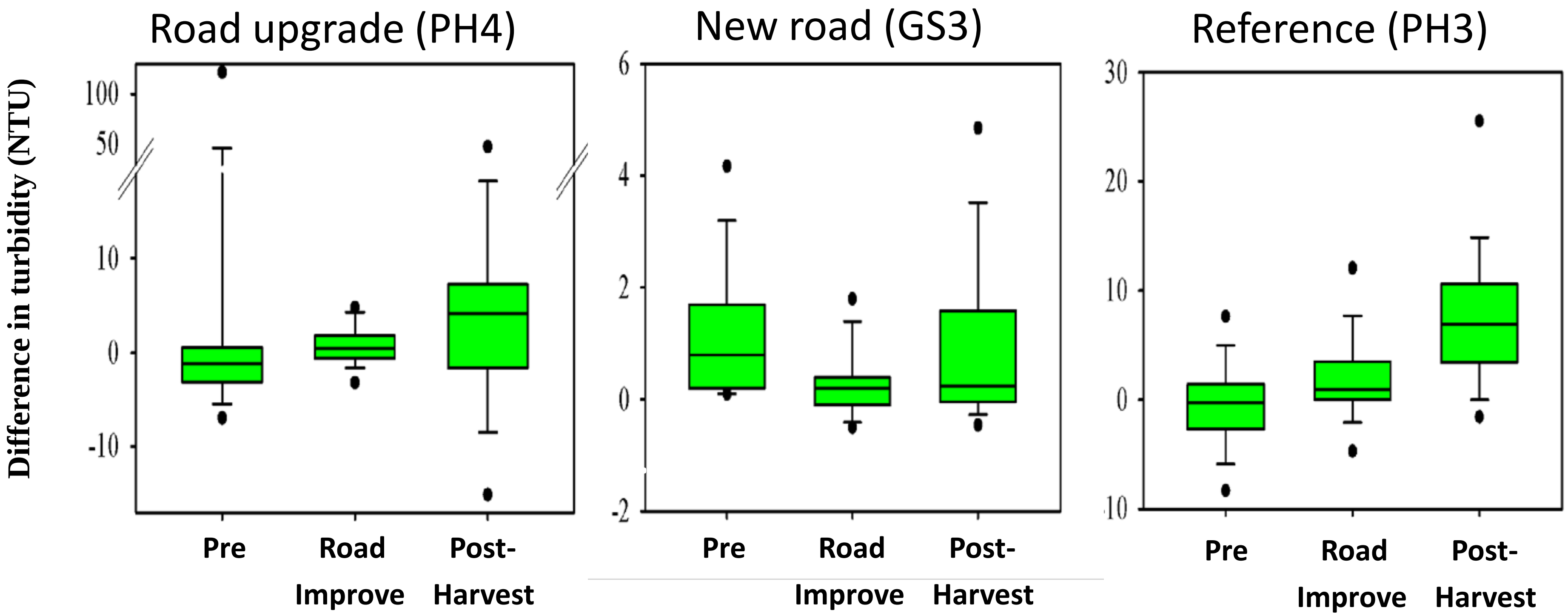
Suspended sediment above and below roads

Other sites include road improvement PH2 & PH4 on State Forest and the reference site PH3.

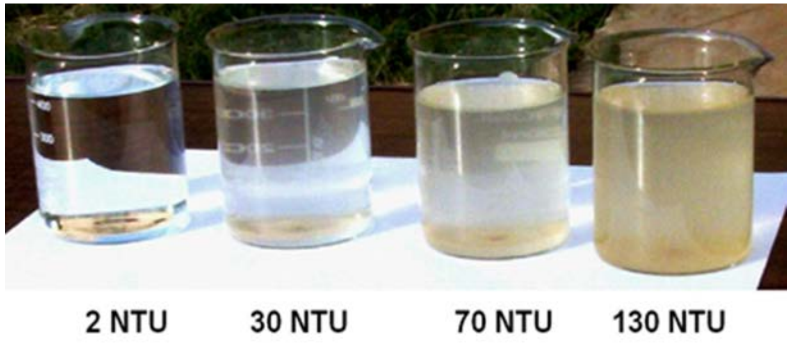


Trask River Watershed Study

Suspended sediment above and below roads



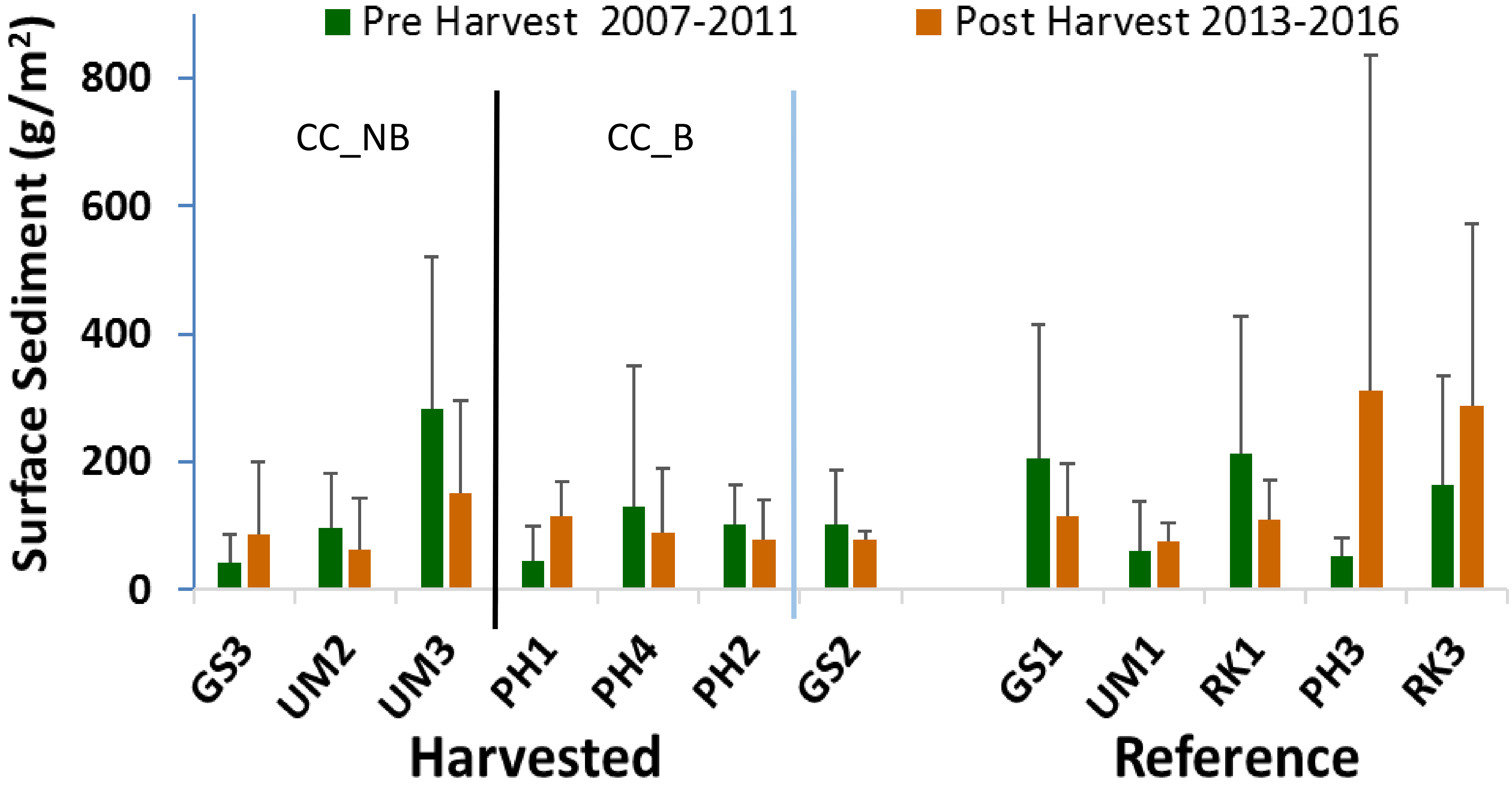
- **Minimal increases in sediment & turbidity**
- **Local disturbances important in headwaters**
- **Natural variability within/between streams**



