Effects of Forest Management on Salmonids in Headwater Streams of Western Oregon

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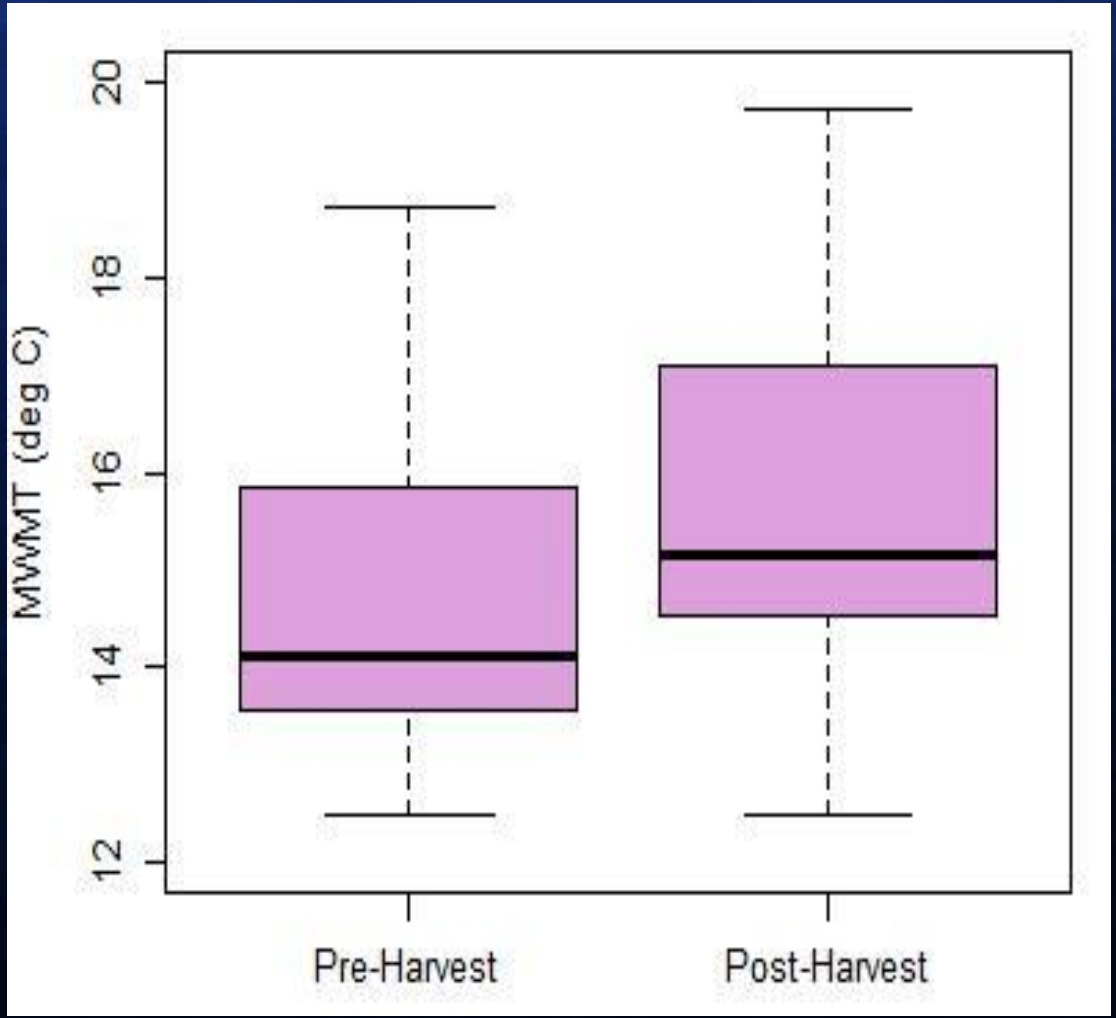
Questions we are Addressing

- How are stream temperatures and biotic productivity affected by contemporary timber harvesting in the riparian zone of headwater streams in the coastal region?
- How do fish respond to such changes?

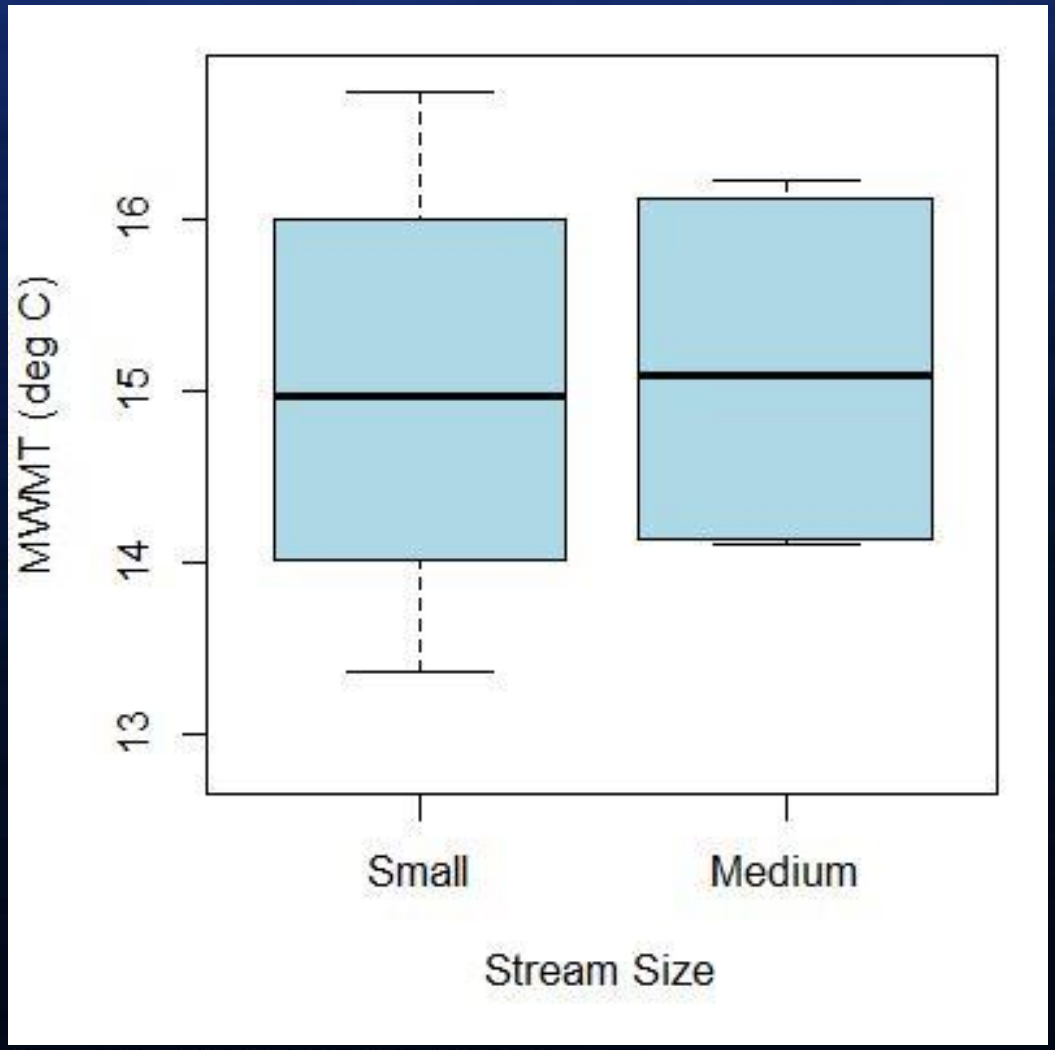
The Present Issue

- ODF completed “RipStream” study during 2002-2008 that evaluated effects of current forest practices on water quality in 33 streams of coastal Oregon (18 on private forests).
- Increases of 1-2°C were found in 40% of stream reaches with riparian harvesting, but no effects in the other 60% of reaches with harvesting.
- Do the biological responses in these streams indicate a need to revise forest practices in small and medium class streams?

Pre & Post Harvest Stream Temperatures, RipStream Study (Groom et al. 2011)

