Response of Coastal Cutthroat Trout to Timber Harvest in Previously Harvested Headwater Catchments

Objective

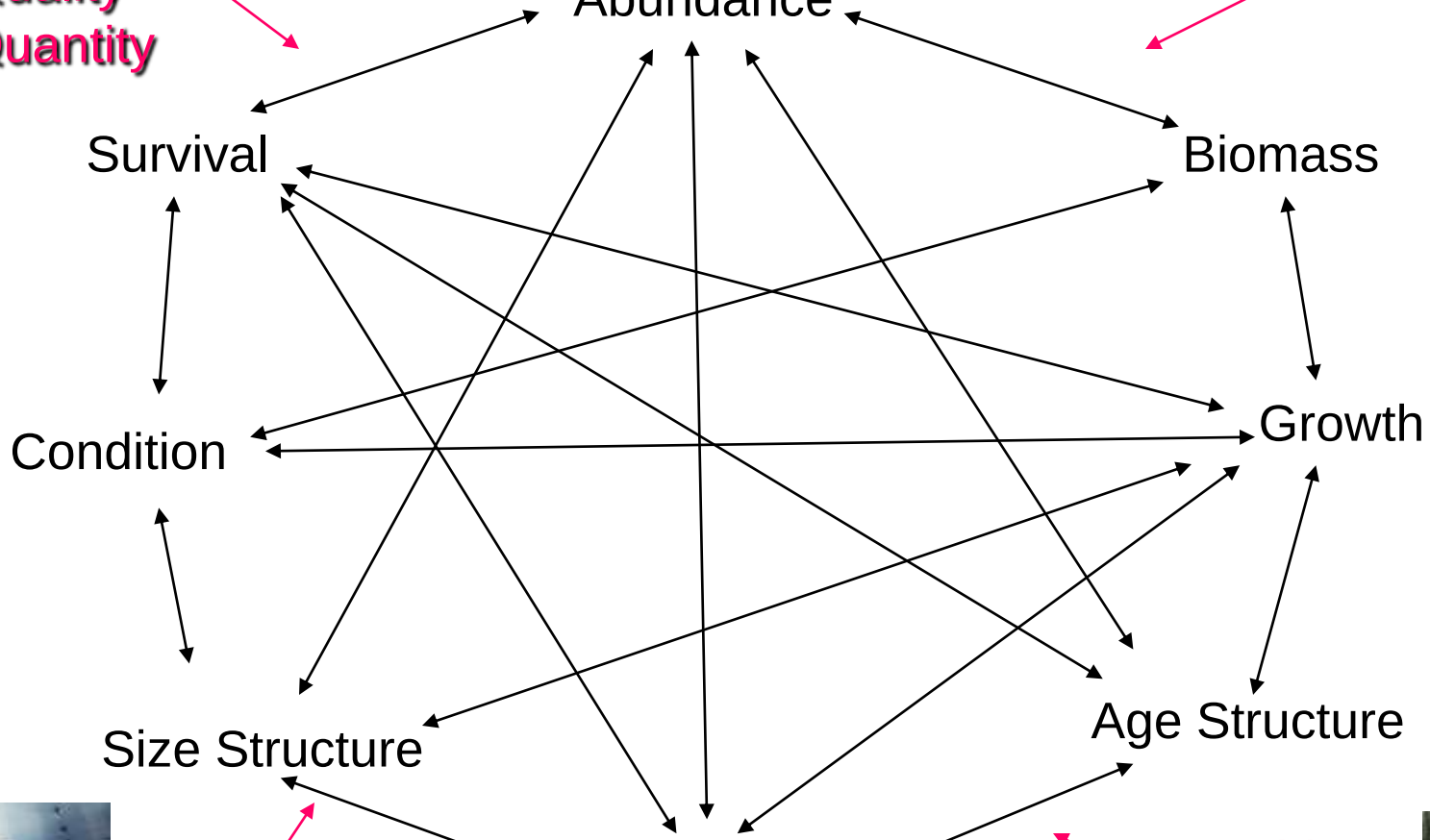
- Evaluate the response of coastal cutthroat trout in previously logged catchments to timber harvest under current forest practice regulations

Network of Biologic Response

Coastal Cutthroat Trout

Water
Quality
Quantity

Food



coho

Interspecific
Interactions

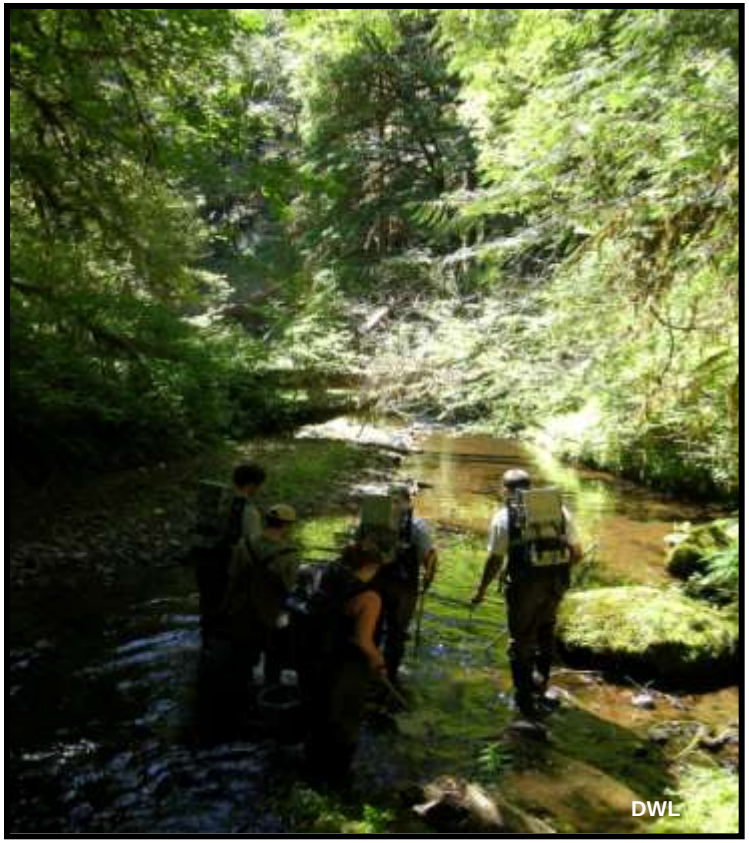
sculpin

steelhead

Habitat
Structure

Fish Capture and Tagging

Single pass electrofishing



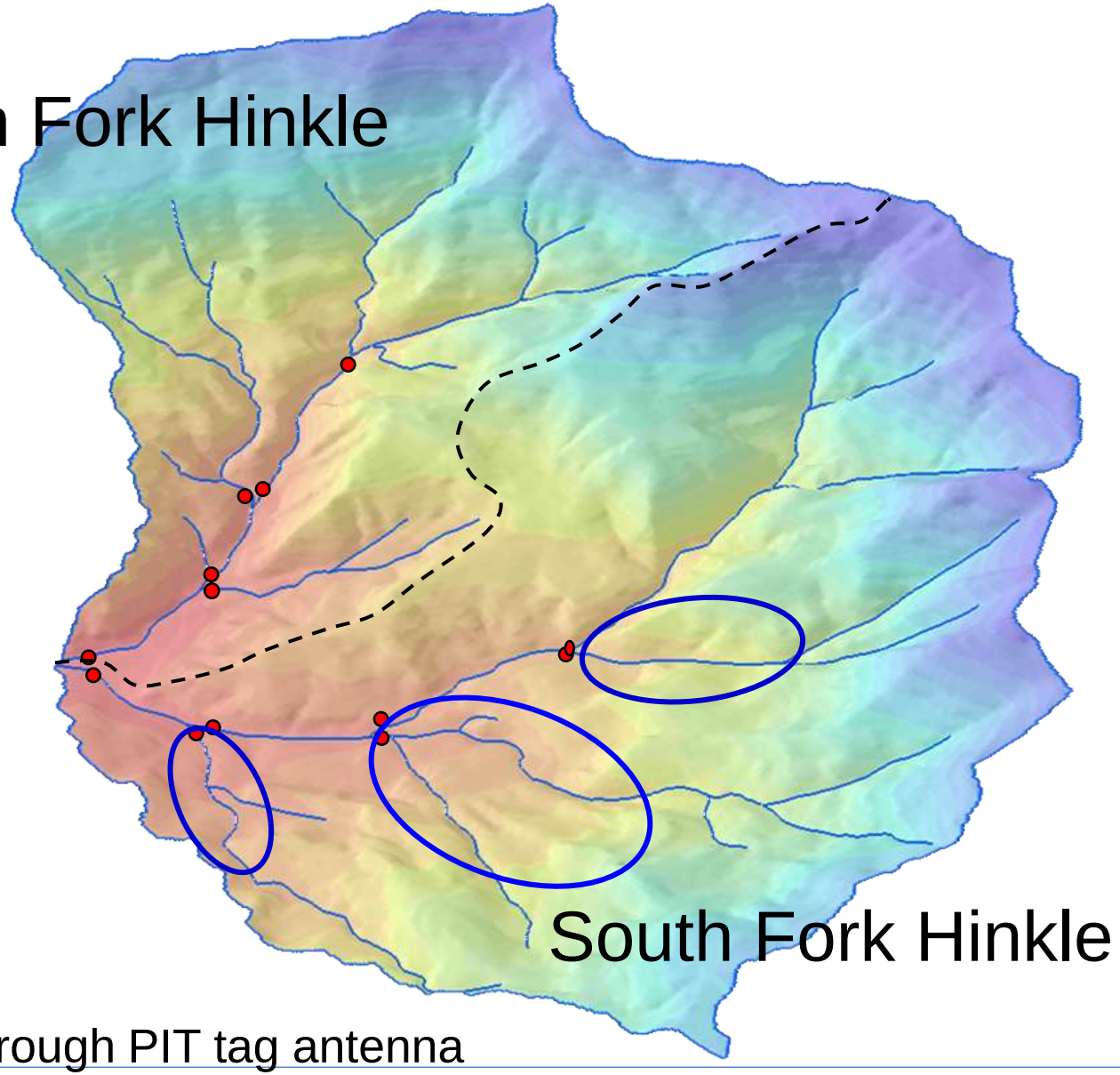
PIT-tags
(23mm half duplex)