Arismendi et al. 2017, *Water Resources Research*

Trask River Watershed Study | Instream sediment

Deposited sediment on stream beds was not higher at harvested sites



Water Quality Metrics

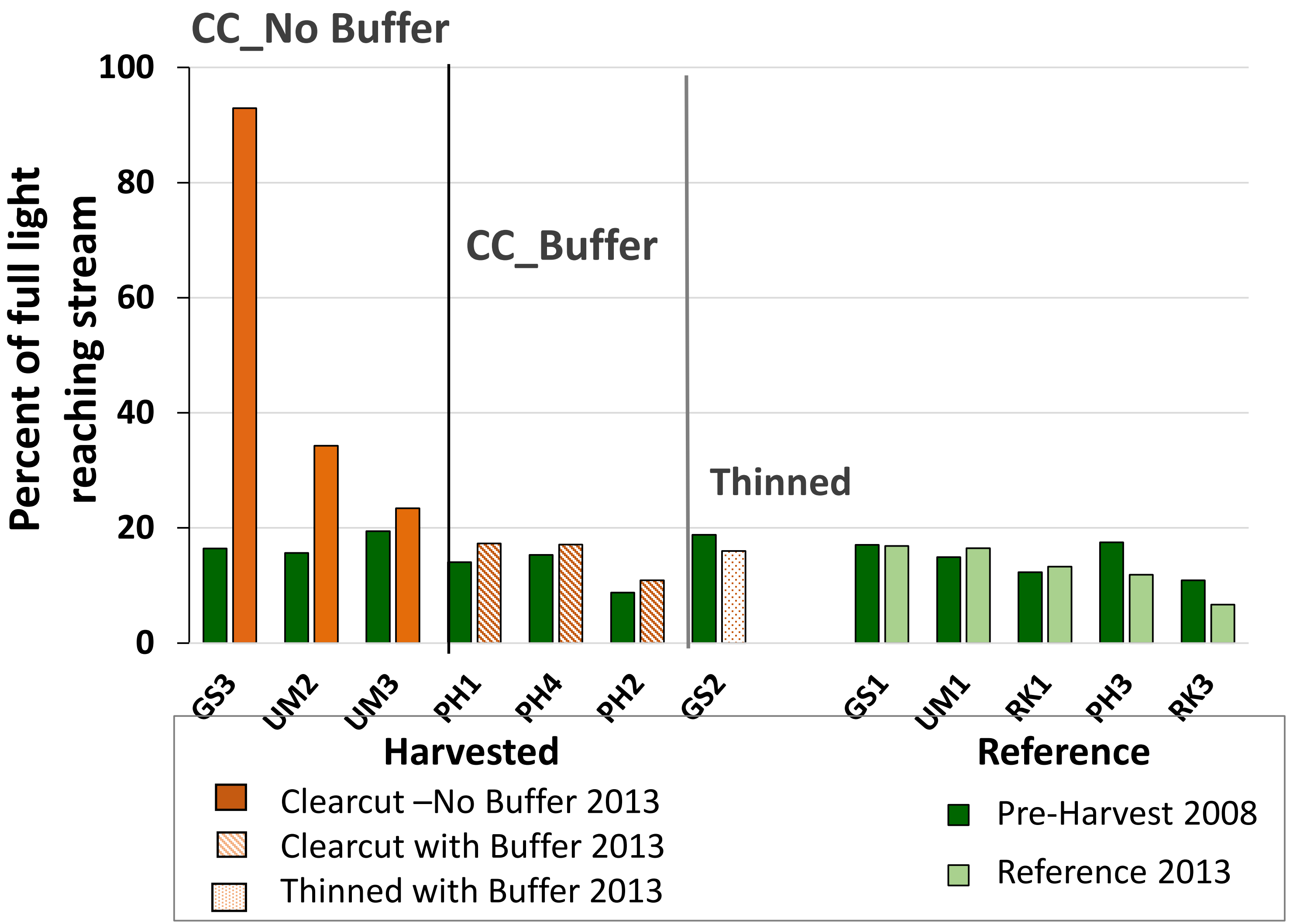
-Clean Water Act directs EPA to set water quality guidelines for drinking water and especially where there are threatened or endangered cold water fish species

-States implement water quality regulations

- Thresholds are common water quality metric and used to quantify effects of land use change – simple to calculate, but not site specific

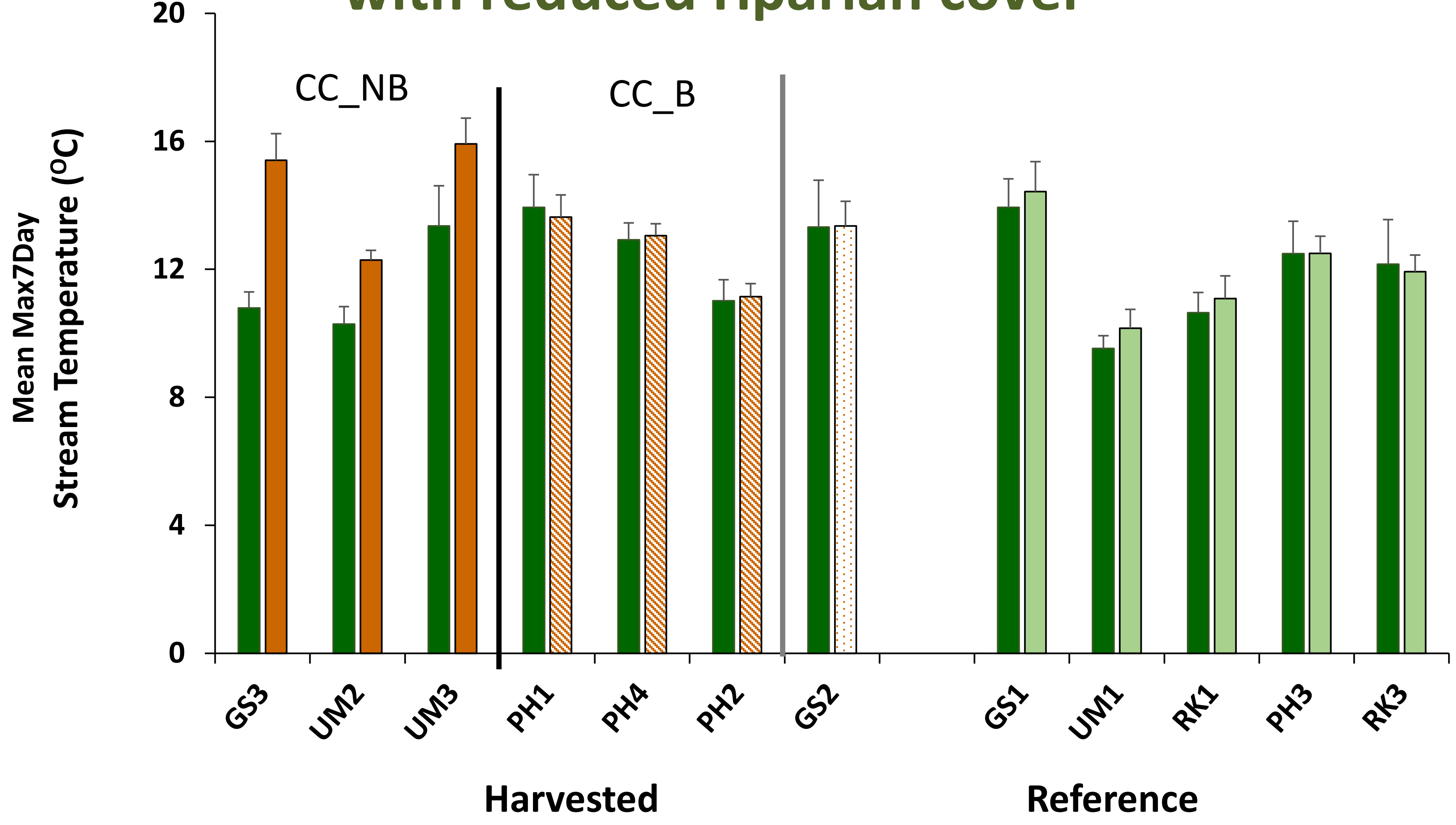
-Streaming data, sensor technology, and updates in computing allow us to go beyond simple thresholds and binary classifications to duration, frequency as well as magnitude

Trask River Watershed Study | Change in Light



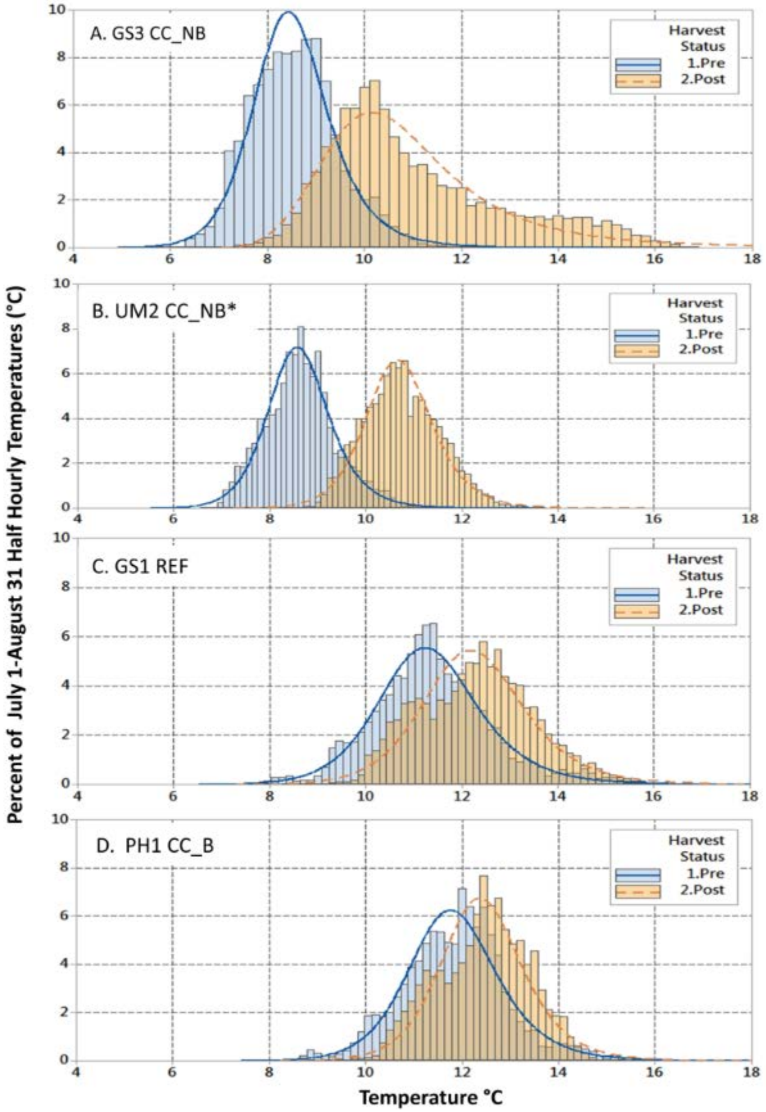
Trask River Watershed Study | Stream temperature