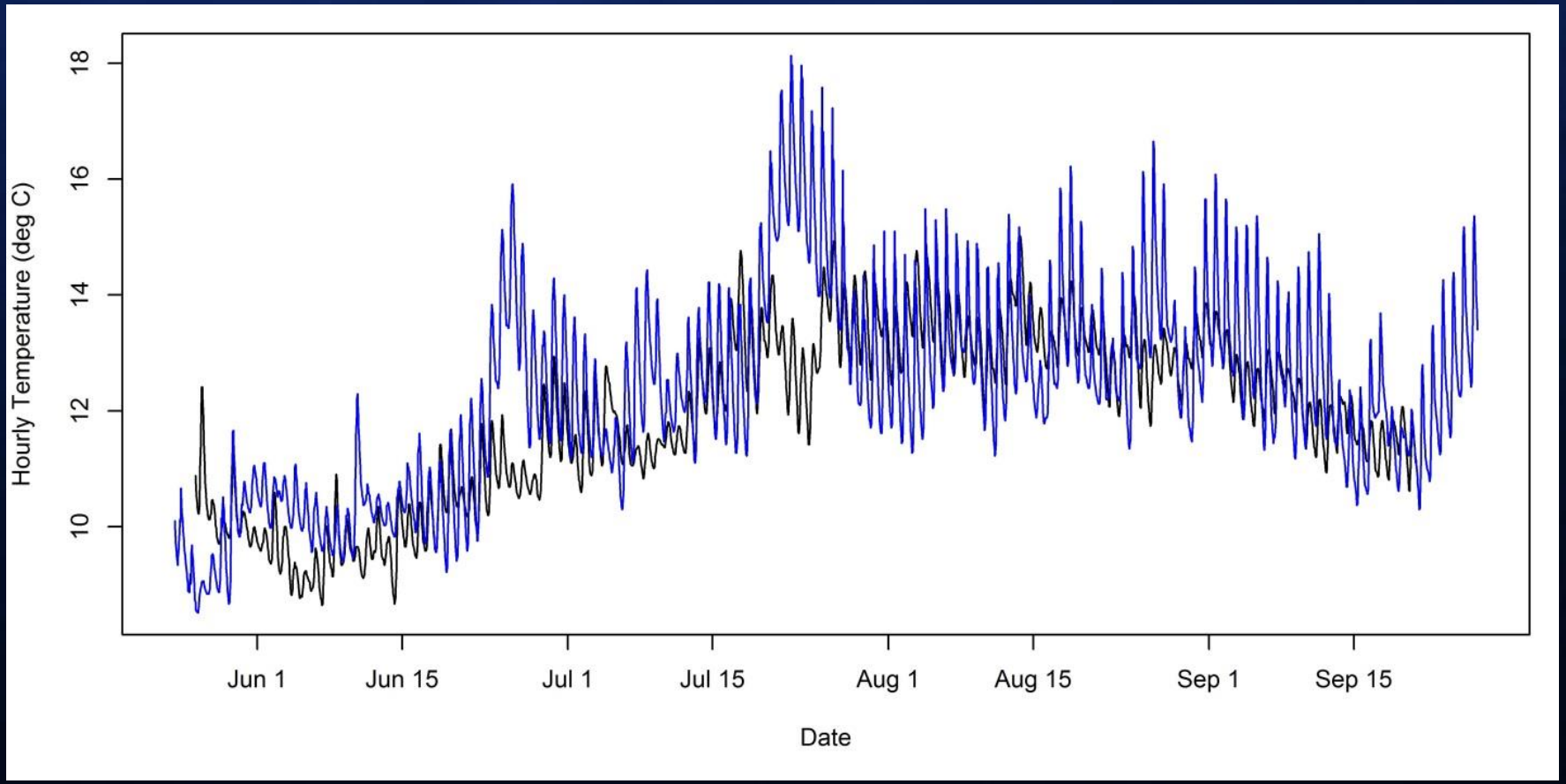


Oregon Coastal Stream Temperatures Private Timberlands

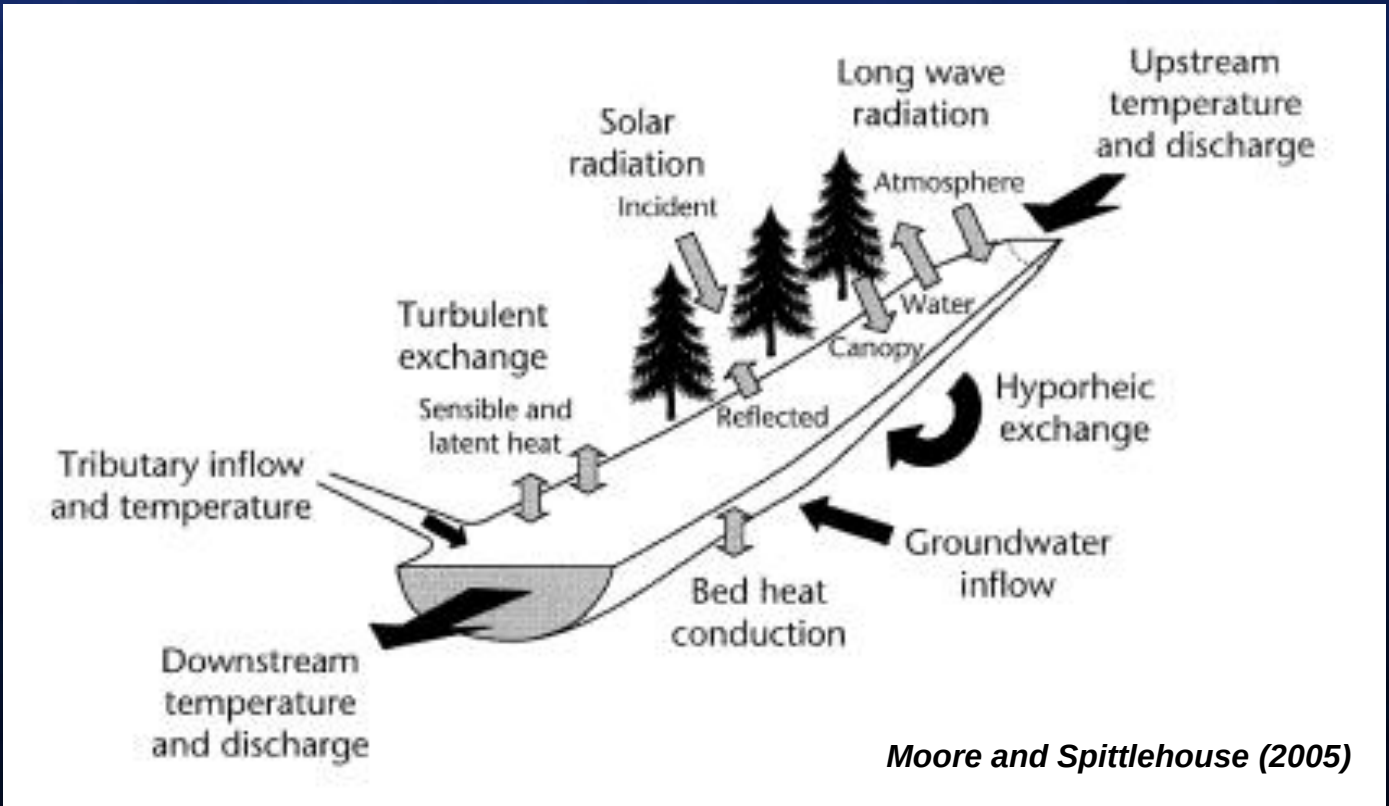


Coastal Stream Temperature Regime

RipStream site 5556



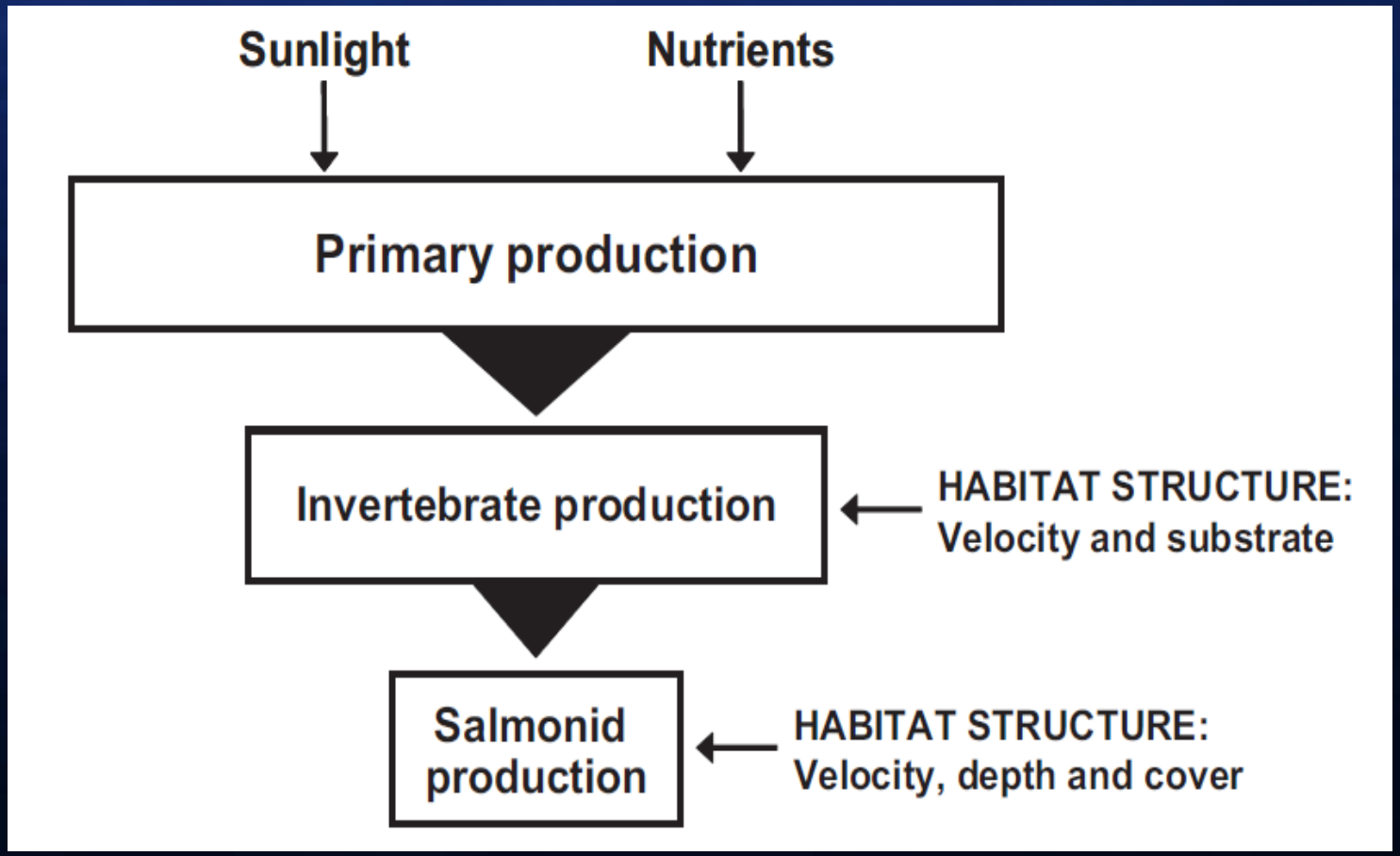
Riparian Buffers Can Limit the Effects on Streams