Fish Monitoring

Mobile PIT-tag antennas

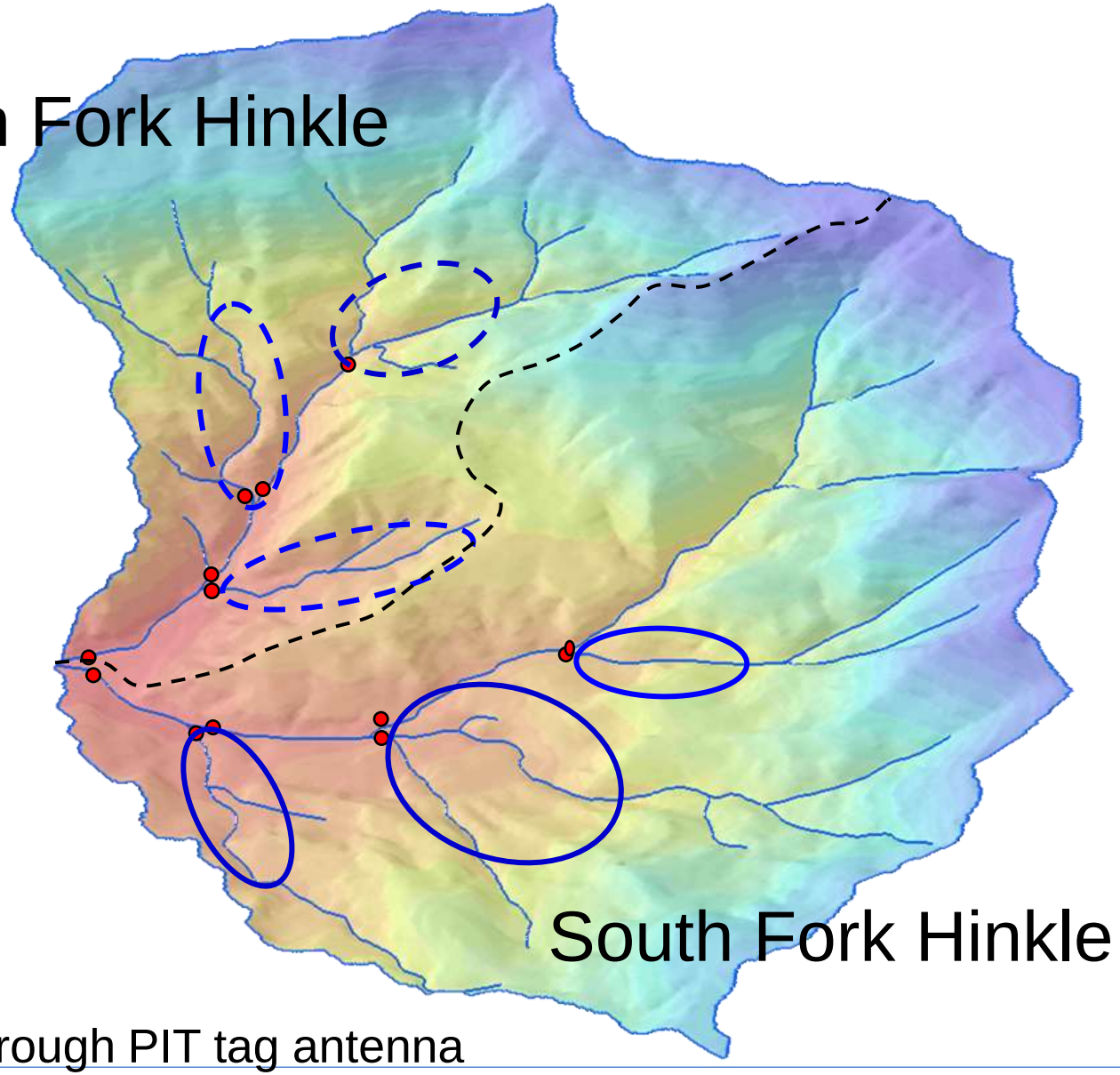
Stationary (gate) PIT-tag antennas

Tributary Scale



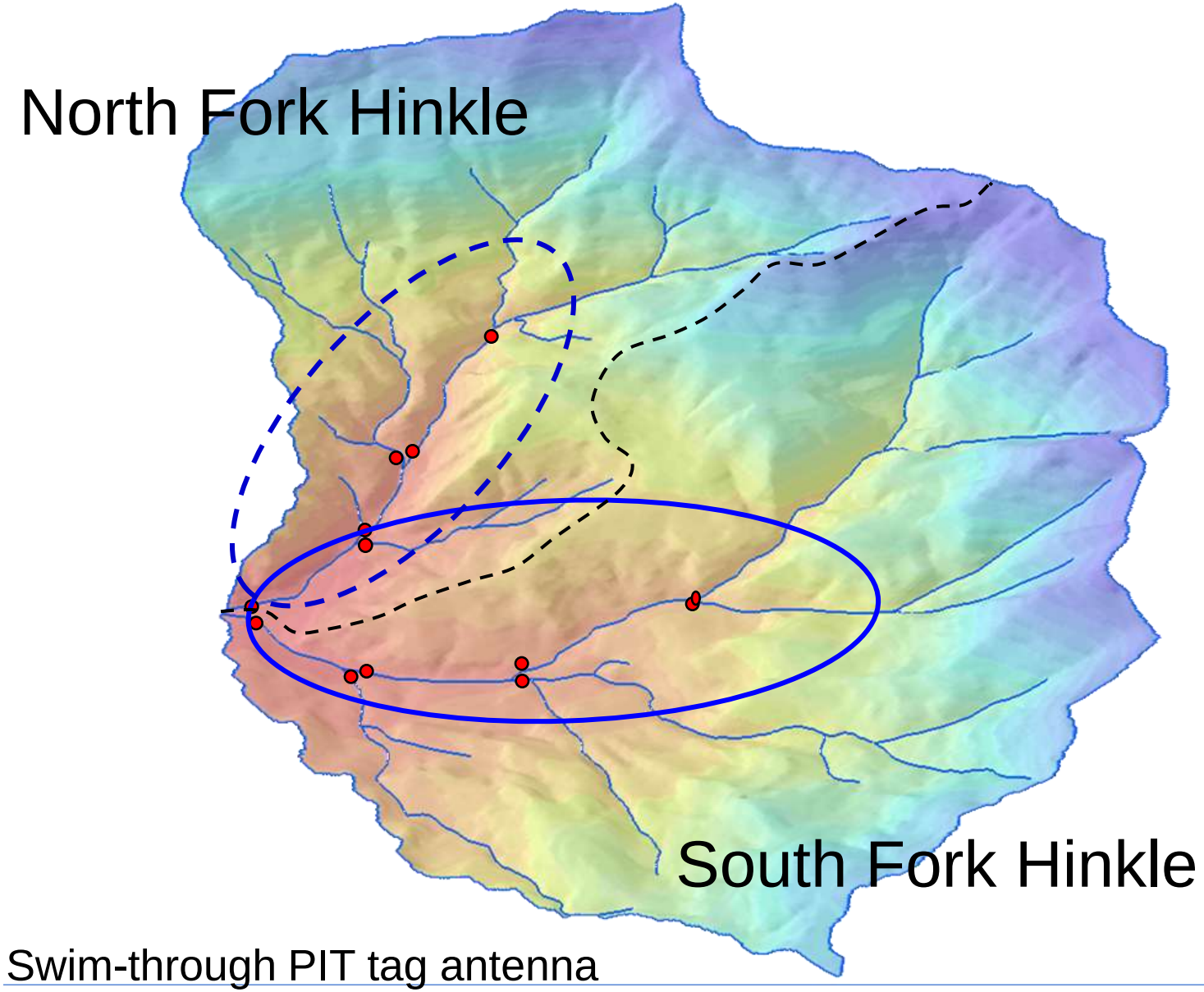
- Swim-through PIT tag antenna

Tributary Scale



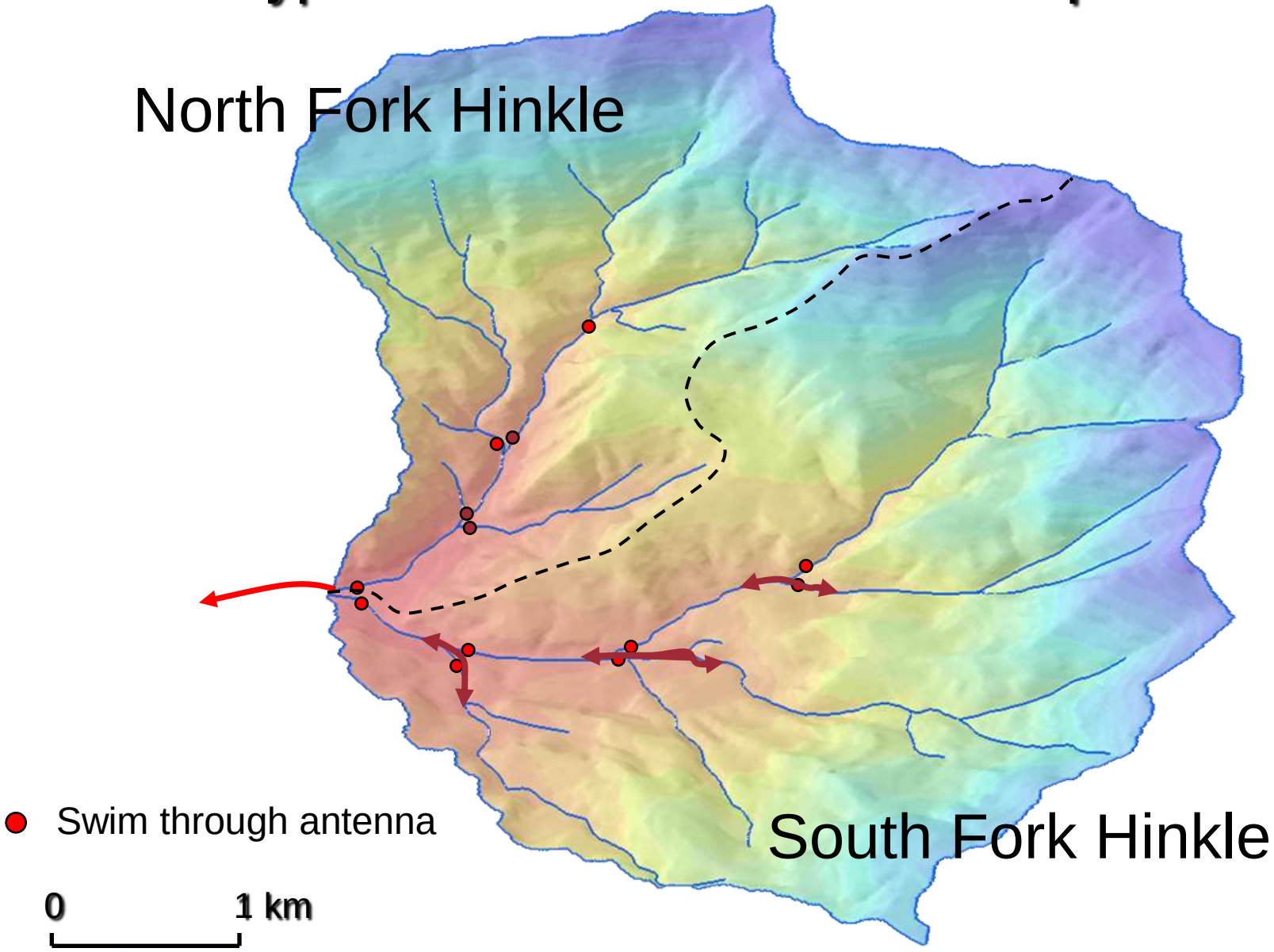
- Swim-through PIT tag antenna

Catchment Scale



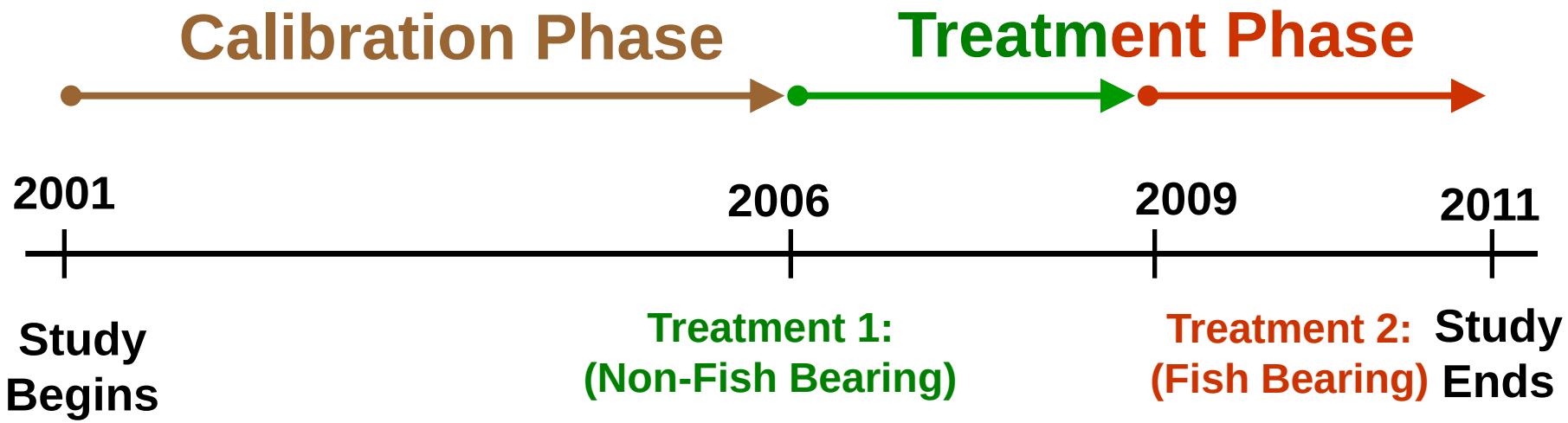