Increase in maximum stream temperatures at sites with reduced riparian cover

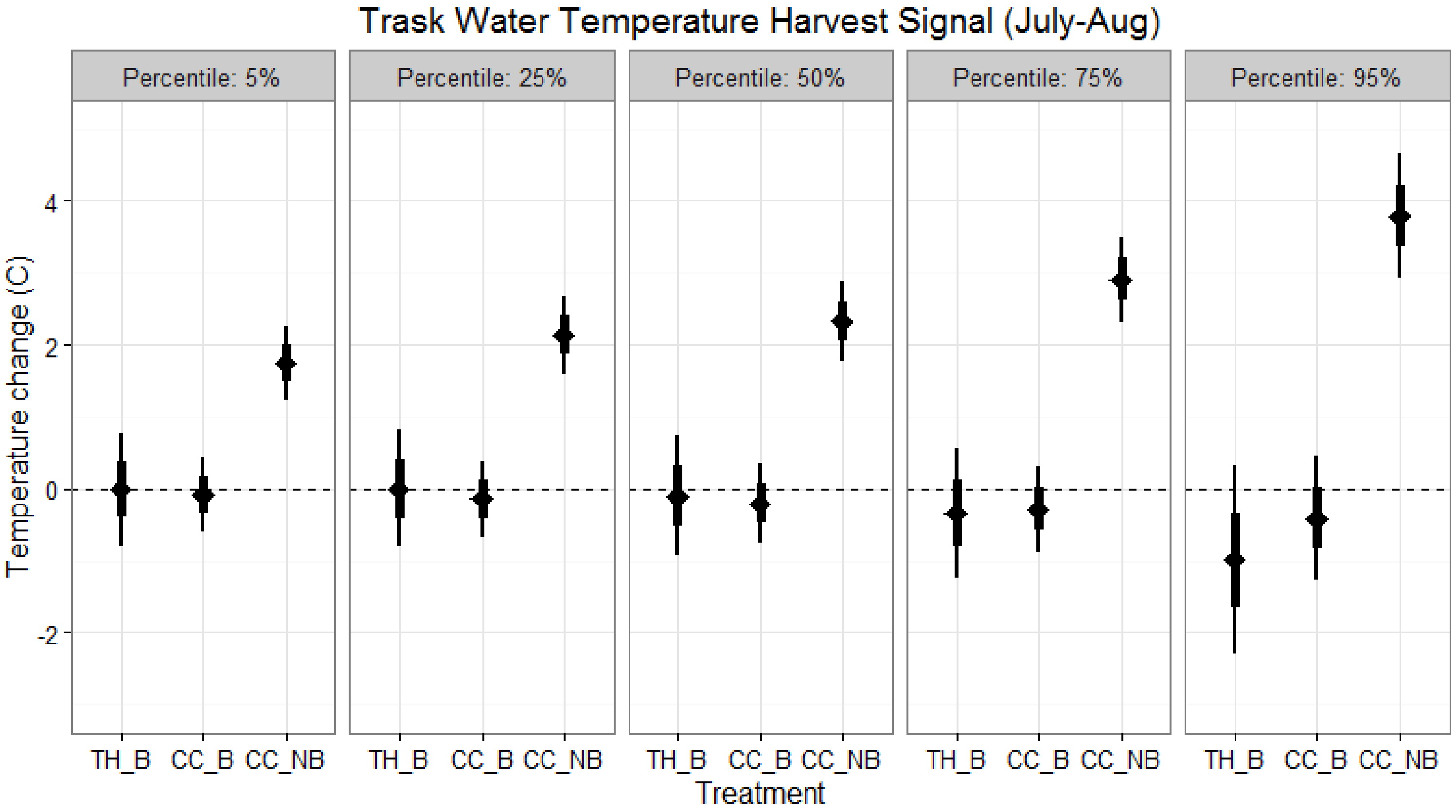


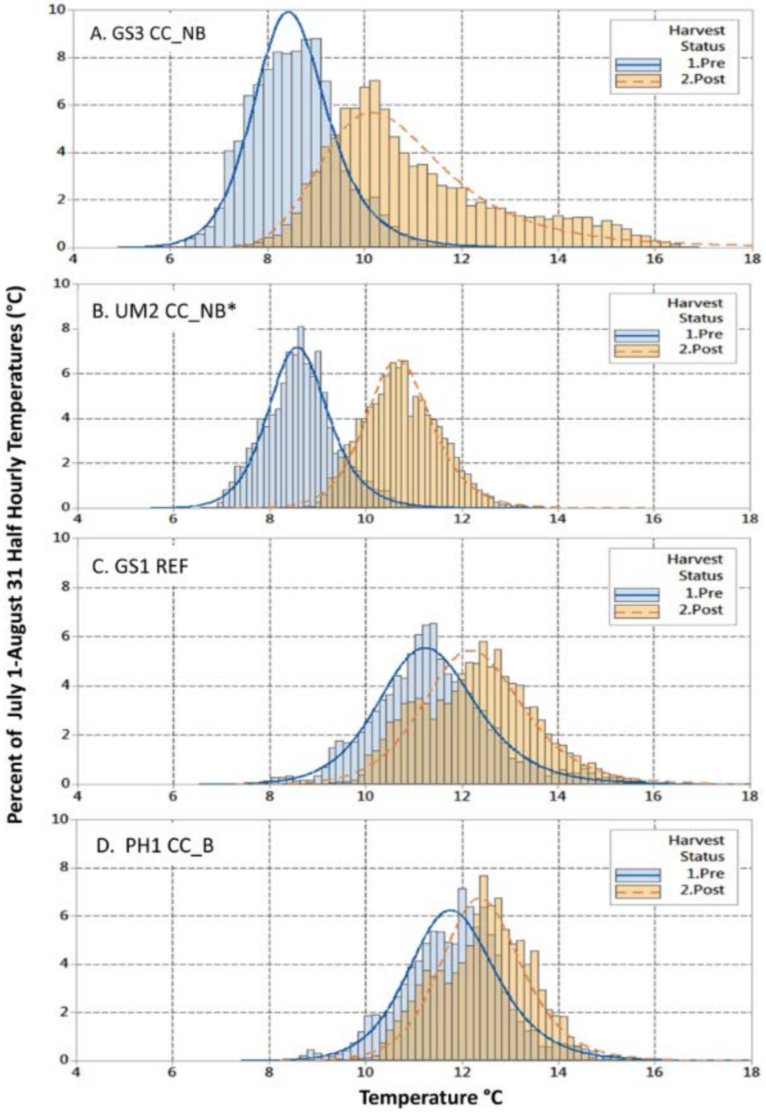
Trask River Watershed Study | Stream temperature

A comprehensive metric would go beyond a single value for each summer and examine full distribution of temperatures that biota are exposed to.



Trask River Watershed Study | Stream temperature

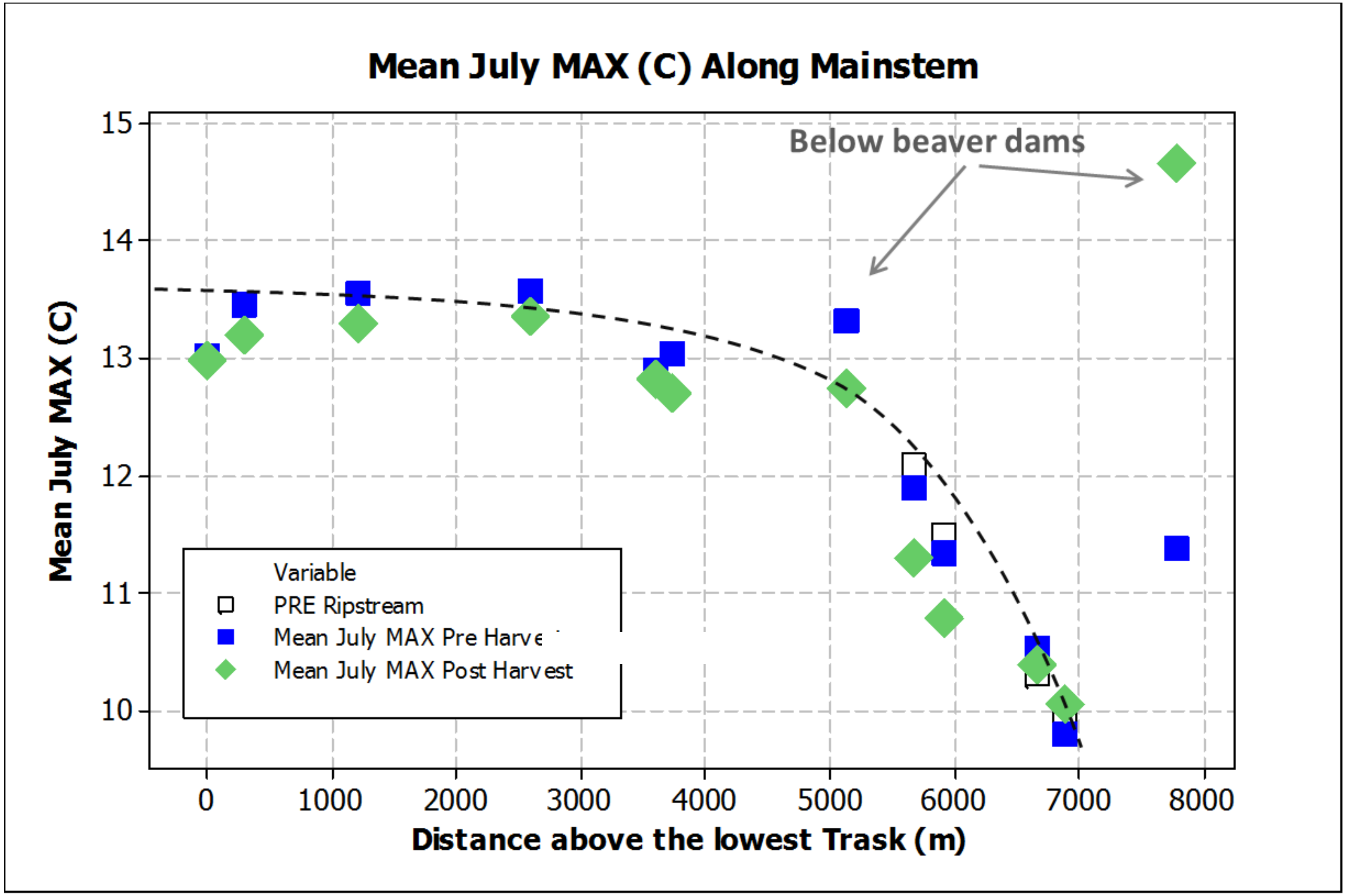




Fixed effects: Year, Trt, Year*Trt; Random effects: Site
Removed 2012 data
Included all Reference sites