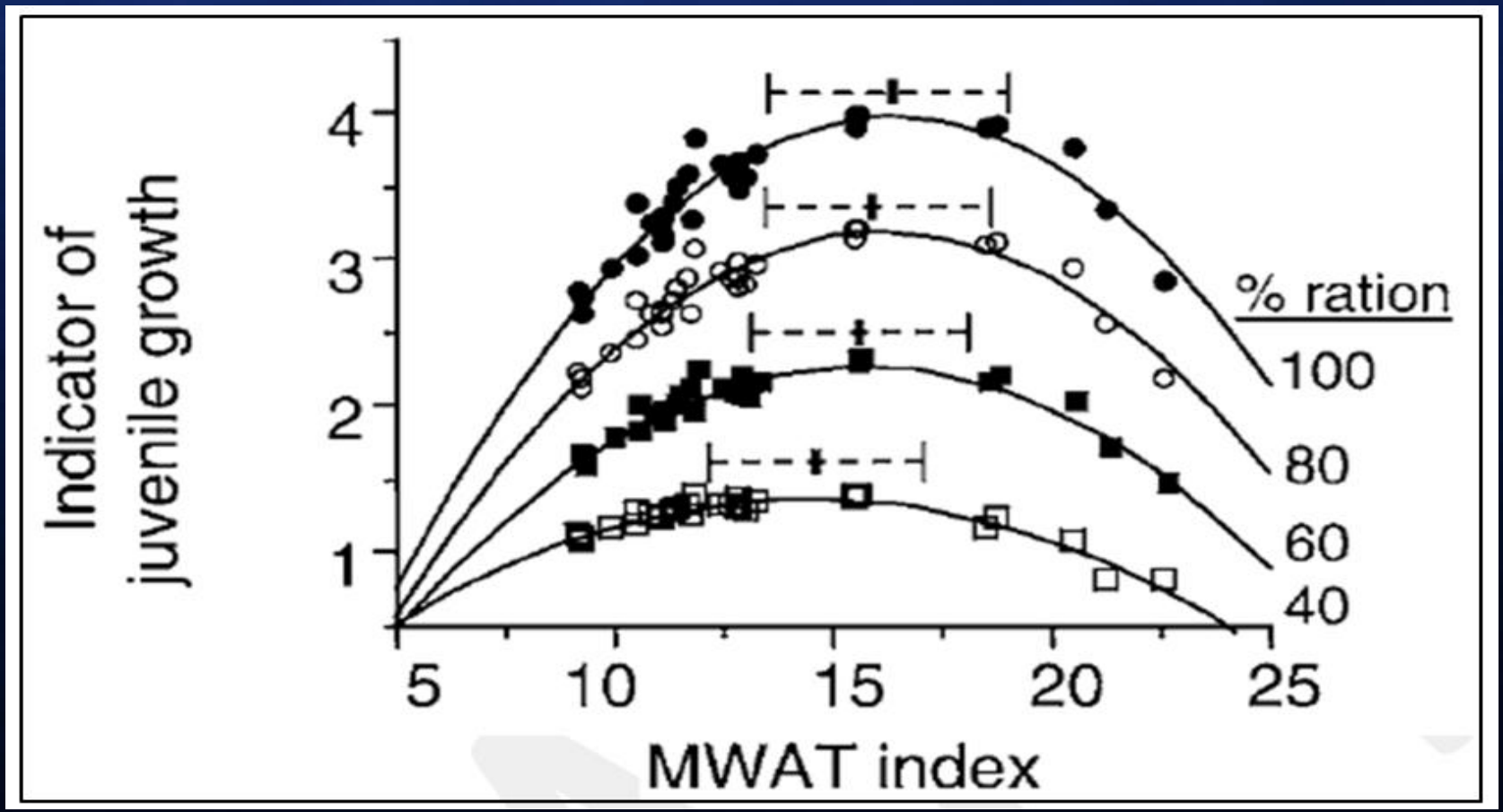


Moore and Spittlehouse (2005)

- Shading is the primary way to protect against stream heating
- Streams can cool as well as warm as they flow downstream

The Benefits of Increased Light



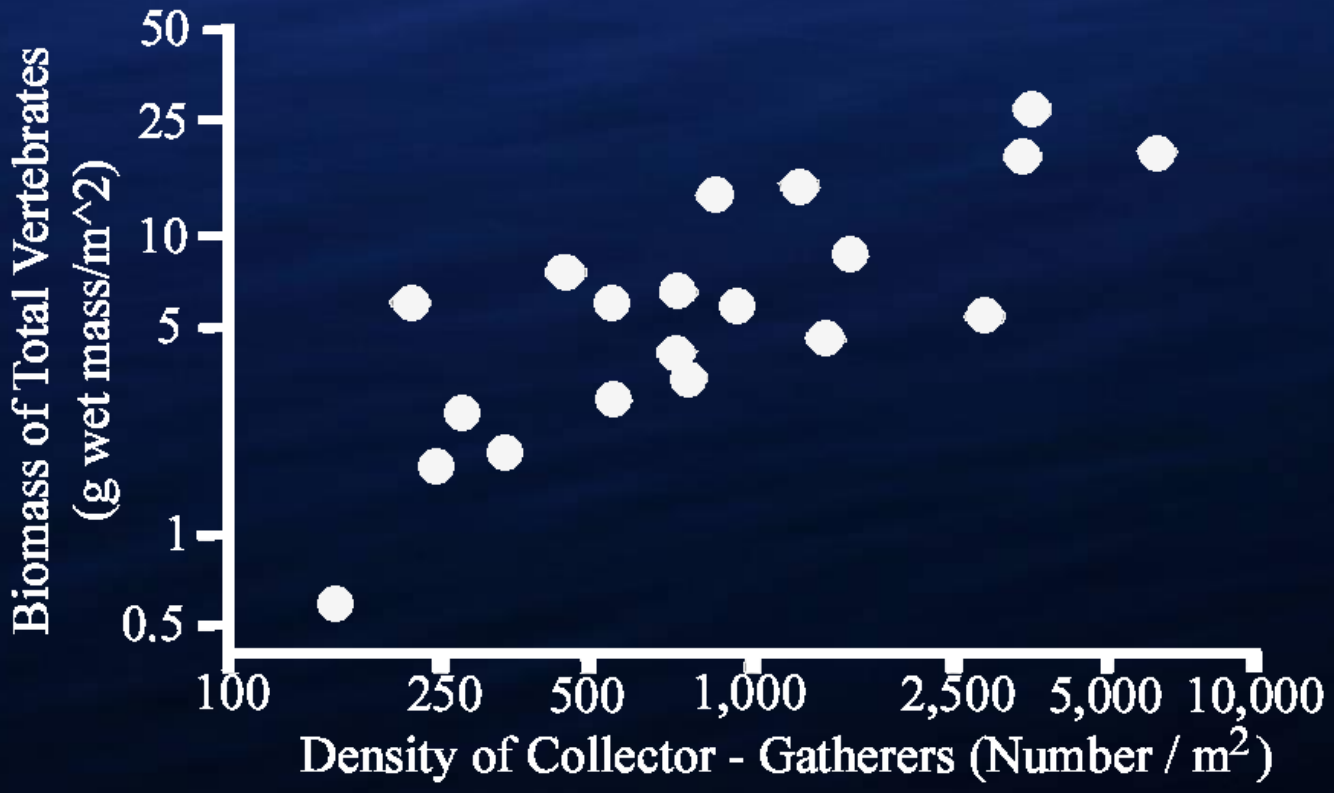

Indicator of juvenile growth
4
3
2
1
5
10
15
20
25
MWAT index
% ration
100
80
60
40

How has forest management changed solar radiation along coastal streams?