- Swim-through PIT tag antenna

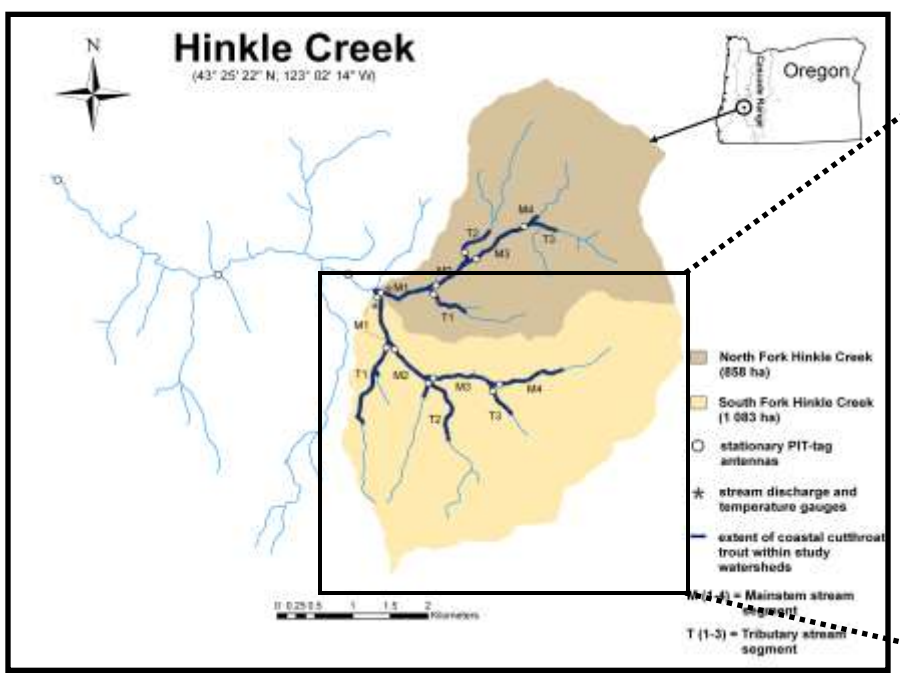
Hypotheses On Behavioral Response

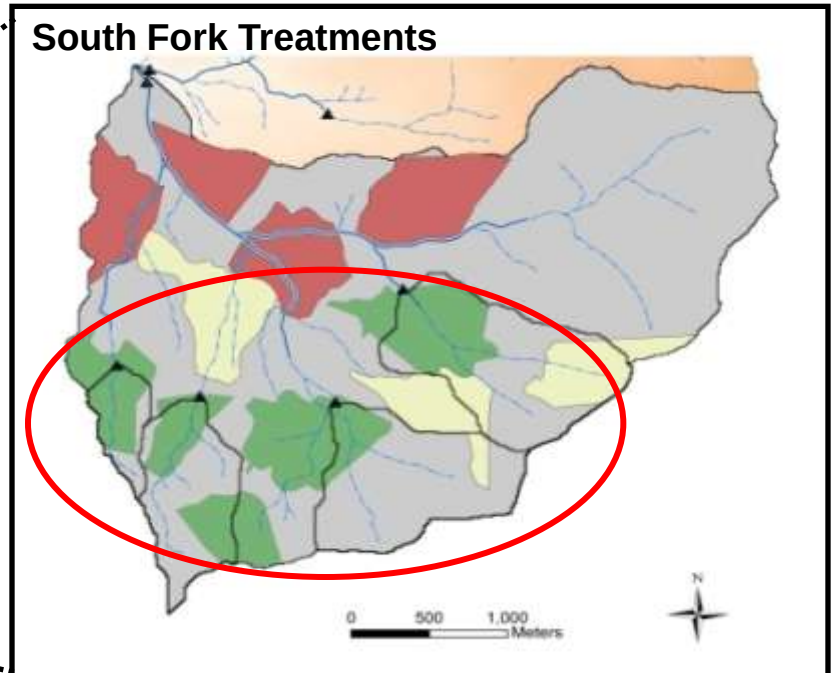


Hinkle Creek First Entry

Experimental Timeline: Hinkle Creek



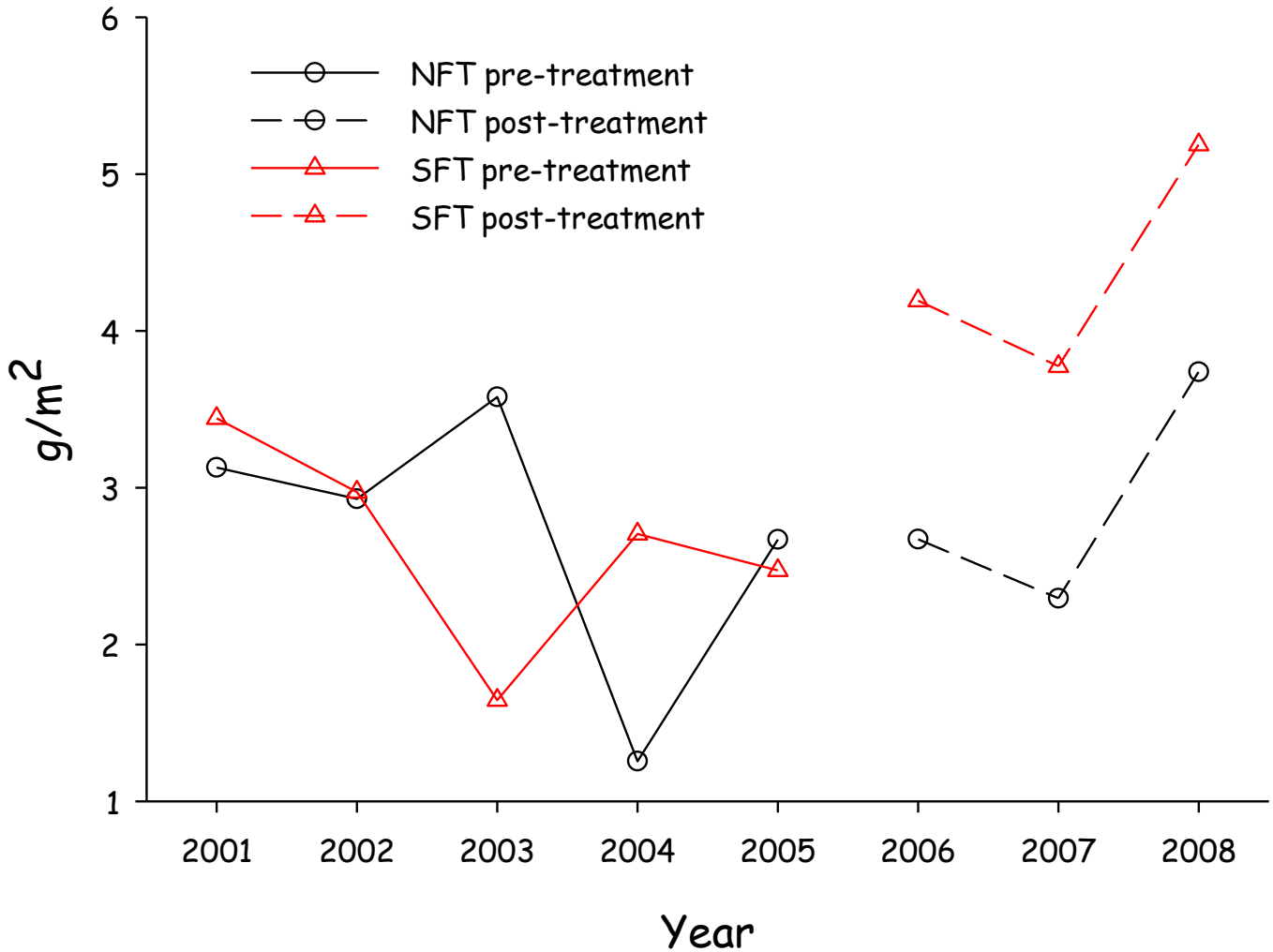




Currently streams without fish or a domestic water use do not require the retention of a standing tree buffer.