Thick bar = +/- 1 SE; Thin bar = +/- 2 SE
Treatment effect estimator:
$$(\mu_{i,Trt,After} - \mu_{i,Trt,Before}) - (\mu_{i,Ctrl,After} - \mu_{i,Ctrl,Before})$$

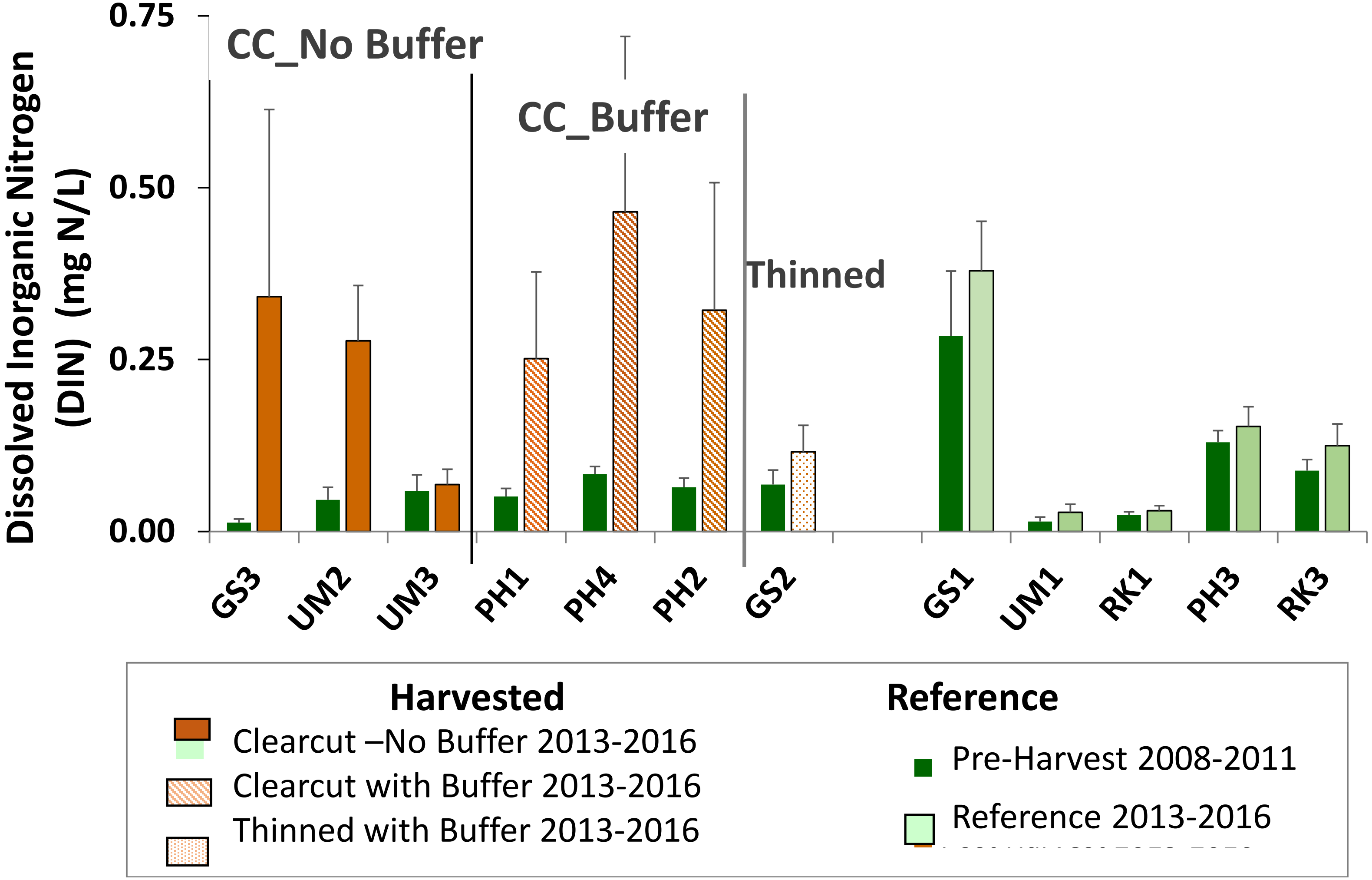
Trask River Watershed Study | Stream Temperature



- Even large temperature increases (harvest and/or beaver activity) had no detectable effect downstream
- Water temperature increases localized – no downstream response

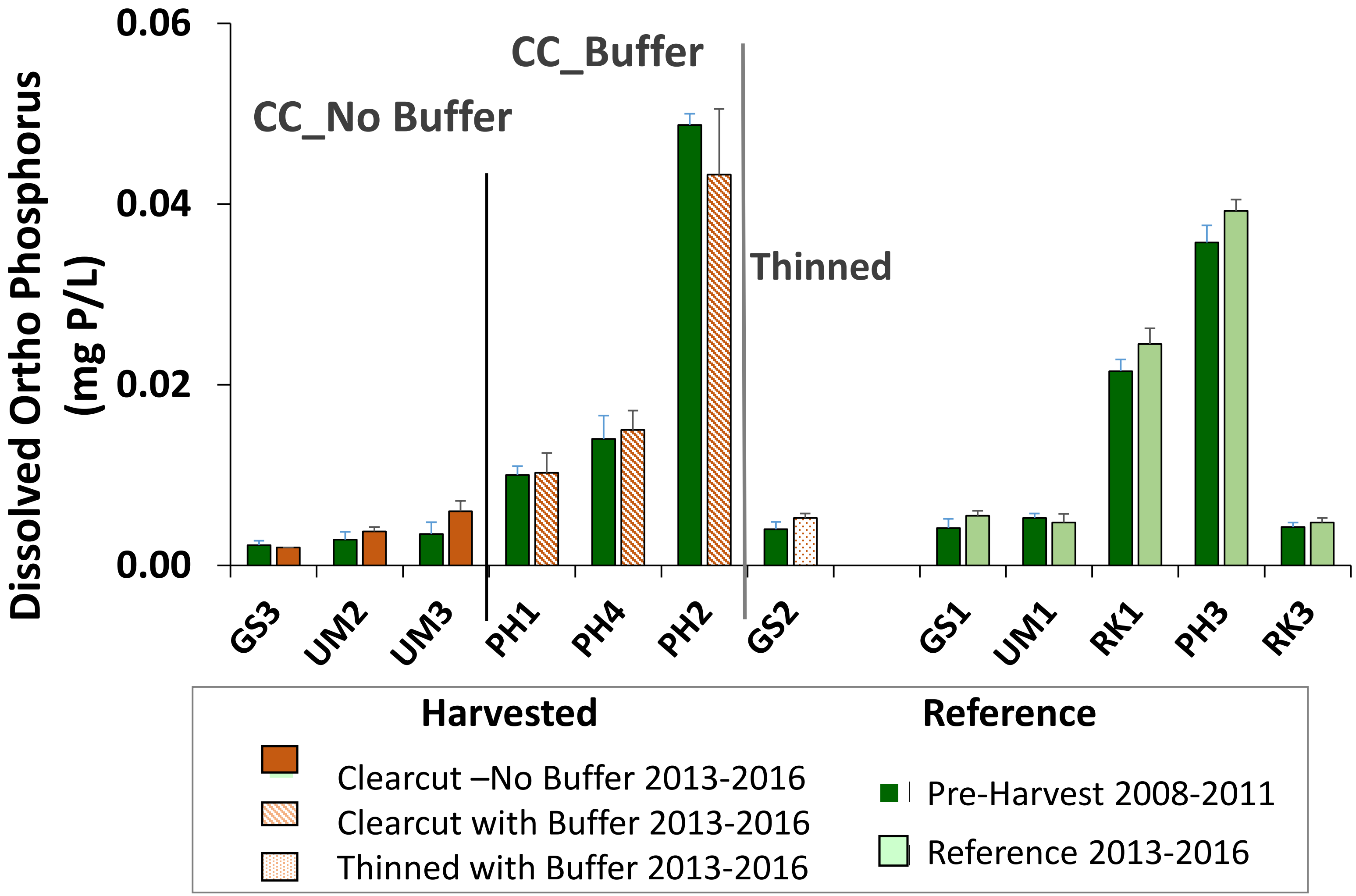
Trask River Watershed Study | Dissolved nitrogen

Higher dissolved inorganic nitrogen with and without buffers post-harvest



Trask River Watershed Study | Ortho-Phosphorus

No increases in ortho-phosphorus post-harvest



Why Stream Invertebrates?

1. Good indicators of stream conditions: varied sensitivities, different life spans

2. Abundant and quickly responsive to change

Why Stream Invertebrates?