Study	Riparian Measure	Shade Loss	Shade Retention
Allen 2001	1994 Oregon Stream Protection Rules	Small streams – 13% Medium streams – 7%	Small streams – 78% Medium streams – 81%
Allen and Dent 2001	1994 Oregon Stream Protection Rules	Type F streams – 11%	Type F streams – 73%
Janisch et al. 2012	50-ft Continuous Buffer	Type N streams – 8%	Type N streams – 86%
Schuett-Hames et al. 2012	50-ft Continuous Buffer	Type N streams – 13%	Type N streams – 76%

- Several studies conducted along coastal streams in Oregon and Washington
- They evaluated shade response to each state's forest practices rules
- Magnitude of shade loss is about 10%; shade retention about 70 to 80%
- This is the same order of magnitude reported in the RipStream study

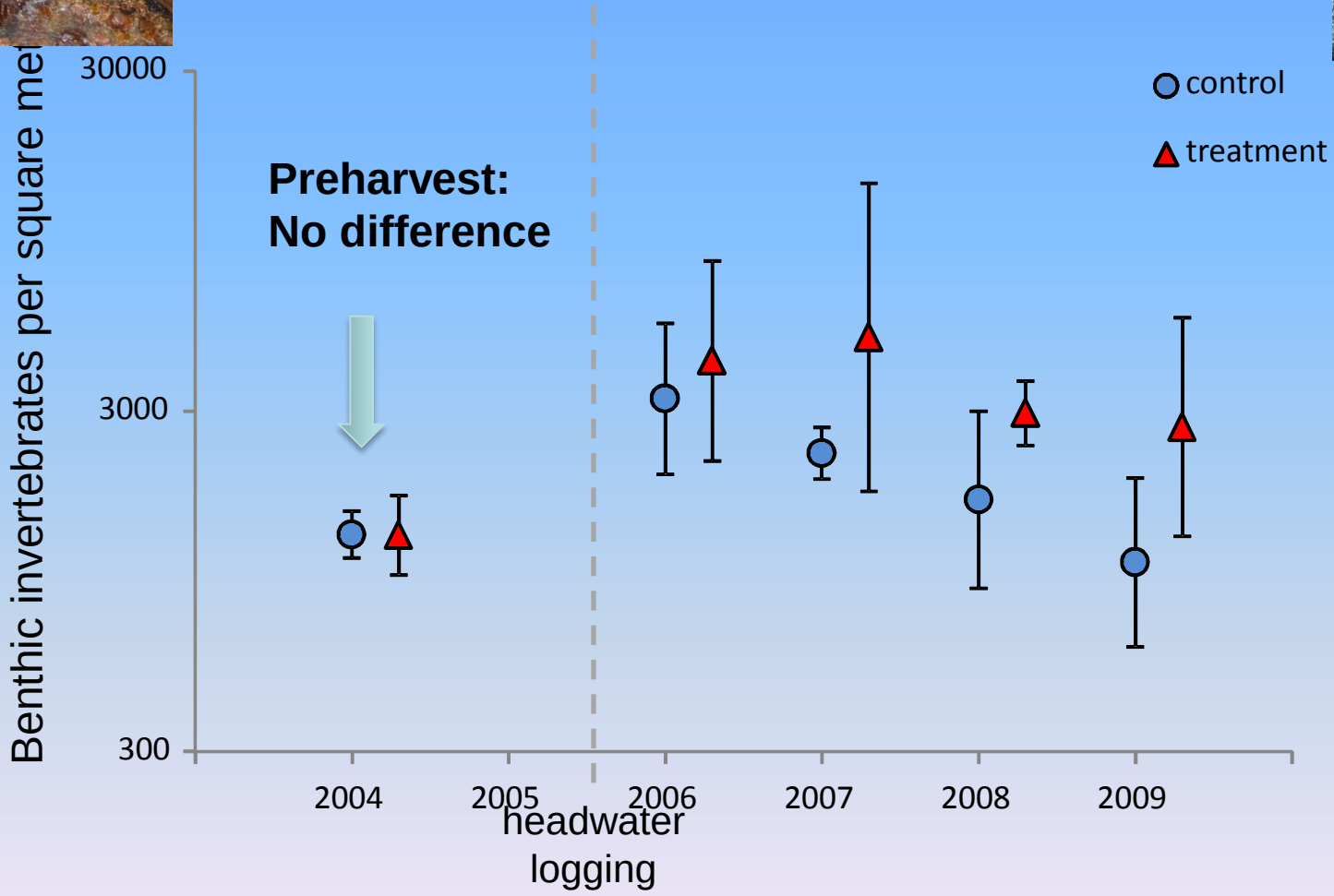
The Benefits of Increased Light



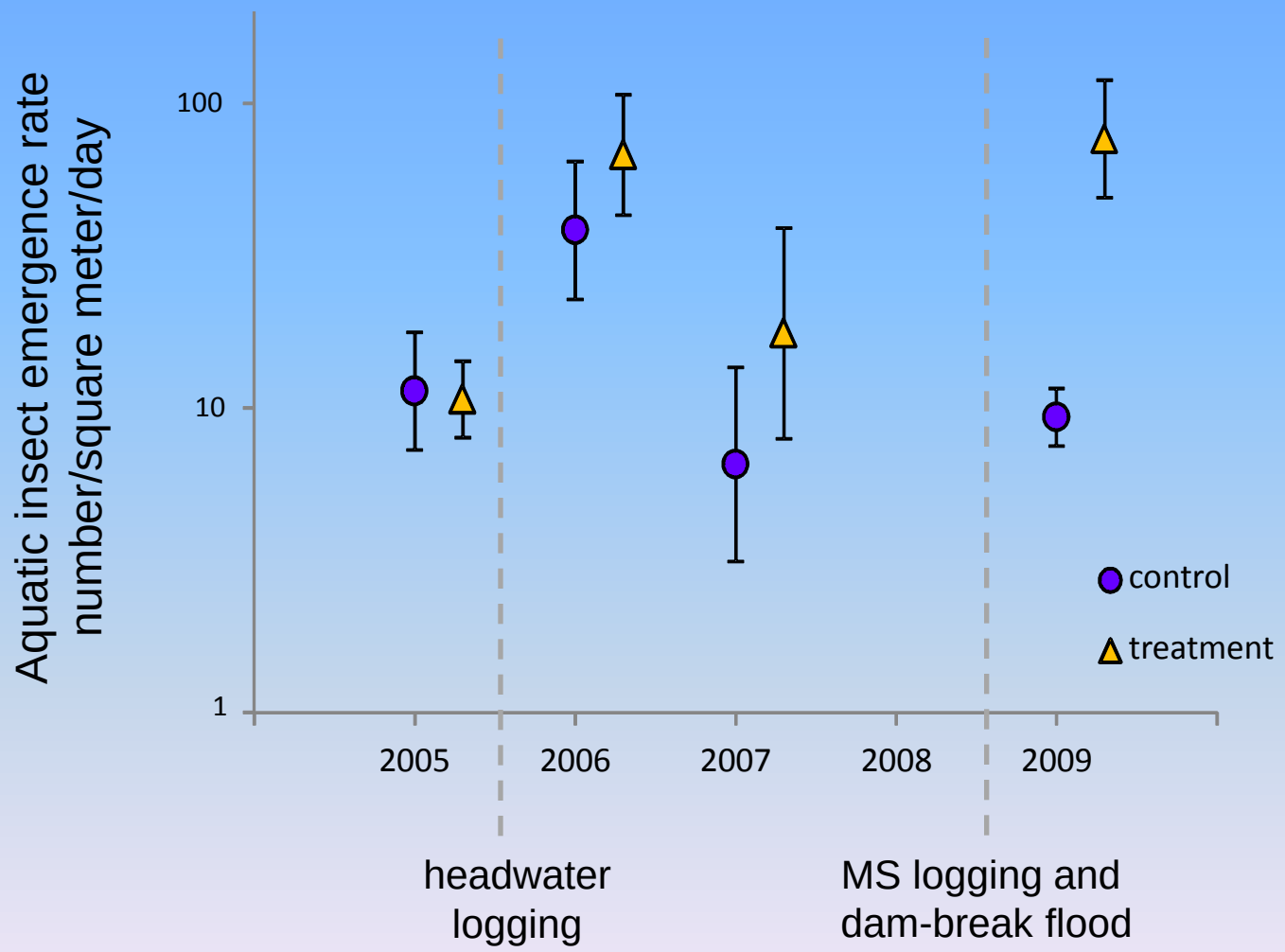
From *Hawkins et al. (1983)*

Invertebrate Response in Hinkle Headwaters:

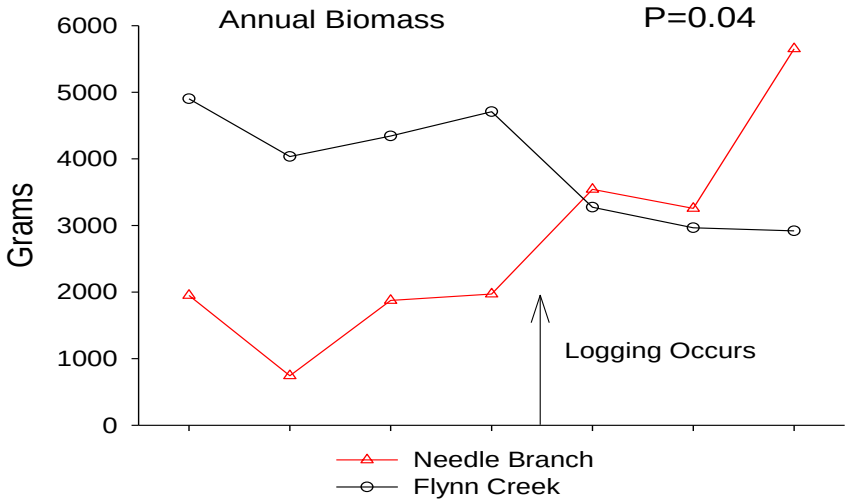
Densities Increased

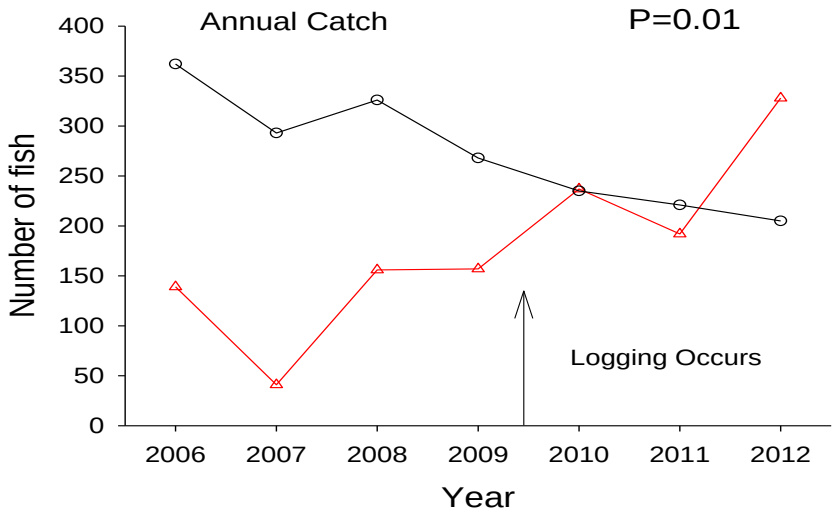


Invertebrate Mainstem Responses:
Adult Aquatic Emergence Increased

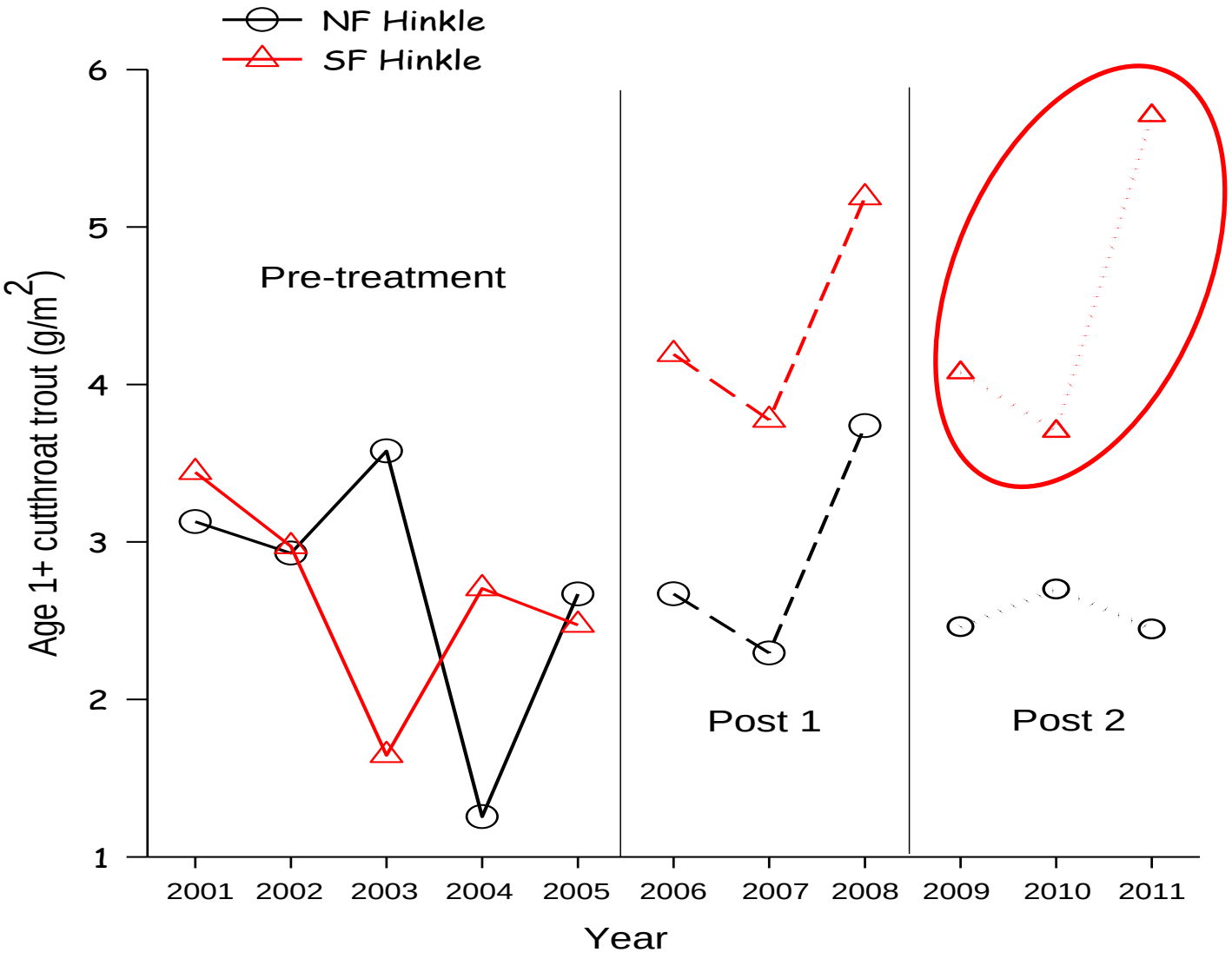


Needle Branch and Flynn Creek: Annual Total Biomass and Catch of Age 1+ Cutthroat Trout

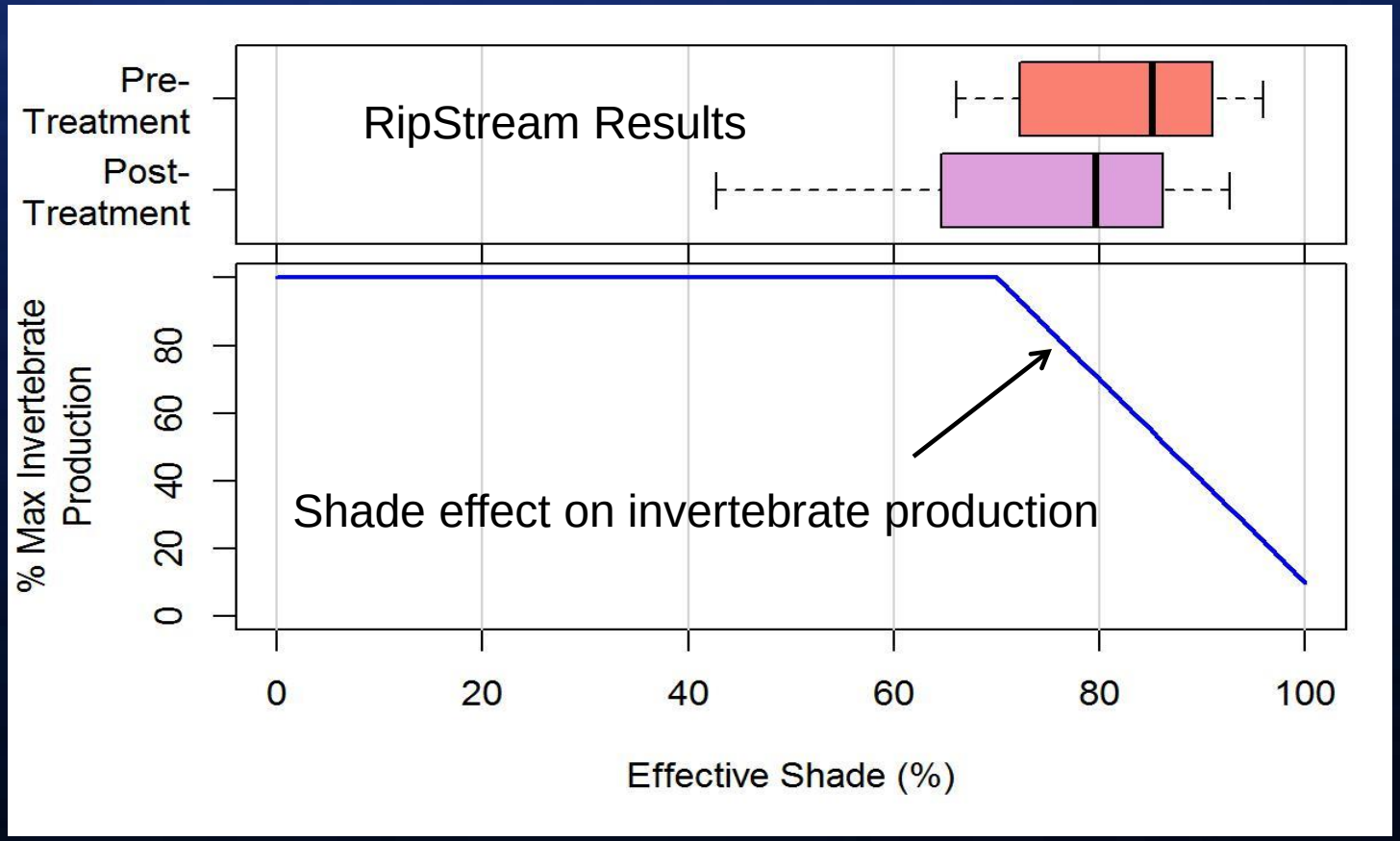




Mean Biomass Age 1+ Cutthroat Trout from Pools in North and South Fork Hinkle Tributaries