Results

Mean Biomass of Age 1+ Cutthroat Trout in Pool Habitats North and South Fork Hinkle Creek: Tributary Scale



Summary First Harvest Tributary Scale

Response	Age 1+ Cutthroat	Age 0 Trout
Biomass	↑	NC
Abundance	↑	NC
Size	NC	NC
Condition	NC	NC
Survival	NC	NA
Behavior	NC	NA

↑ = detectable treatment effect with relative increase in treated catchment

↓ = detectable treatment effect with relative decline in treated catchment

NC = no detectable treatment effect

NA = not measured for this age class or species

IP = in process

Summary First Harvest Catchment Scale

Response	Age 1+ Cutthroat	Age 0 Trout
Biomass	NC	NC
Abundance	NC	NC
Size	NC	NC
Growth	NC	NA
Condition	NC	NC
Survival	NC	NA
Behavior	NC	NA

↑ = detectable treatment effect with relative increase in treated catchment

↓ = detectable treatment effect with relative decline in treated catchment

NC = no detectable treatment effect

NA = not measured for this age class or species

IP = in process

Experimental Timeline: Hinkle Creek

Calibration Phase

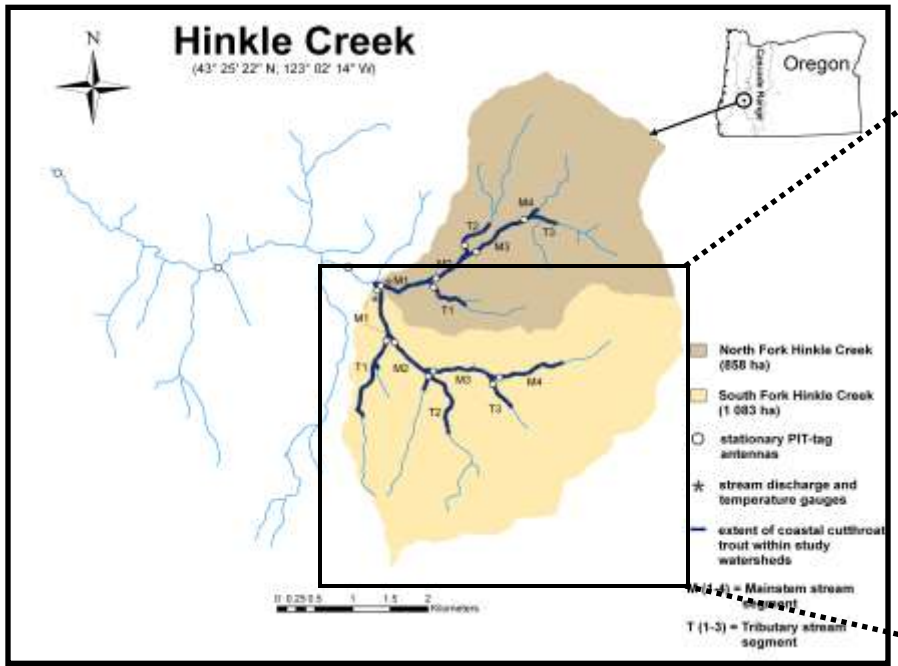
Treatment Phase

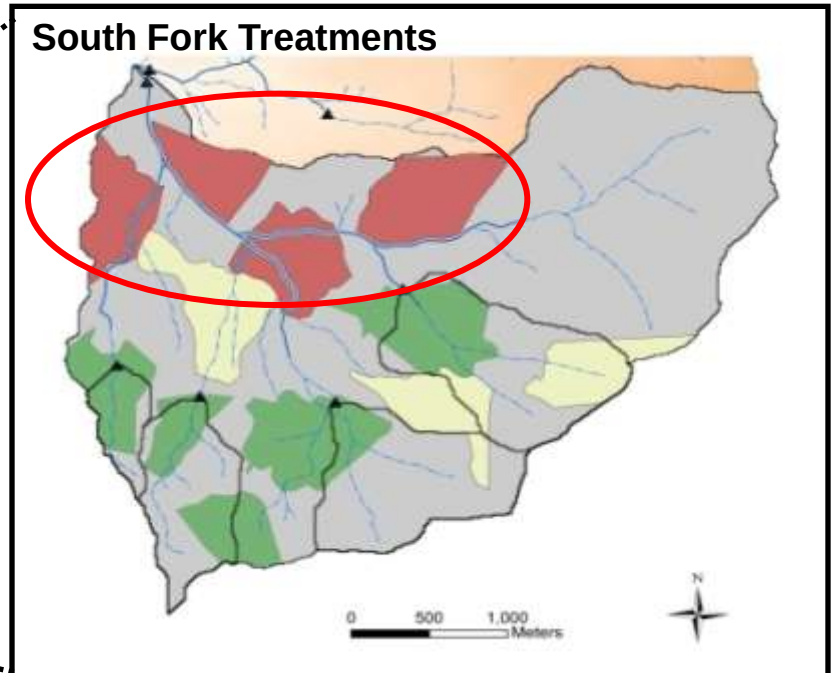
2001 — Study Begins

2006 — Treatment 1: (Non-Fish Bearing)

2009 — Treatment 2: Log 4 MU (Fish Bearing)

2011 — Study Ends





Summary Second Harvest Tributary Scale

Response	Age 1+ Cutthroat	Age 0 Trout
Biomass	↑	↑
Abundance	NC	↑
Size	↑	↑
Condition	NC	NC
Survival	NC	NA
Behavior	NC	NA

↑ = detectable treatment effect with relative increase in treated catchment

↓ = detectable treatment effect with relative decline in treated catchment

NC = no detectable treatment effect

NA = not measured for this age class or species

IP = in process

Summary Second Harvest Catchment Scale

Response	Age 1+ Cutthroat	Age 0 Trout
Biomass	NC	↑
Abundance	NC	↑
Size	↑	↑
Growth	↑	NA
Condition	NC	NC
Survival	IP	NA
Behavior	NC	NA

↑ = detectable treatment effect with relative increase in treated catchment

↓ = detectable treatment effect with relative decline in treated catchment

NC = no detectable treatment effect

NA = not measured for this age class or species

IP = in process

Habitat Summary Second Harvest

Response	Tributary	Catchment
Pool Area	NC	NC
Pool Length	NC	NC
Pool Depth	NC	NC
Fine Sediment	NC	NC

↑ = detectable treatment effect with relative increase in treated catchment

↓ = detectable treatment effect with relative decline in treated catchment

NC = no detectable treatment effect

NA = not measured for this age class or species

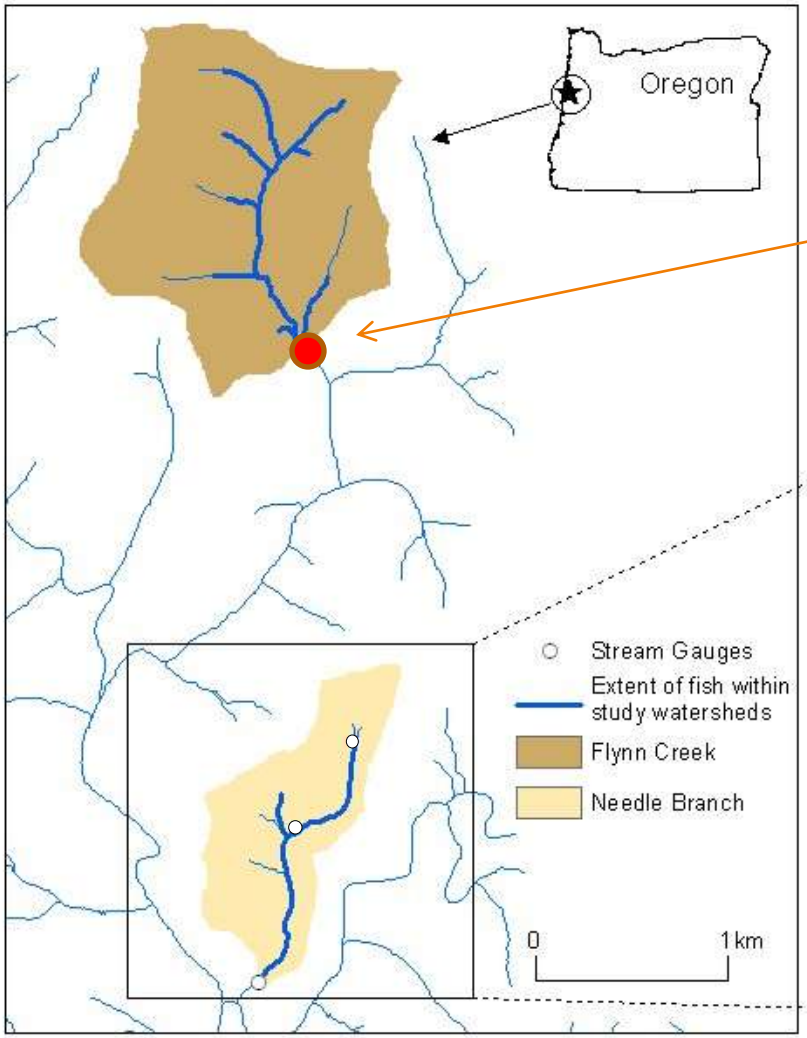
IP = in process

Alsea First Harvest

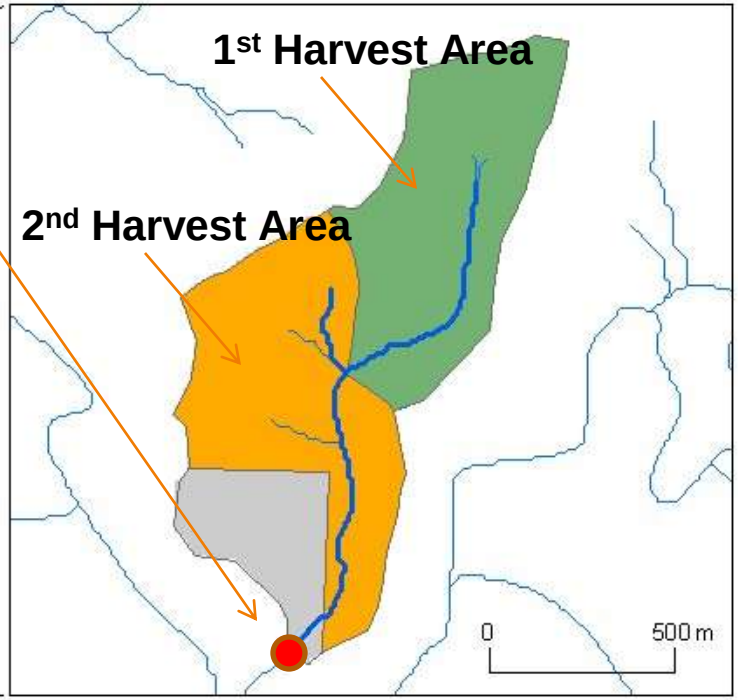
Experimental Timeline: Alsea Watershed Study Revisted