Grazers

Shredders

Filterers

3. Multiple functions and roles in stream food webs

Predators

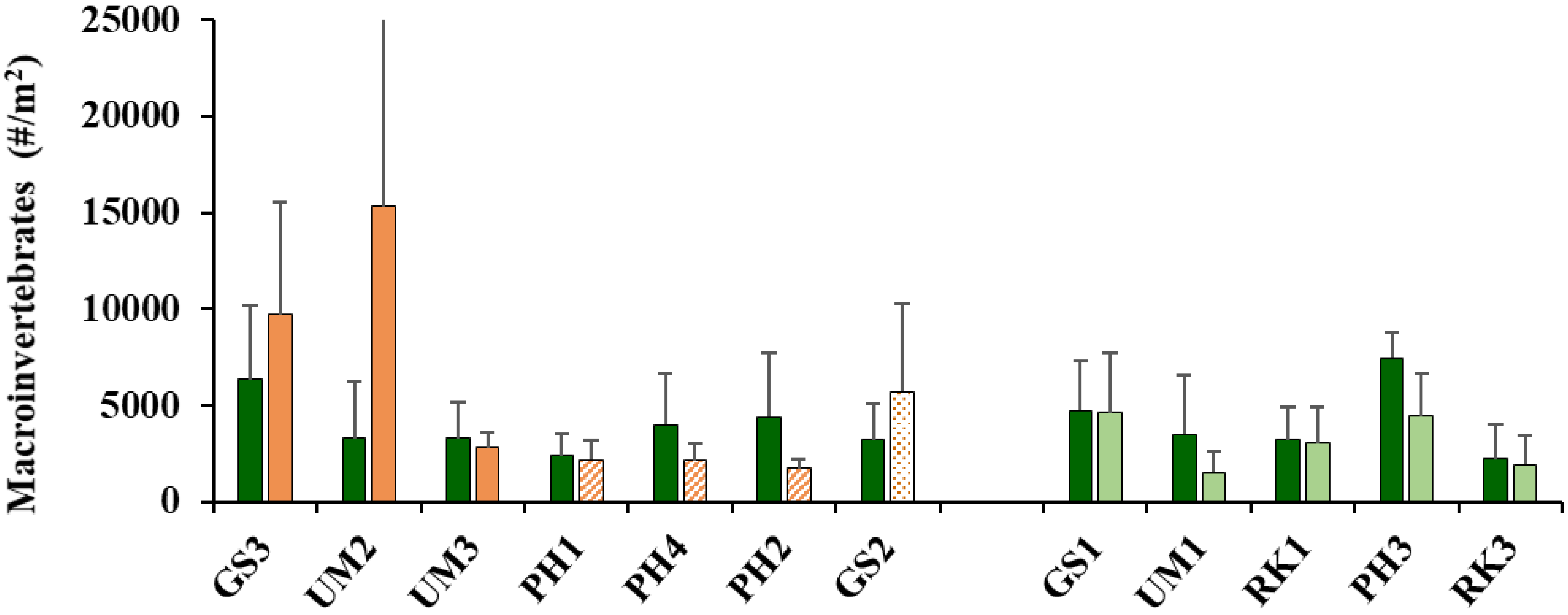
Why Stream Invertebrates?

4. Essential prey in stream & riparian foodwebs

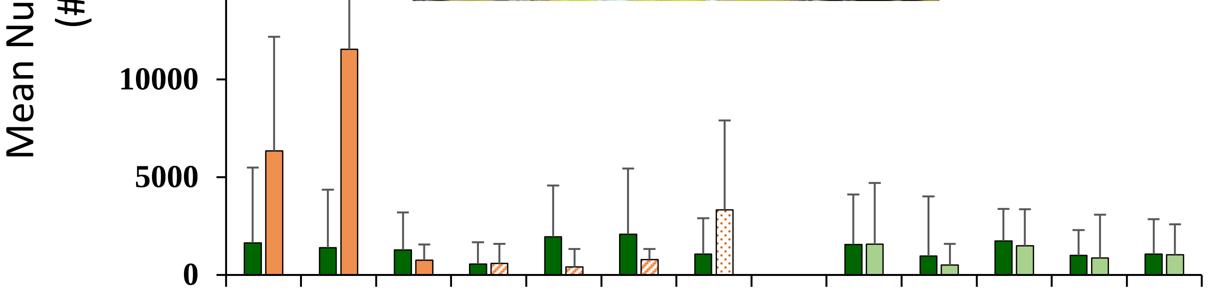
Vertebrate Predators

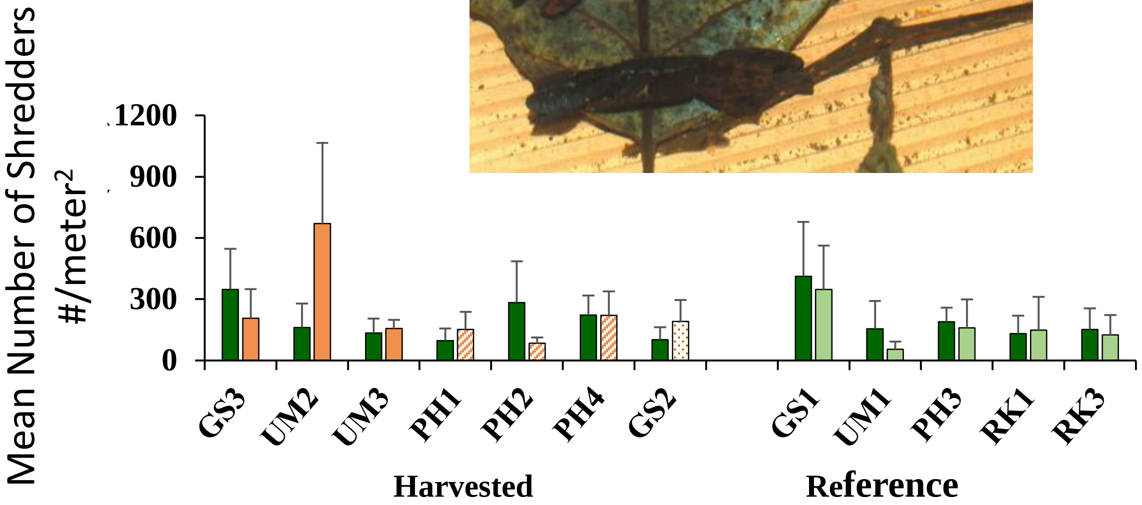
Trask River Watershed Study

Macroinvertebrates



Types and functions of invertebrates changed at 2 non-buffered sites





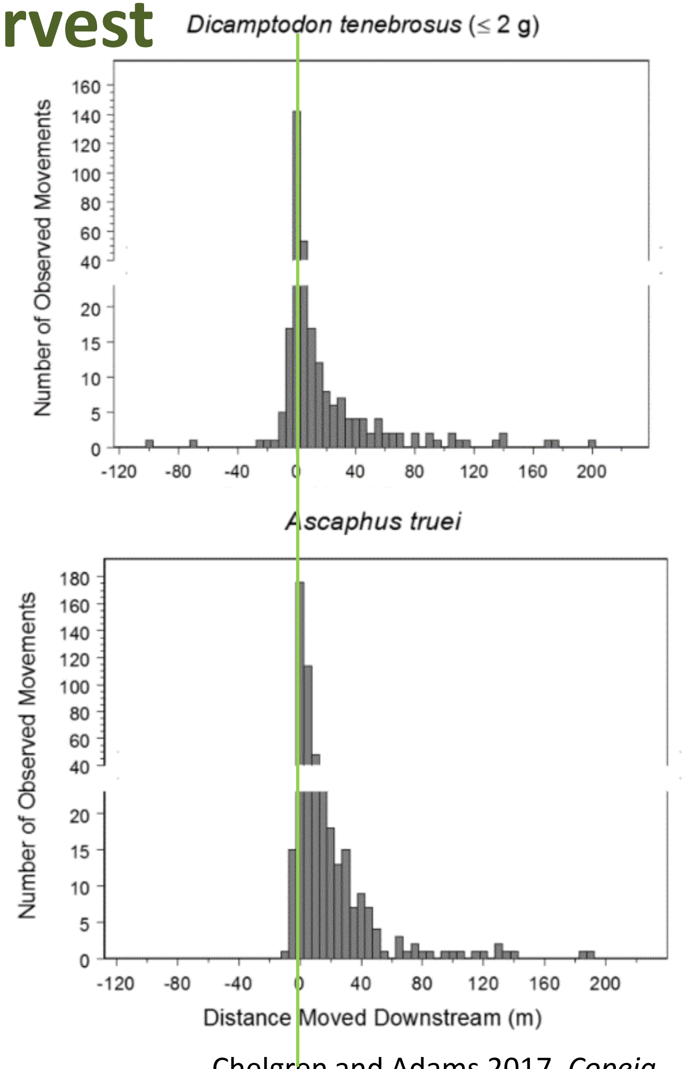
Trask River Watershed Study | Amphibian species and movement

Downstream movement complicates quantifying amphibian responses to forest harvest

Coastal Giant Salamander
(Dicamptodon tenebrosus)

Coastal Tailed Frog
(*Ascaphus truei*)