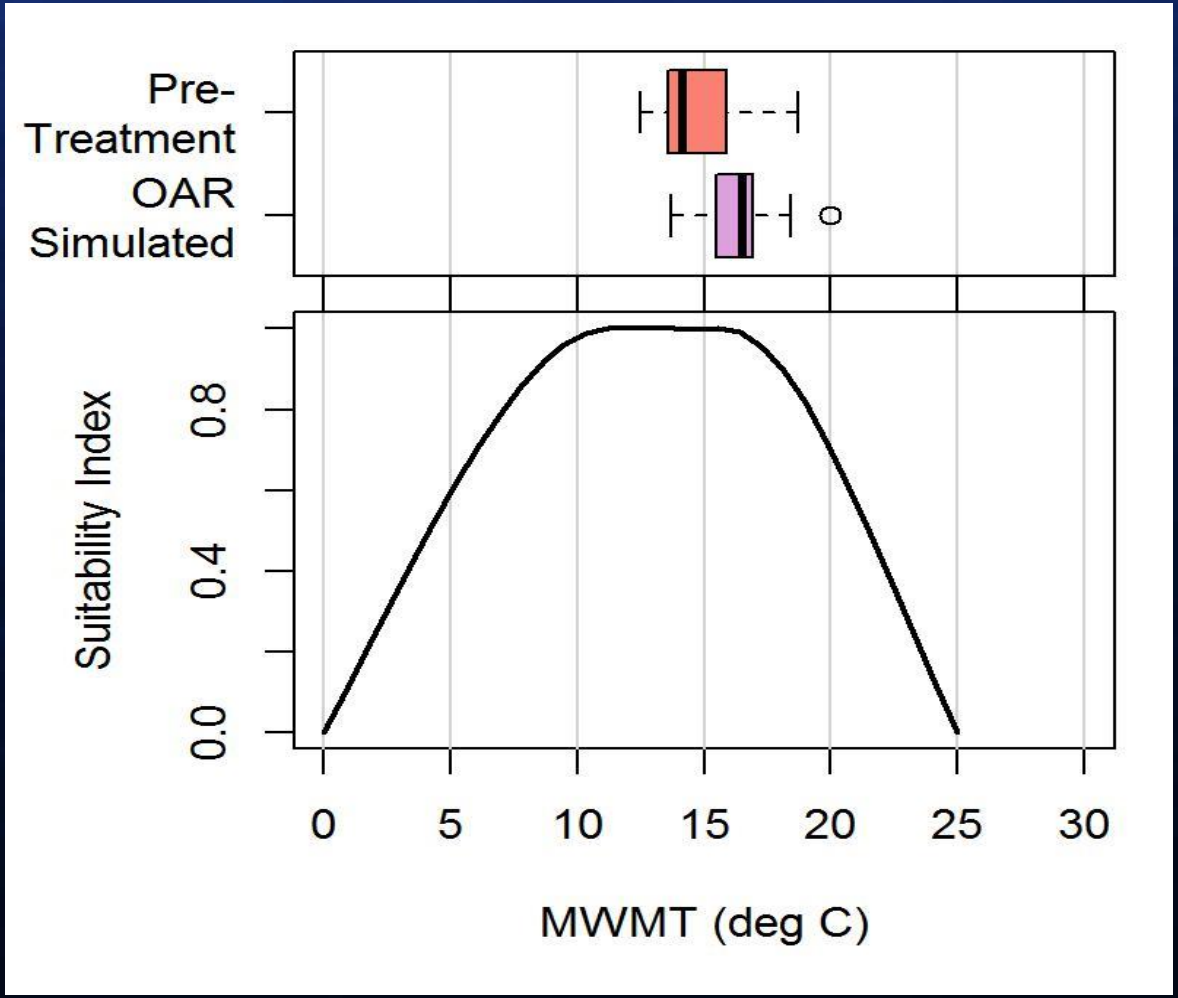


The Benefits of Increased Light

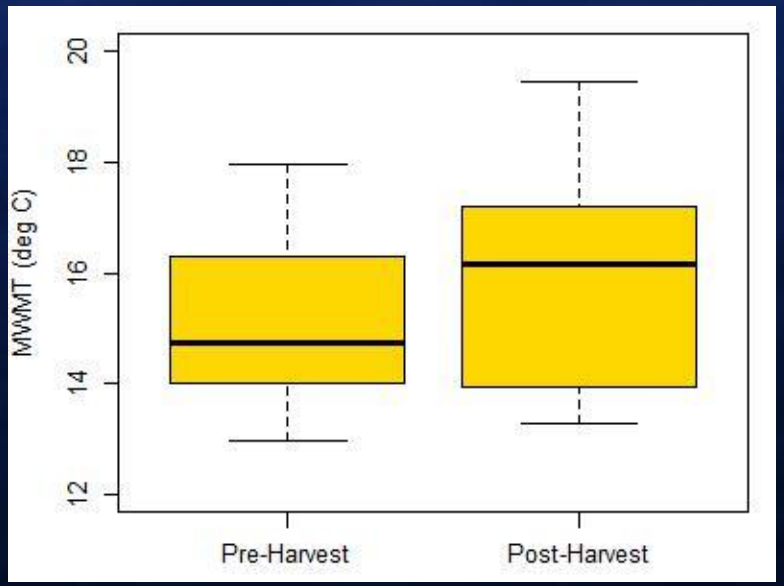


- *Derived from* McIntire 1975 and Carlson et al. 1990

Effect of Temperature on Probability-of-Use by Salmonids



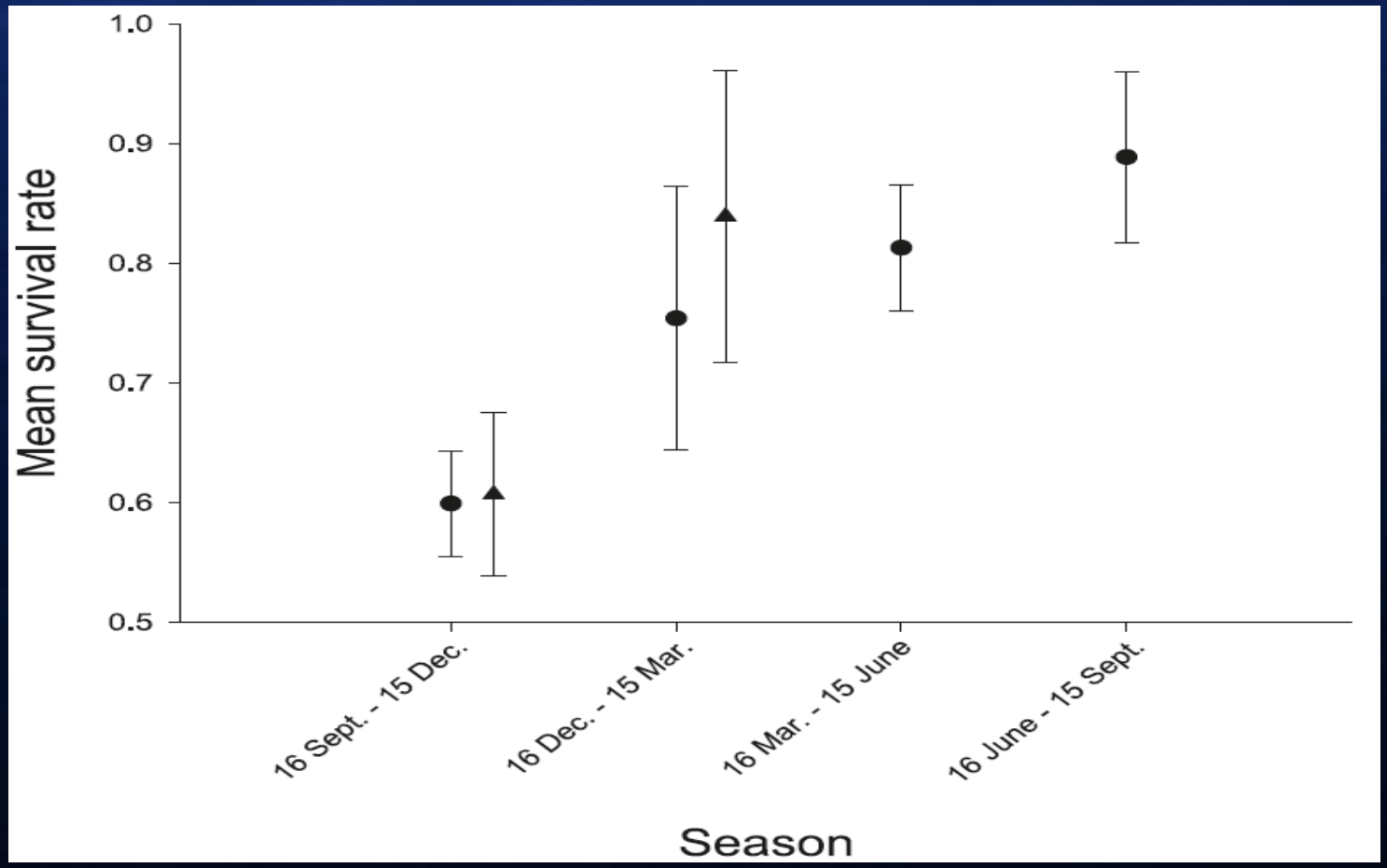
Stream Temperature Back in the Forest ~240 m Downstream