Calibration Phase — **1st Harvest** — **2nd Harvest**

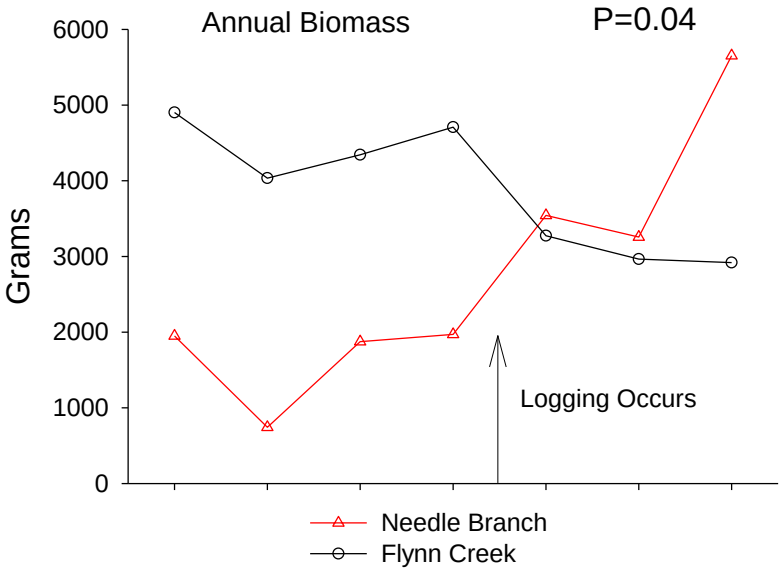
2006 Study Begins — **2009** — **2014** — **2017** Study Ends

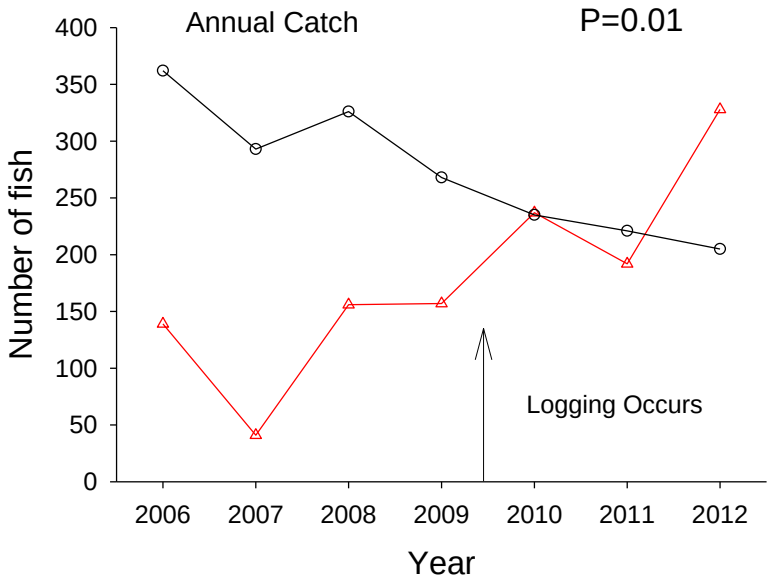


Swim Through PIT Tag Antennas



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





Summary First Harvest

Response	Age 1+ Cutthroat	Age 0 Trout	Coho
Biomass	↑	NC	NC
Abundance	↑	NC	NC
Size	NC	↓	NC
Growth	NC	NA	NA
Condition	NC	NC	NC
Survival	IP	NA	NA
Behavior	NC	NA	NA

↑ = detectable treatment effect with relative increase in treated catchment

↓ = detectable treatment effect with relative decline in treated catchment

NC = no detectable treatment effect

NA = not measured for this age class or species

IP = in process

Habitat Summary Harvest

Response	
Pool Area	↑
Pool Length	NC
Pool Depth	NC
Fine Sediment	NC
Cover (All)	NC

↑ = detectable treatment effect with relative increase in treated catchment

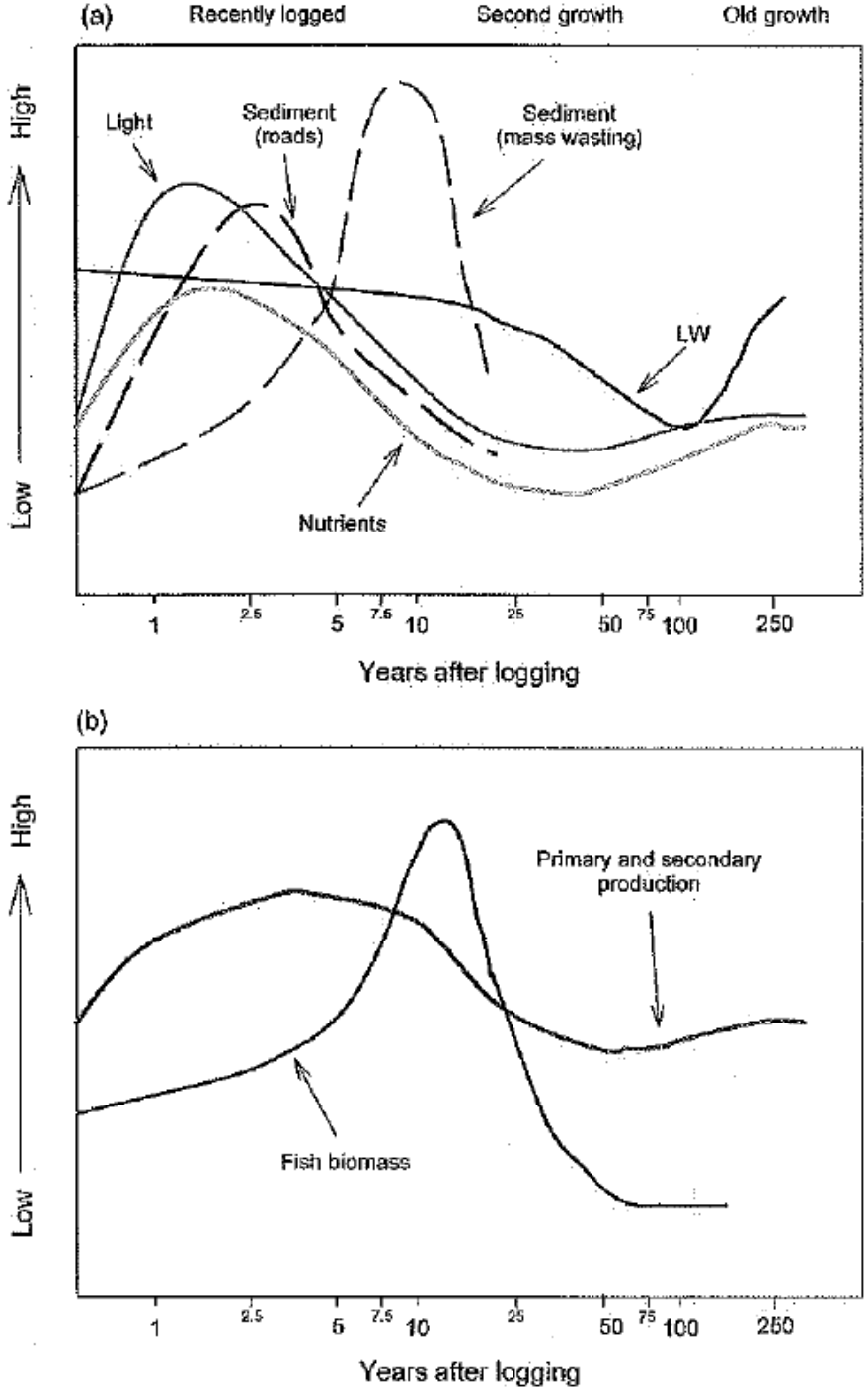
↓ = detectable treatment effect with relative decline in treated catchment

NC = no detectable treatment effect

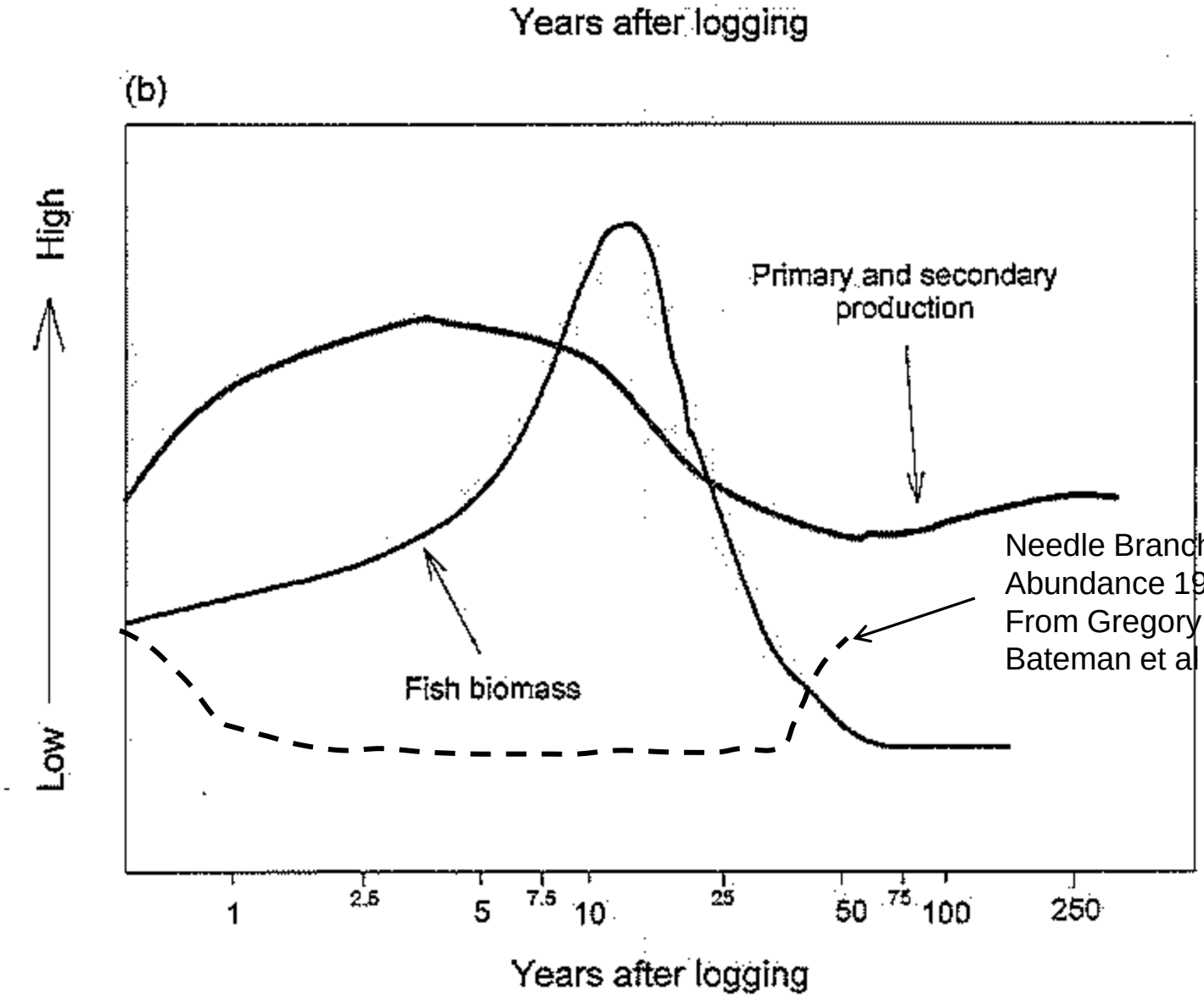
NA = not measured for this age class or species