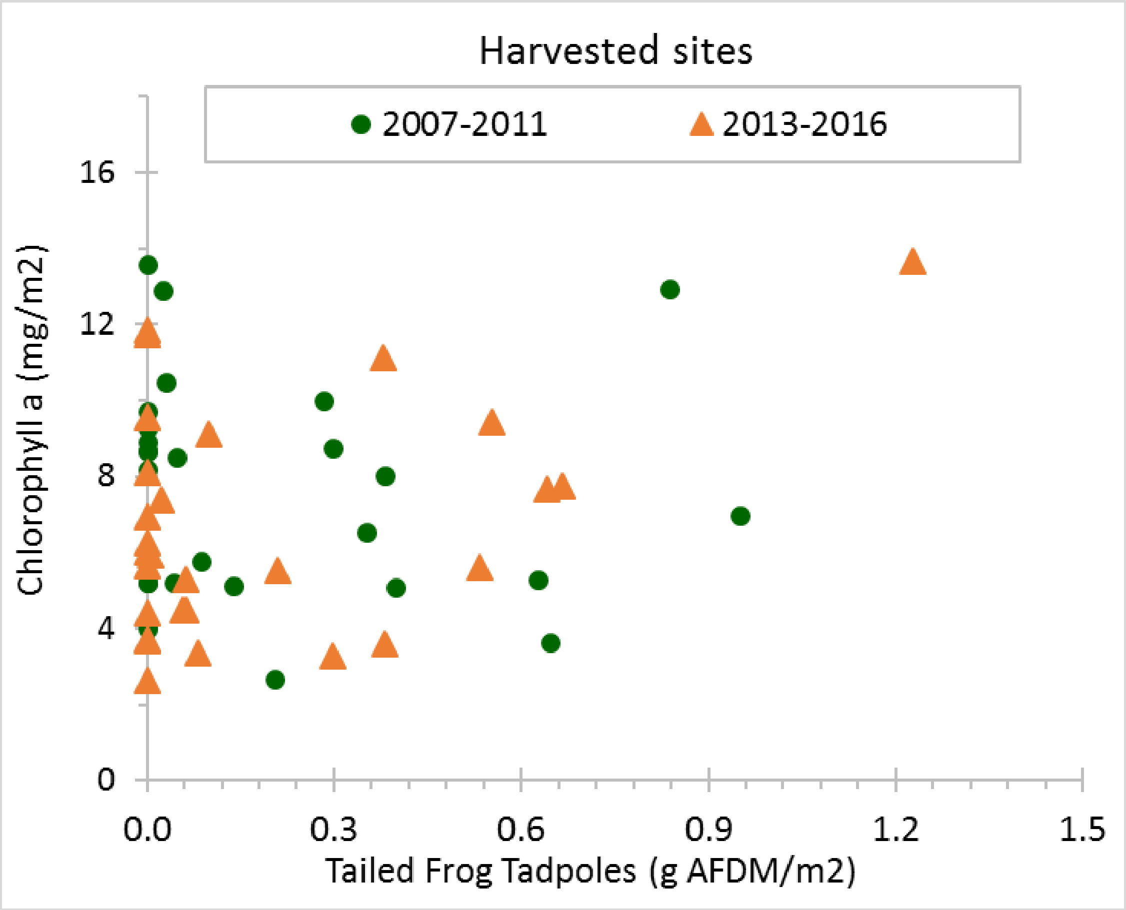
Columbia Torrent Salamander
(*Rhyacotriton kezeri*)



Chelgren and Adams 2017, *Copeia*

Trask River Watershed Study | Tailed Frog Tadpoles

Neither tadpole mass nor their algal food resource significantly changed after harvest



Tadpole data: Nate Chelgren, Mike Adams

Response metrics:

- Abundance
- Growth and development stage
- Overwinter survival
- Movement

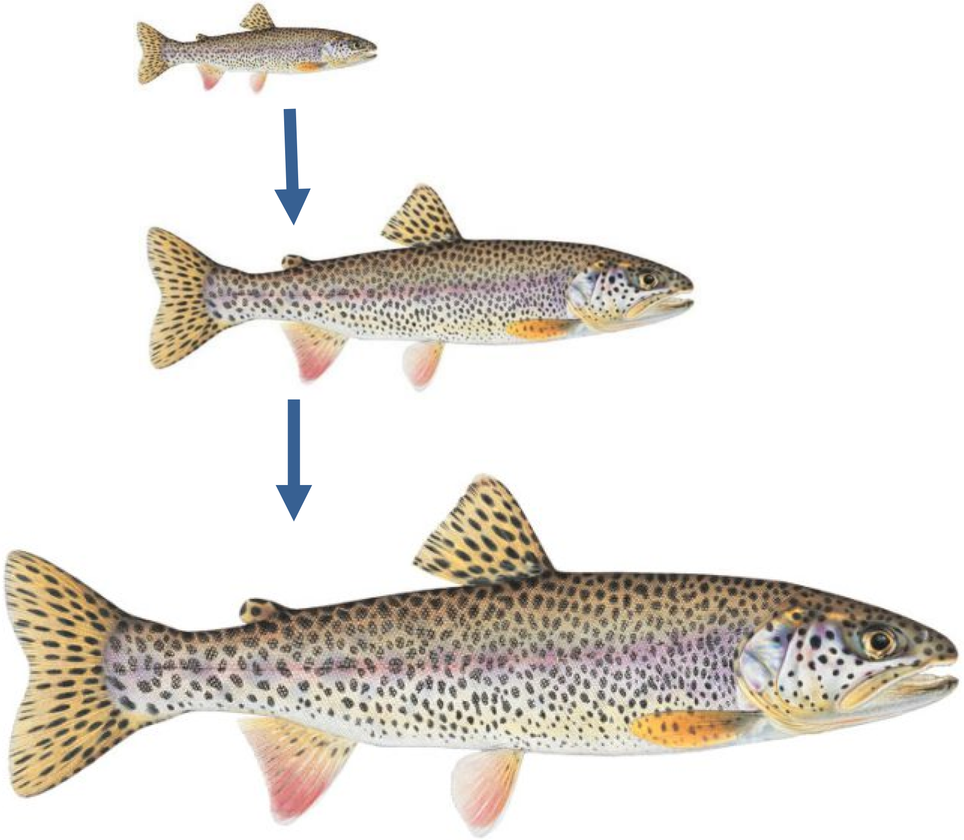
Trask River Watershed Study | Trout and Sculpin Response

- Jason Dunham, USGS
- Leslie Jensen, MS, Fisheries Science, Department of Fisheries and Wildlife, 2017

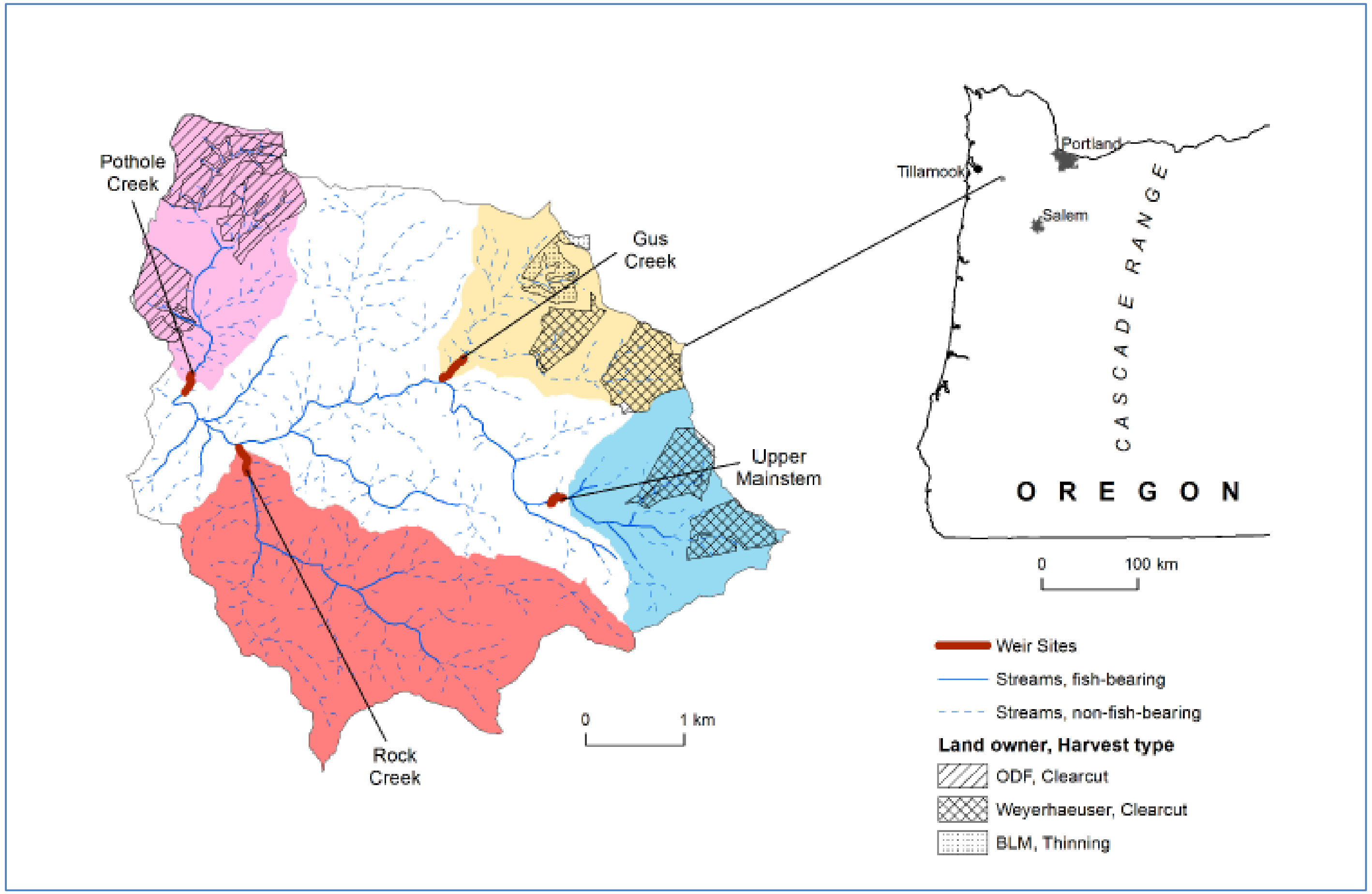
Trask River Watershed Study | **Why Growth?**

Growth

- Integrates biological processes
- Measurable in the field
- Responds quickly to environmental variability
- Key component of individual fitness