Limiting Factors for Fish Hinkle Creek

- Berger and Greswell (2009) - “Seasonal abiotic conditions affected the adult cutthroat trout population in [Hinkle Creek] watersheds, and low-discharge periods (e.g., autumn) were annual survival bottlenecks.”
- “maximum pool depth … was the only habitat characteristic that was correlated with mean survival during the autumn period.”
- Survival rates showed only a weak tendency to increase with higher temperatures

Cutthroat Trout Survival by Season in Hinkle Creek

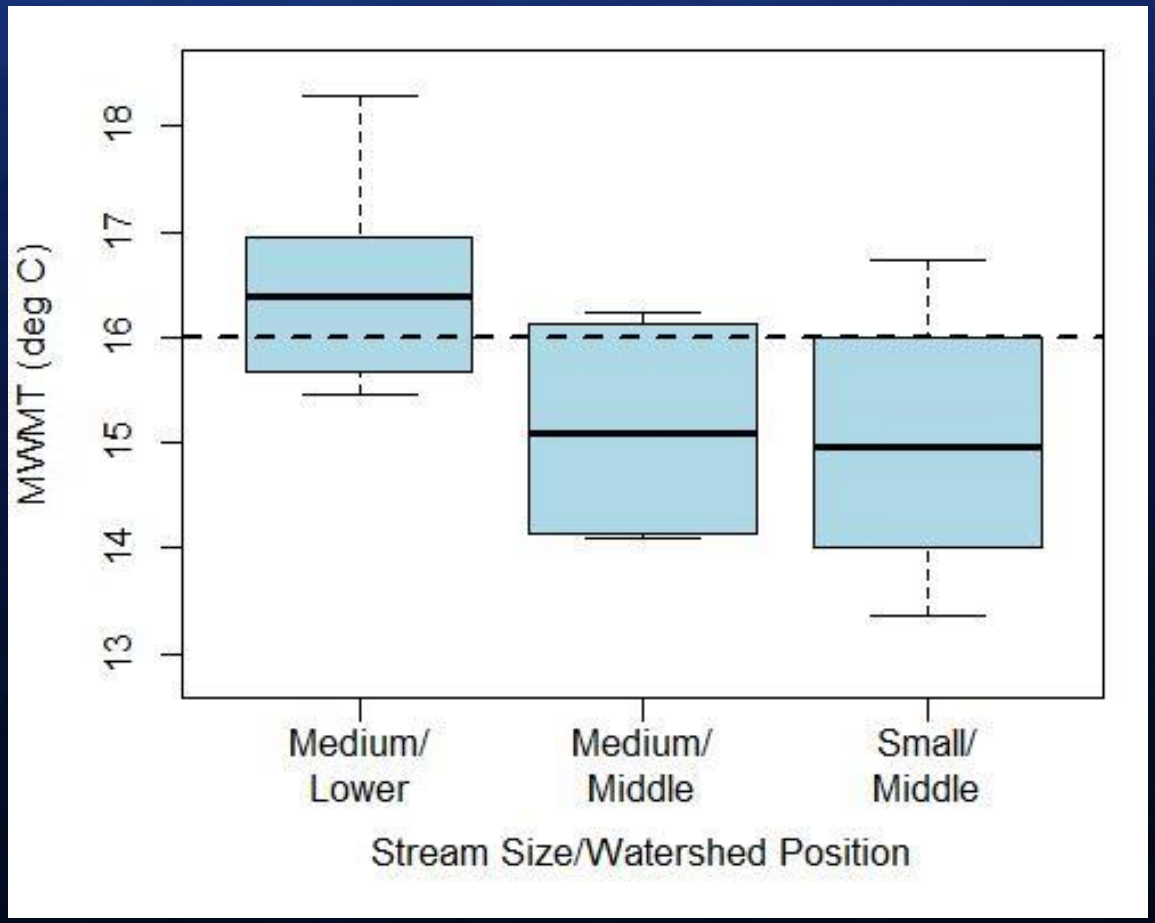


From *Berger and Greswell (2009)*

Conclusions for Headwater Streams

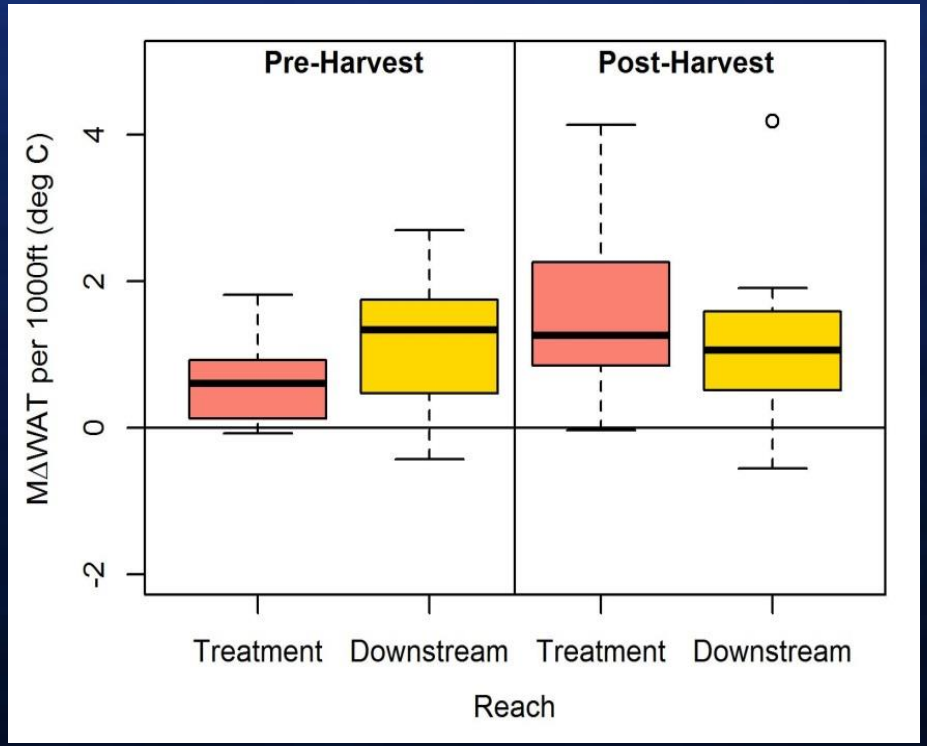
- Current OARs have eliminated most shade loss and temperature gain in small and medium streams.
- Stream temperatures in logged headwater streams remain in the optimum range for salmonids.
- There is no temperature gain (on average) after the stream has flowed 150 -300 m into the forest.
- More light increases primary and secondary production.
- Fish response has consistently been that numbers and growth increase after forest harvesting.
- The key bottleneck to fish survival in headwater streams will typically be low flows in Autumn that expose fish to predation.

Stream Temperature vs Elevation



19 streams on private timberlands - Oregon coast

What were the downstream effects of RipStream on stream temperature?



Private Forests

- Downstream changes in MWAT were greater/less than in treatment reaches
- A variety of factors could account for these increases and decreases
- From pre-harvest data, we posit that the equilibrium temperature is increasing
- Thus, post-harvest data do not suggest a significant effect downstream

Riparian Shading and the Risk-Reward Balance

Full Canopy

- Low light and limited food resources
- Low feeding efficiency
- Cool temperatures
- Fish rely more on cover
- Supports slow growth and low density of fish
- Balance toward risk aversion