IP = in process

Hypothetical Response Curves from Mellina and Hinch (2009)

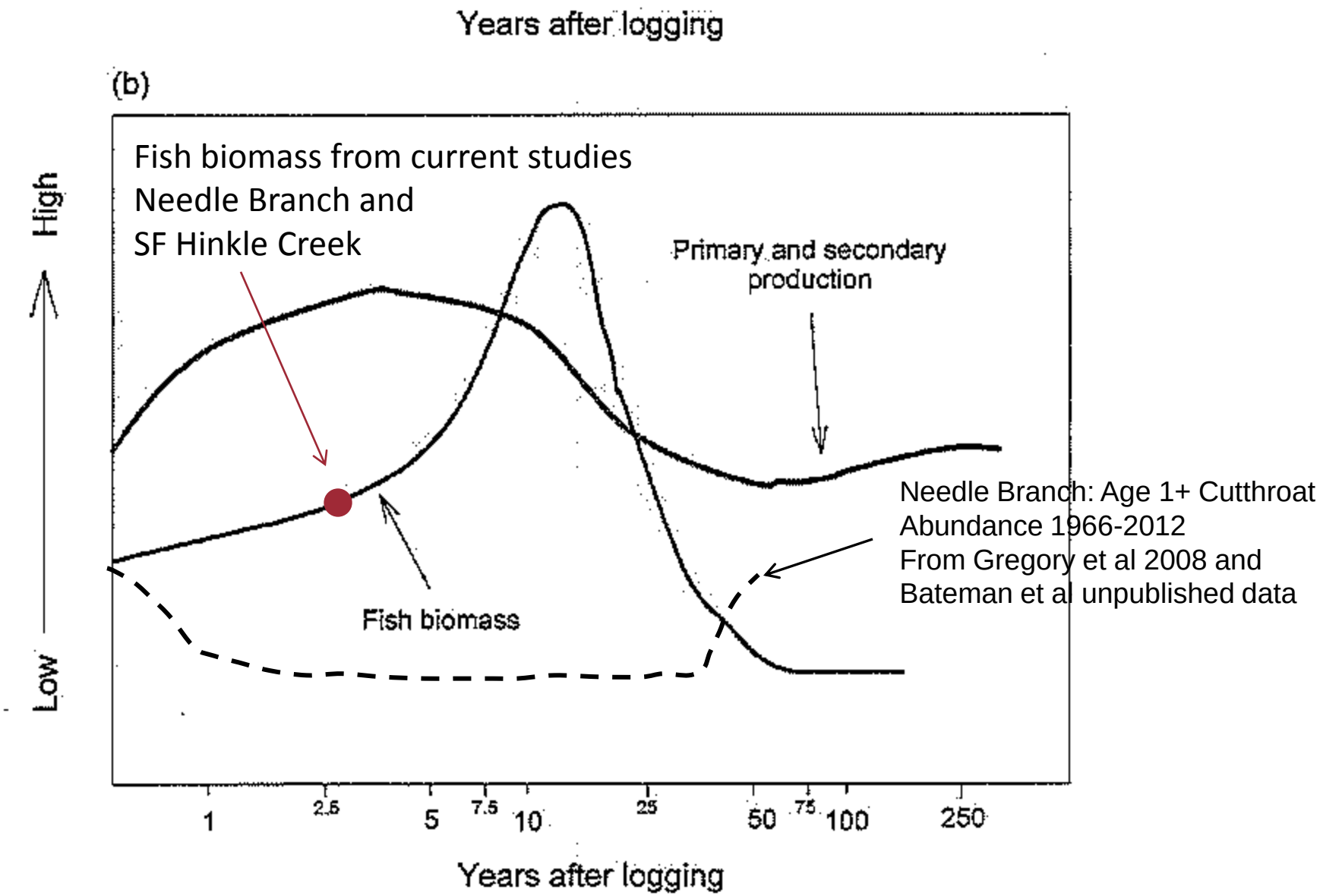


Hypothetical Response Curve from Mellina and Hinch (2009)

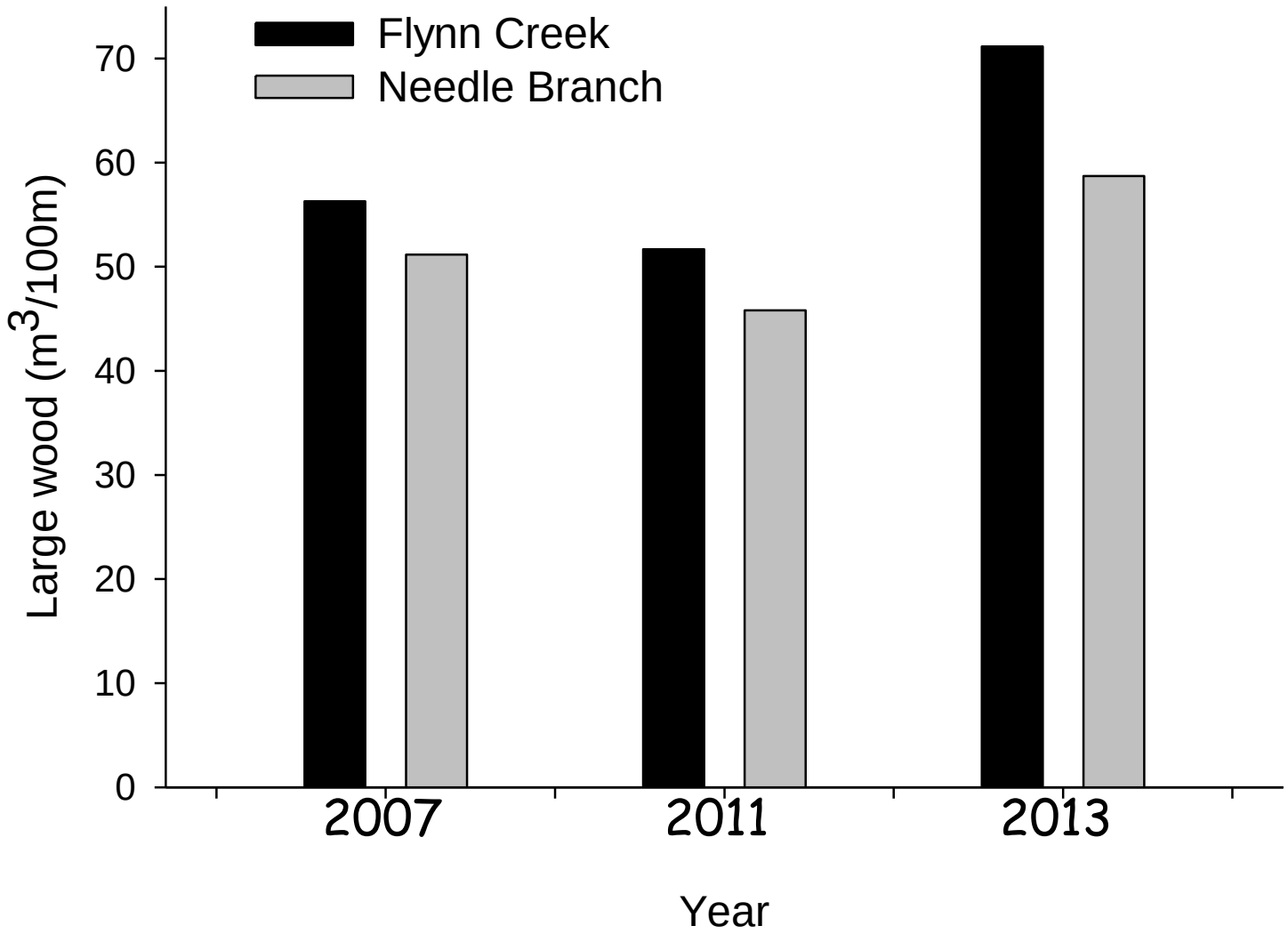


Needle Branch: Age 1+ Cutthroat Abundance 1966-2012
From Gregory et al 2008 and Bateman et al unpublished data

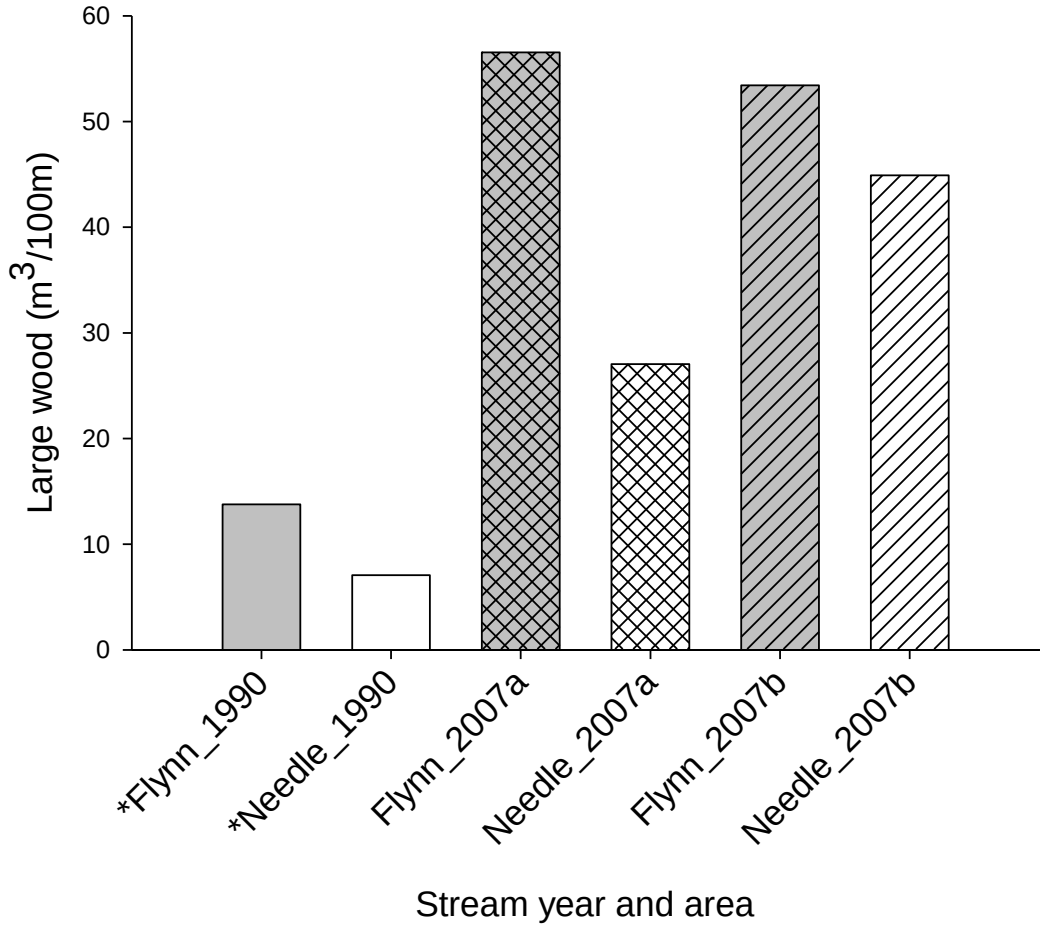
Hypothetical Response Curve from Mellina and Hinch (2009)



Total Large Wood Volume by Year from Flynn Creek and Needle Branch (10cm by 2m)



Large Wood VolumeThrough Time and by Location for Flynn Creek and Needle Branch (15cm by 2m)



* Veldhuisen, C.N. 1990. Coarse Woody Debris in Streams of the Drift Creek Basin, Oregon. M.S. Thesis. Oregon State University.

a = the portions of the watersheds sampled during AWS and by Veldhuisen

b = the portions of the watersheds with fish that were not typicall sampled during the AWS and upstream from the areas of large wood removal in Needle Branch

What Do We Know!