Trask River Watershed Study | Objectives



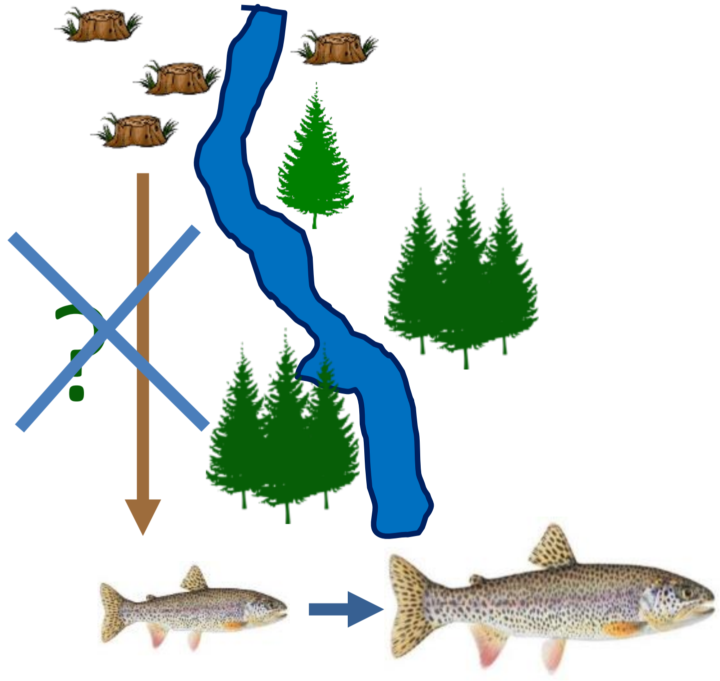
Downstream Sites:

1. Fish response in relation to upstream forest harvest
2. Fish response in relation to water temperature, stream discharge and competition

Trask River Watershed Study | **Harvest Effect**

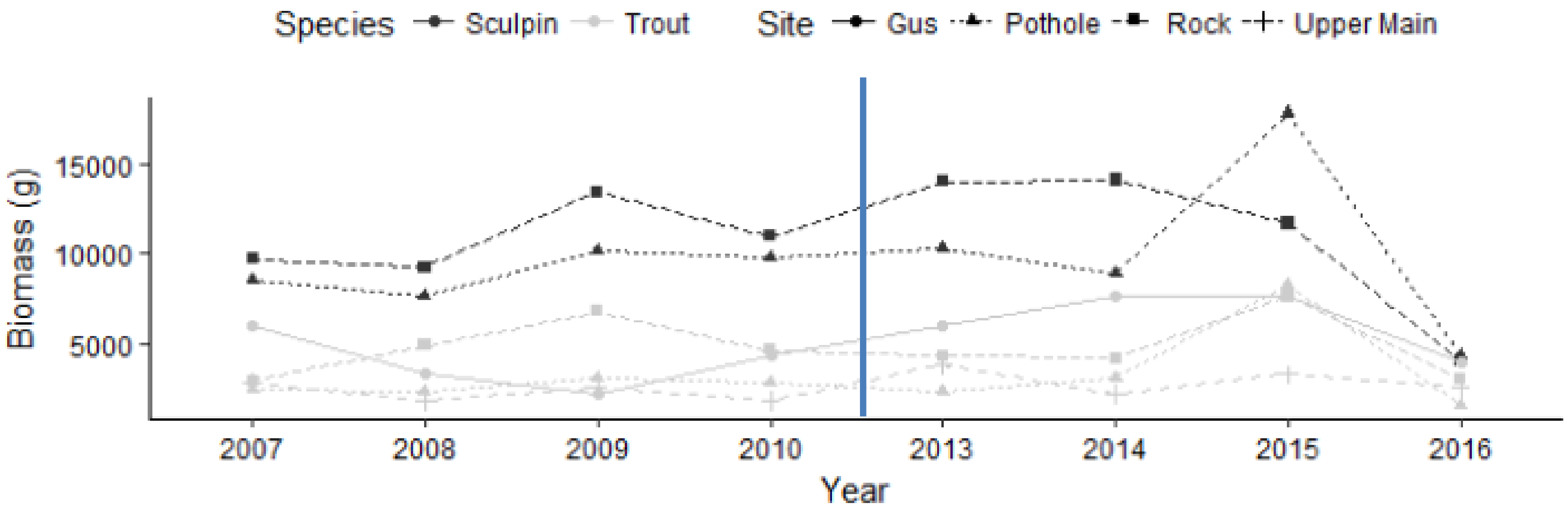
- Growth = Site + Harvest + Site*Harvest

- No harvest effect detected at downstream sites on fish growth



Trask River Watershed Study

Fish Biomass

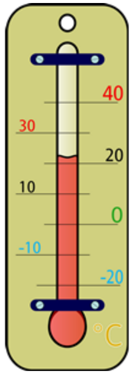


- No response to upstream harvest in either species
- Sculpin more abundant than trout
- Biomass = fish density X average weight

- Growth = Temperature + Discharge + Biomass + *e*
  - Temperature = mean during growth period
  - Discharge = mean during growth period
  - Biomass = biomass of conspecifics (competition)
  - *e* = random effect of stream site

Trask River Watershed Study | **Temperature Variability**

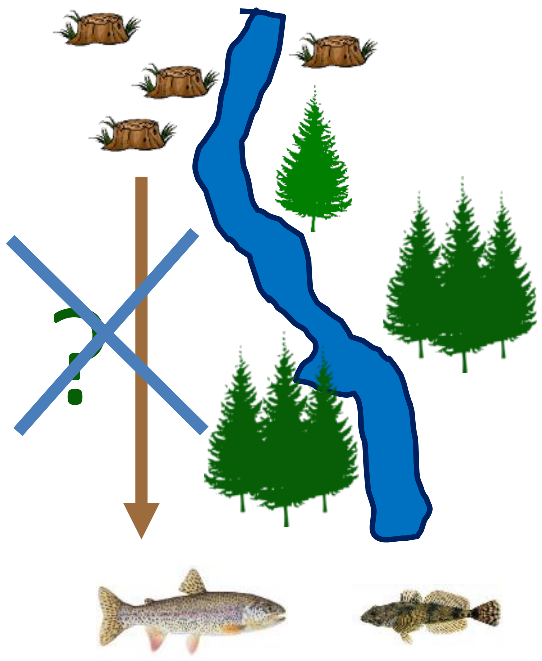
- Positive effect of water temperature on fish size and growth
  - Variation among sites in summer temperature related to growth
  - Growth rate for both trout and sculpin slightly higher at warmer sites:



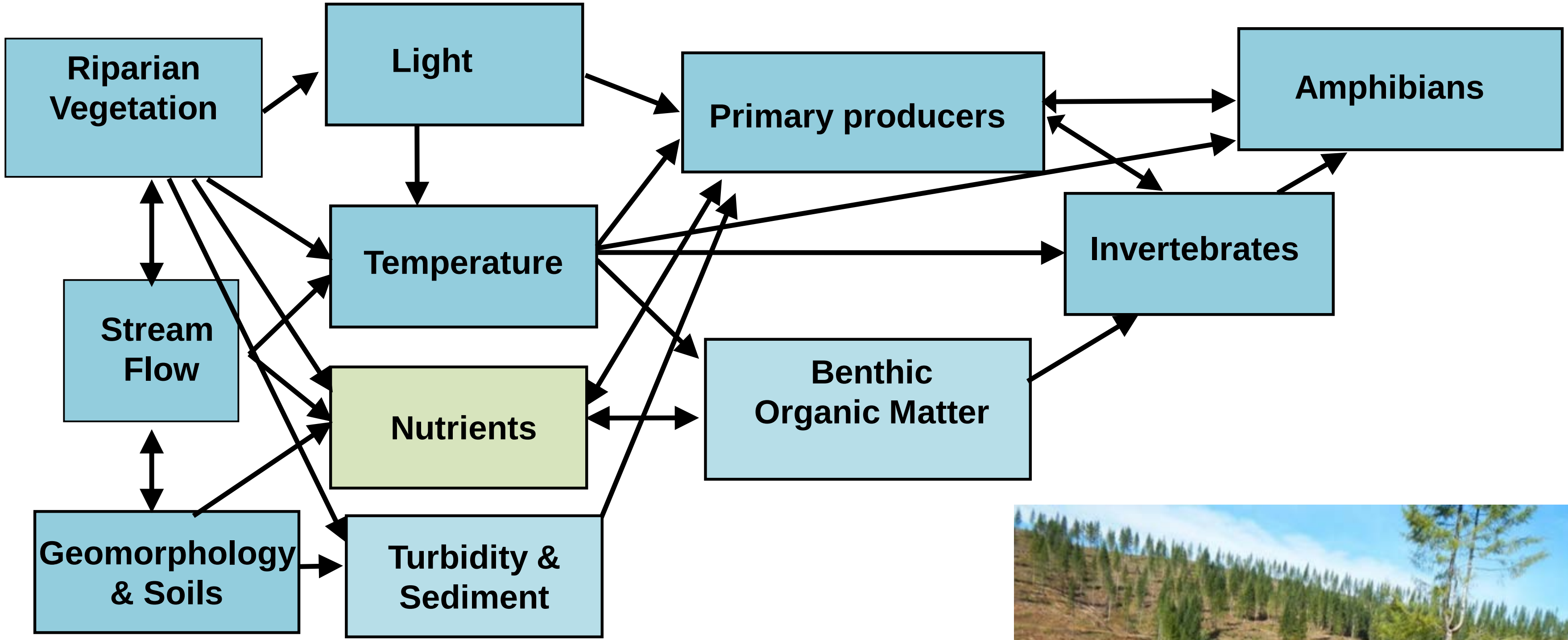
- No observable relationship of growth to discharge or competition

Trask River Watershed Study | **Conclusions**

- No observed effect of forest harvest on trout or sculpin growth or biomass
- Weak association between temperature and fish growth
- Current effort assessing fish response to harvest adjacent to fish bearing reaches
- More details? Graduate student thesis here: https://ir.library.oregonstate.edu/concern/graduate_thesis_or_dissertations/1544bv18p