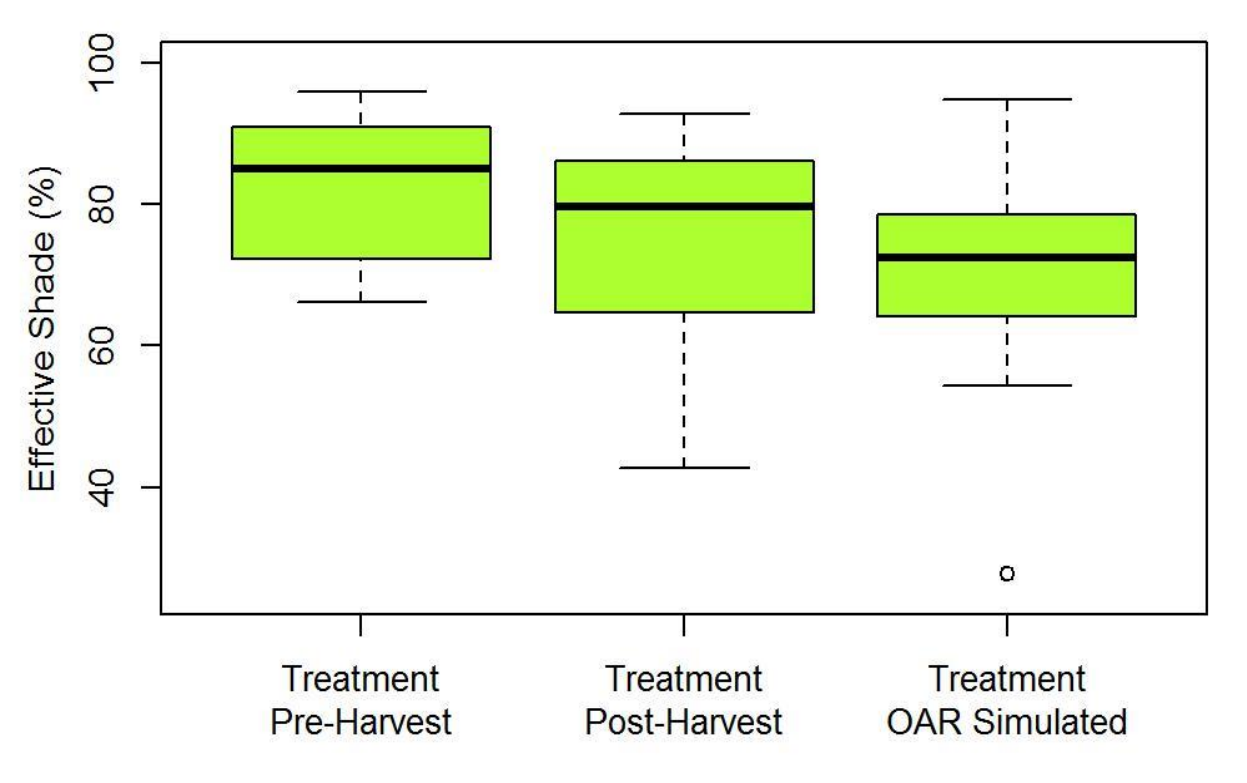
Reduced Canopy

- More light and increased food resources
- Higher feeding efficiency
- Increased temperature
- Fish rely less on cover
- Supports greater growth and density of fish
- Balance toward opportunity gain

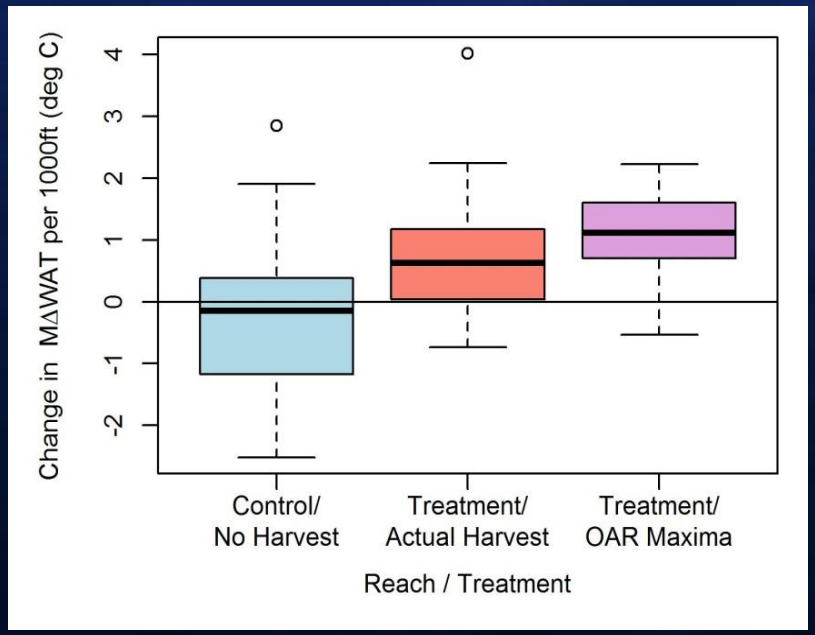
Downstream Effects

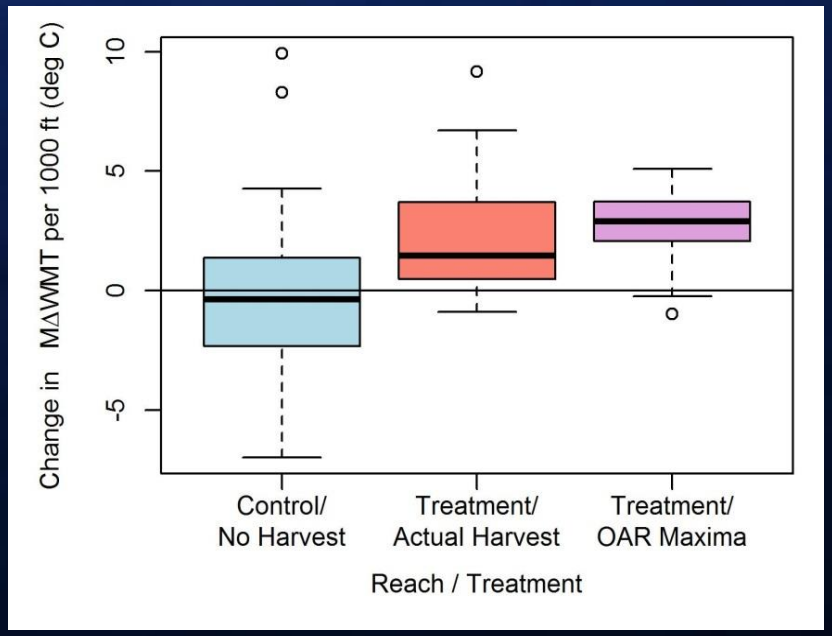
- Numerous studies show that temperature increases can be ameliorated in shaded areas downstream.
- An example…Wilzbach et al (2005)…
  - Solar radiation increased 10-fold after removal of alders within 20 m of streams in a second growth forest
  - Temperature increased 1.5 °C across a 100 m logged reach, but dropped 0.5 °C in the next 300 m downstream, and 1 °C after 430 m downstream."

The Effects of Riparian Buffers – The RipStream Study

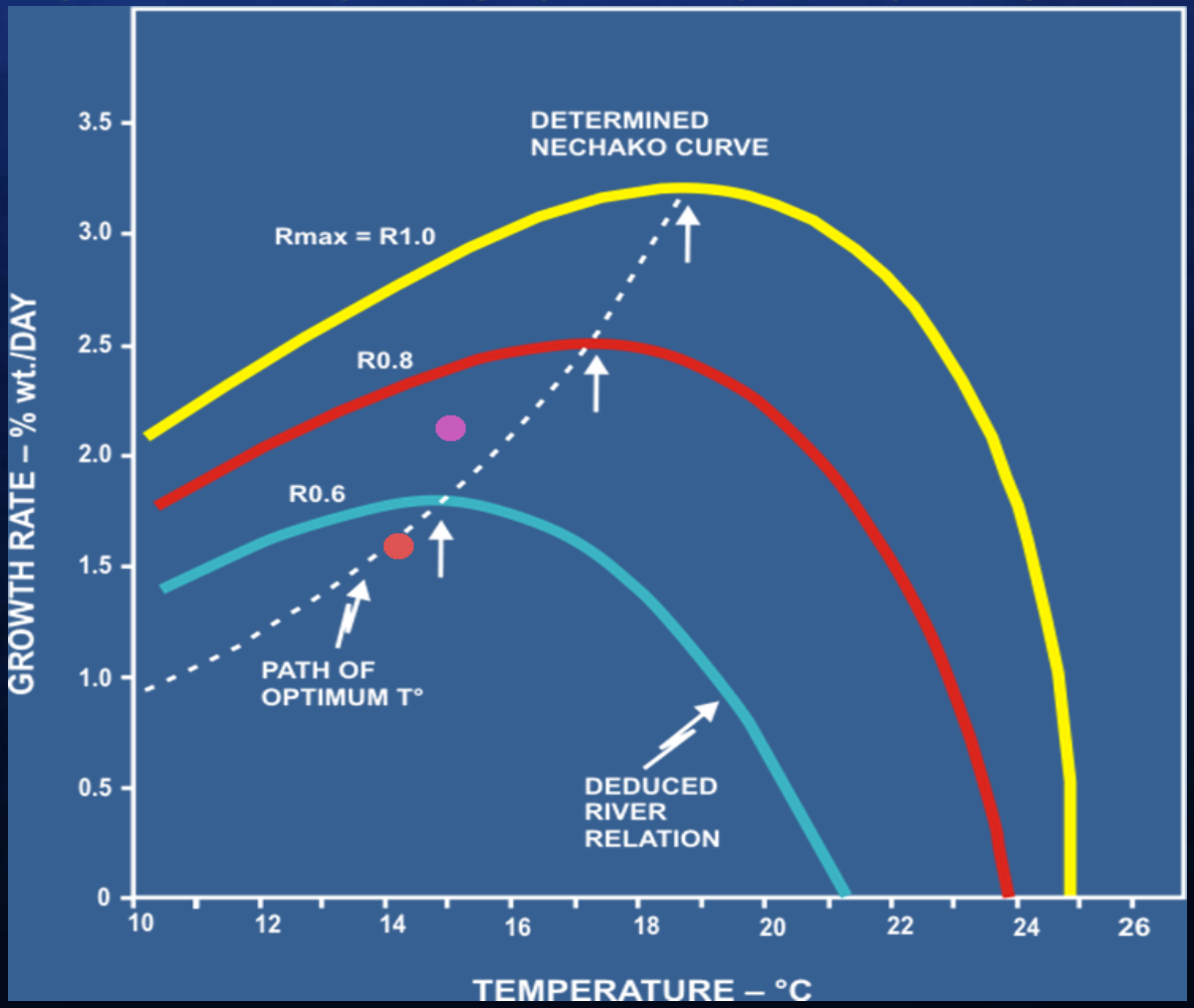


The Effects of Riparian Buffers – The RipStream Study





The Effect of Temperature on Growth of Salmon and Trout



From *Brett et al. (1982)*