Hinkle Creek

- Headwater harvest:

  only increased abundance and biomass of age 1+ cutthroat trout in tributaries

- Downstream harvest:

  Biomass of all trout increased at catchment scale
  Size increased for age 0 trout and 1+cutthroat
  growth increased for age 1+ cutthroat

Alsea

- Increased biomass and abundance of age 1+ cutthroat trout
- Decline in length of age 0 cutthroat trout

What Do We Know!

Overall

- Three years post-harvest: results for cutthroat trout are similar to those predicted from other studies

- The response of steelhead and coho differed from that of cutthroat trout

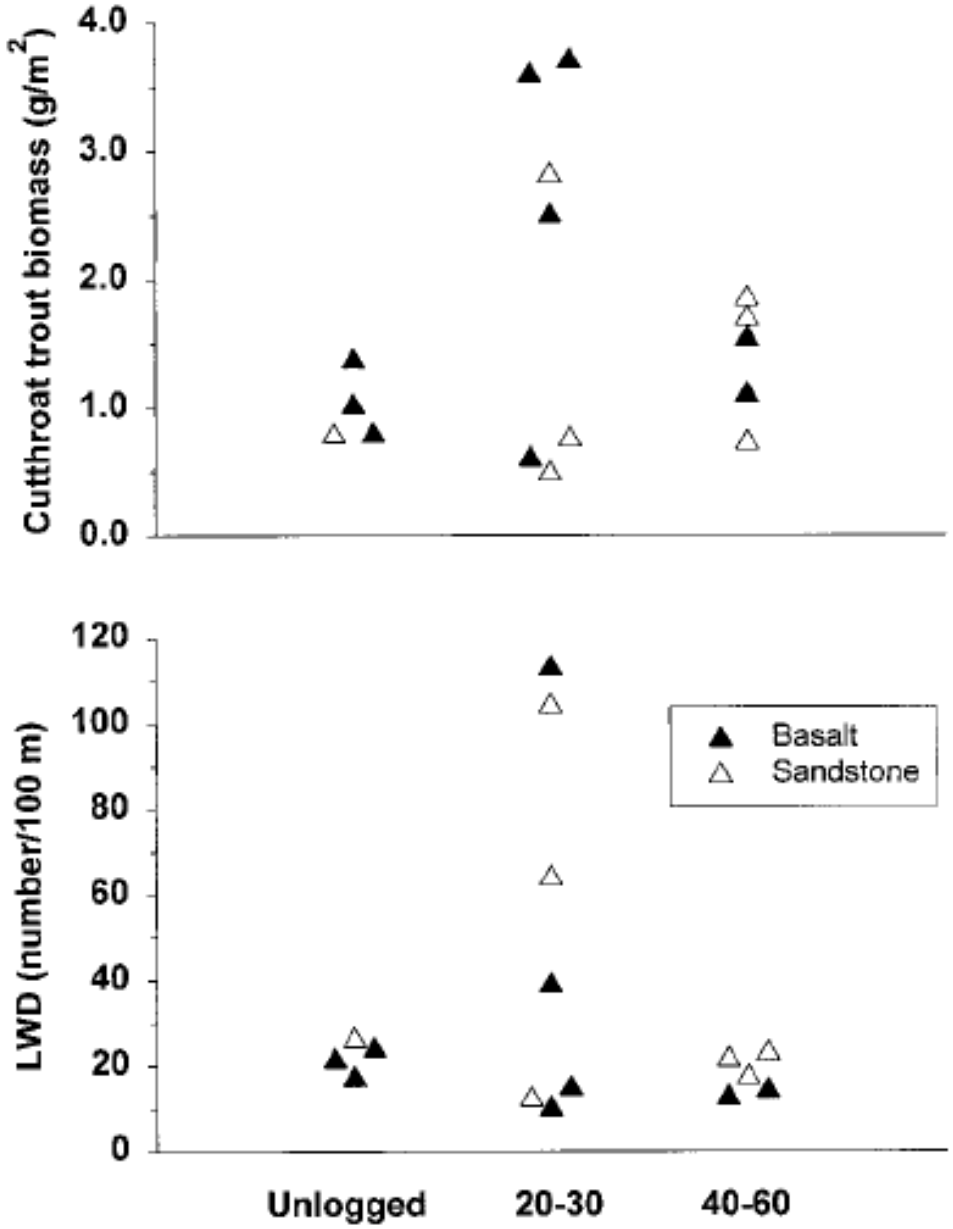
- No evidence of acute negative effects on habitat

What We Think!

- Increases in abundance/biomass will eventually peak and then decline

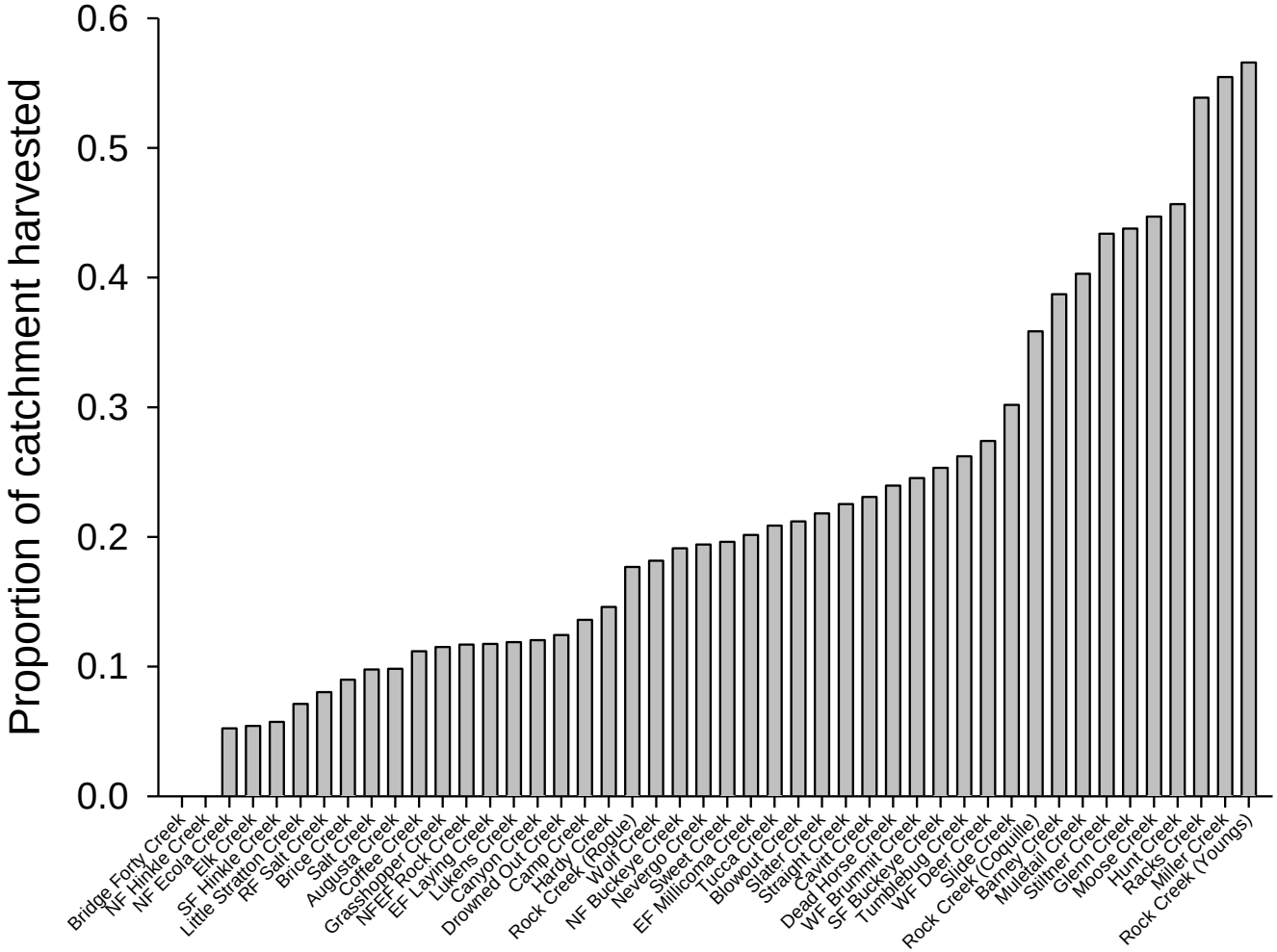
What We Hope to Learn!