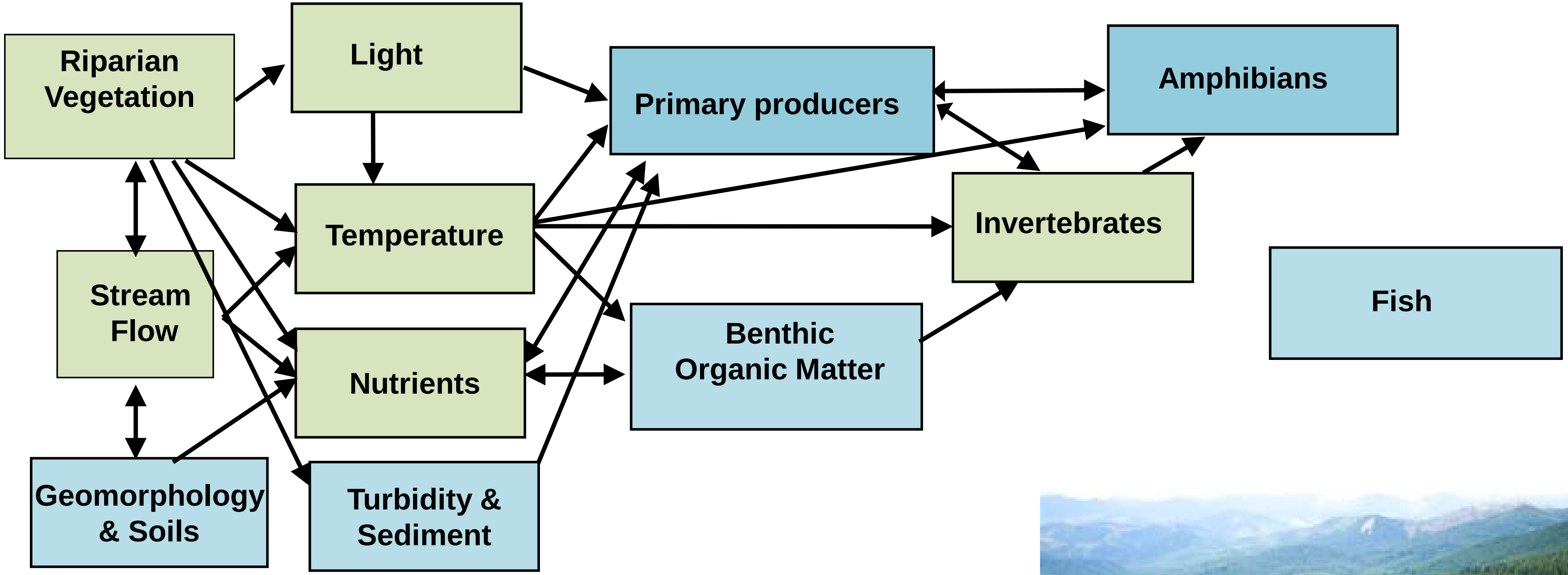
Trask River Watershed Study | Headwater Responses: Clearcut with Buffer



Green boxes=Change after harvest
Blue boxes= No Change

Trask River Watershed Study

Headwater Responses: Clearcut with No Buffers



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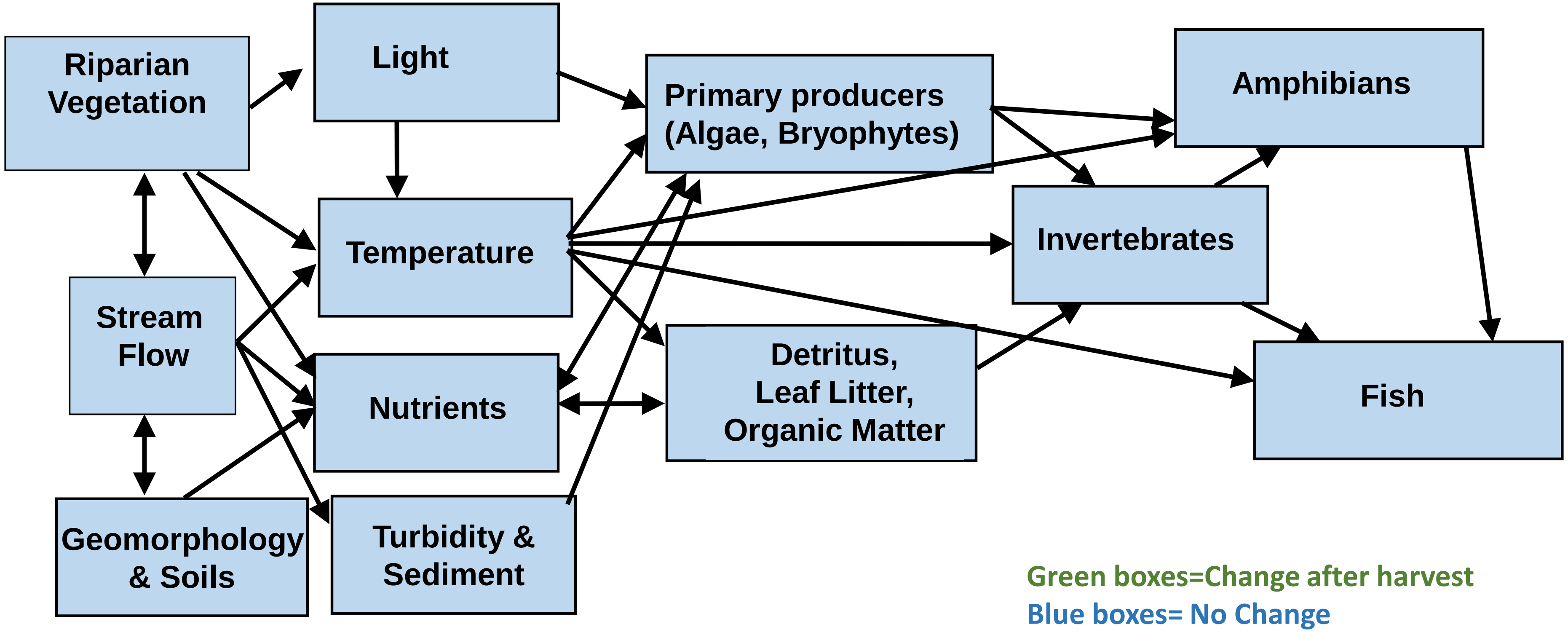
Trask River Watershed Study | Downstream Sites



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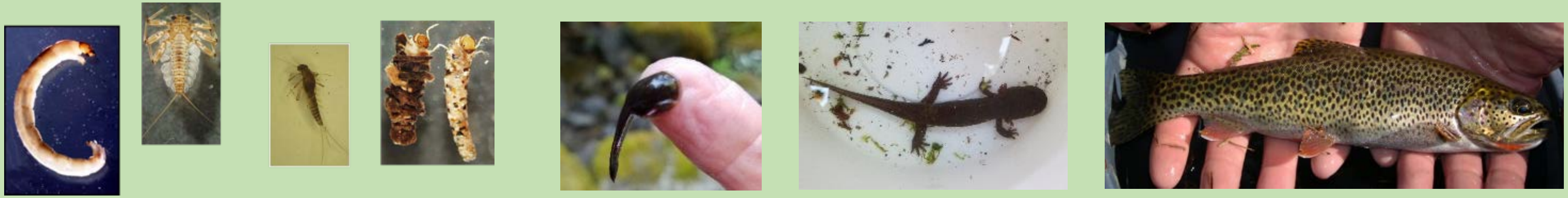

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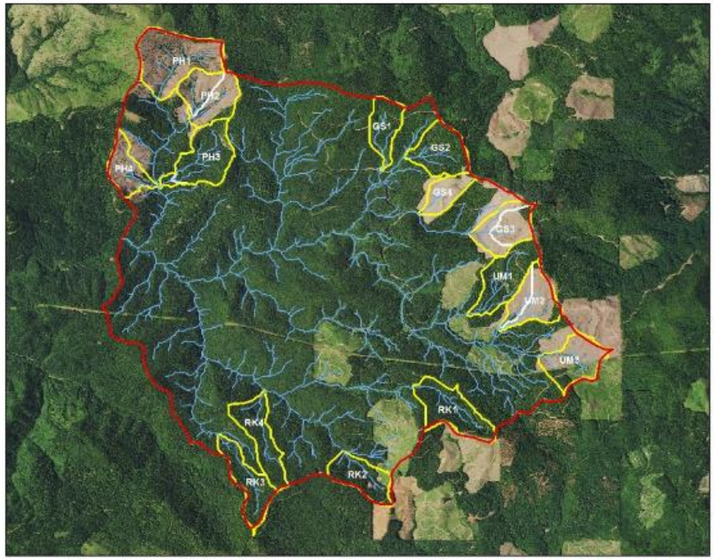

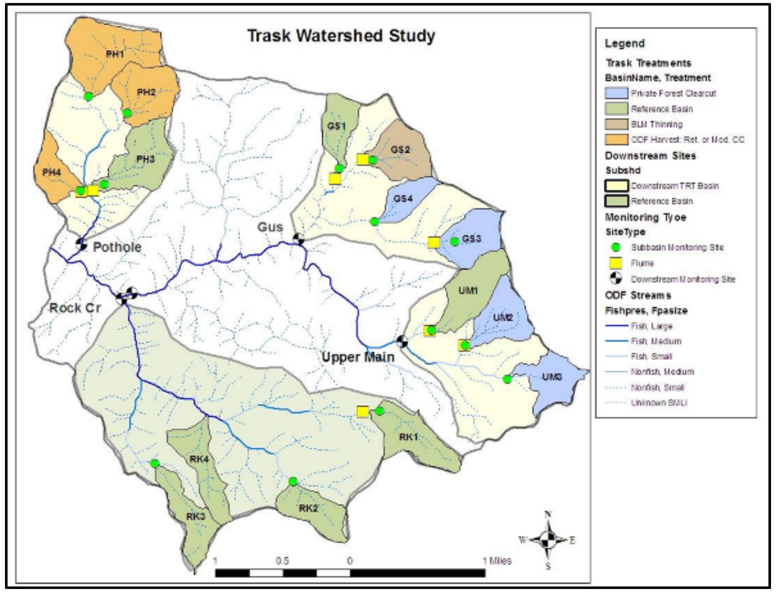

Trask River Watershed Study

Multiple ages of forests within a watershed