- How will fish respond through time in these watersheds
- What the important changes in associated habitat will be



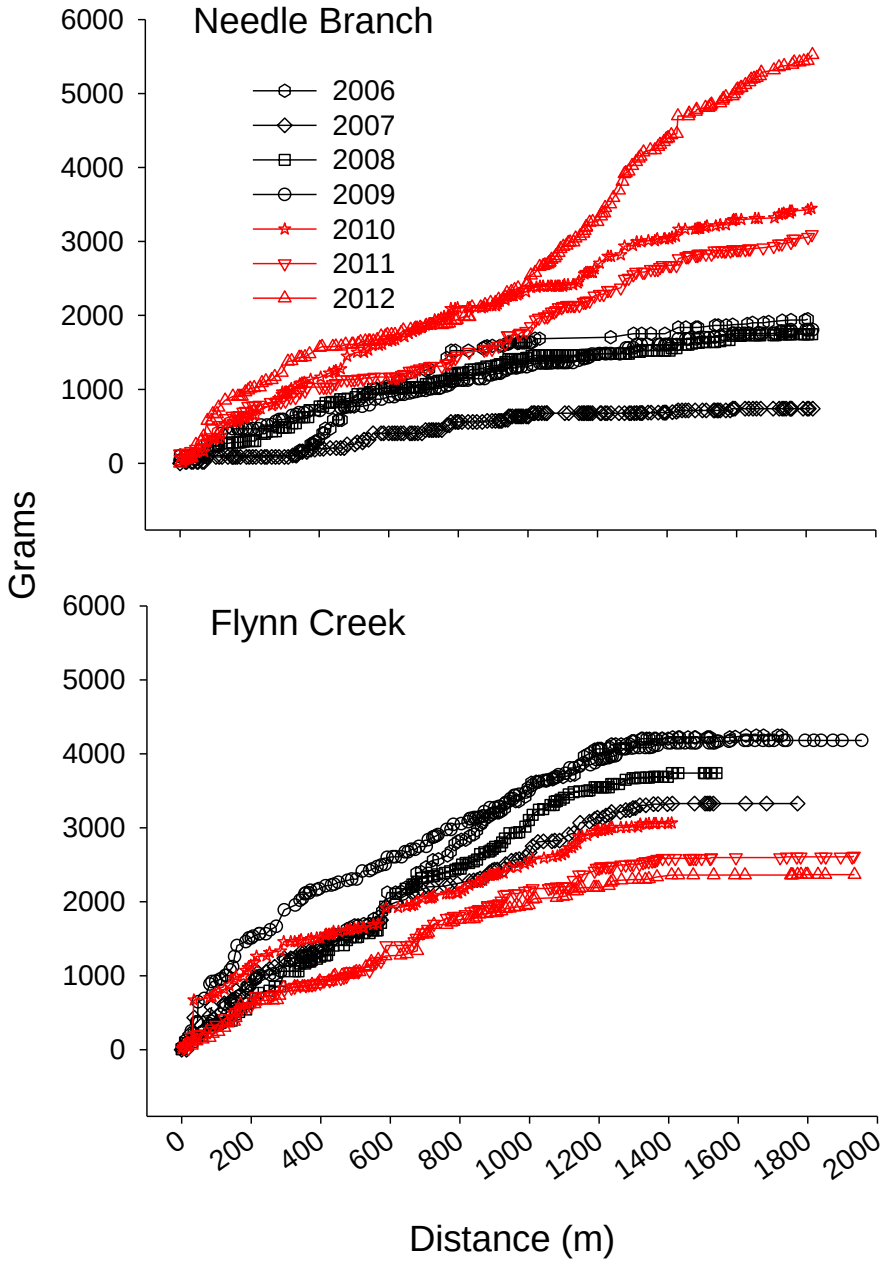
Connolly and Hall 1999

Proportion Harvested from 40 Randomly Selected 500-1000 ha Headwater Catcments in Western Oregon and the North and South Forks of Hinkle Creek



(Torgersen et al unpublished data)

Cumulative Catch in Grams of Age 1+ Cutthroat Trout from Mainstems of Needle Branch and Flynn Creek



Caveats

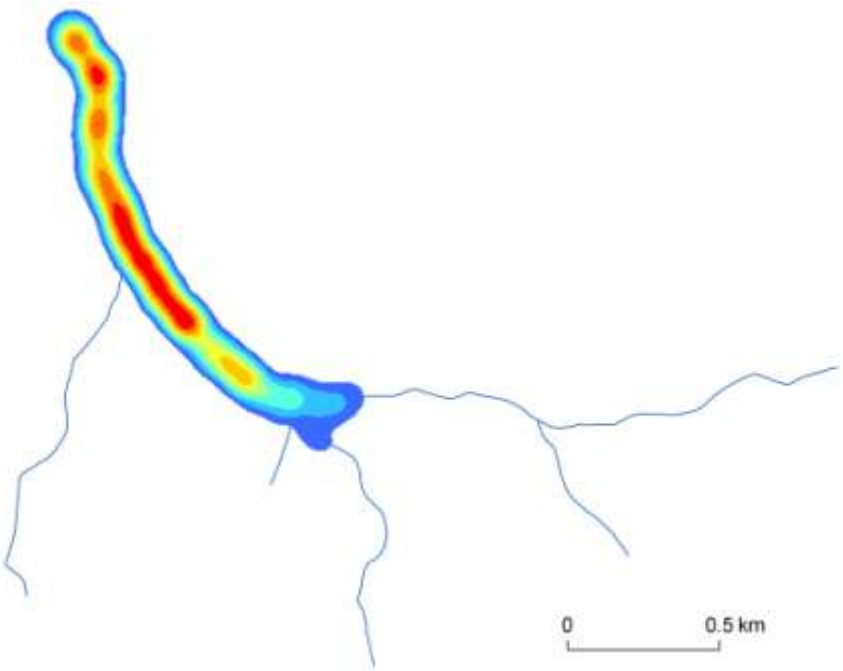
- Study sites not randomly selected
- Treatments within study sites not randomly assigned

Therefore scope of inference of results is limited to the study sites and the duration of the studies

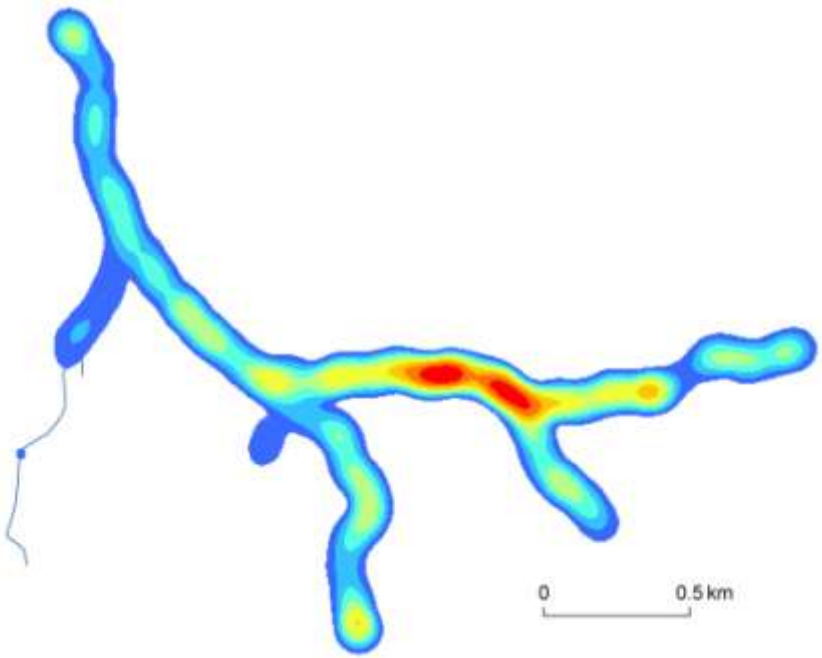
- Hinkle reference site was a previously harvest catchment
- To date post-treatment periods are short i.e. one generation
- No extreme events like 50-100 year flood events?

South Fork Hinkle Pre-treatment Average Fish Distribution

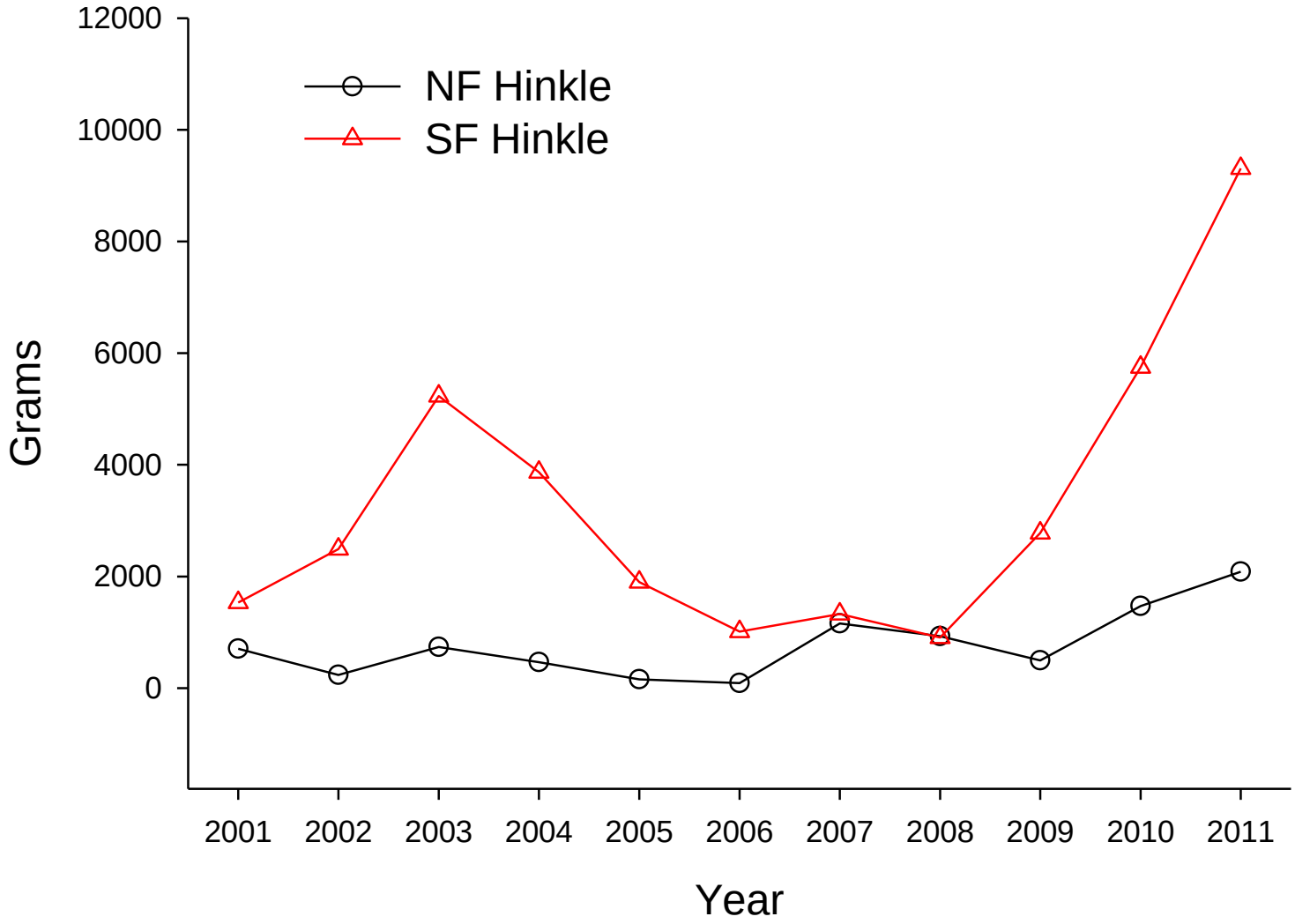
Steelhead



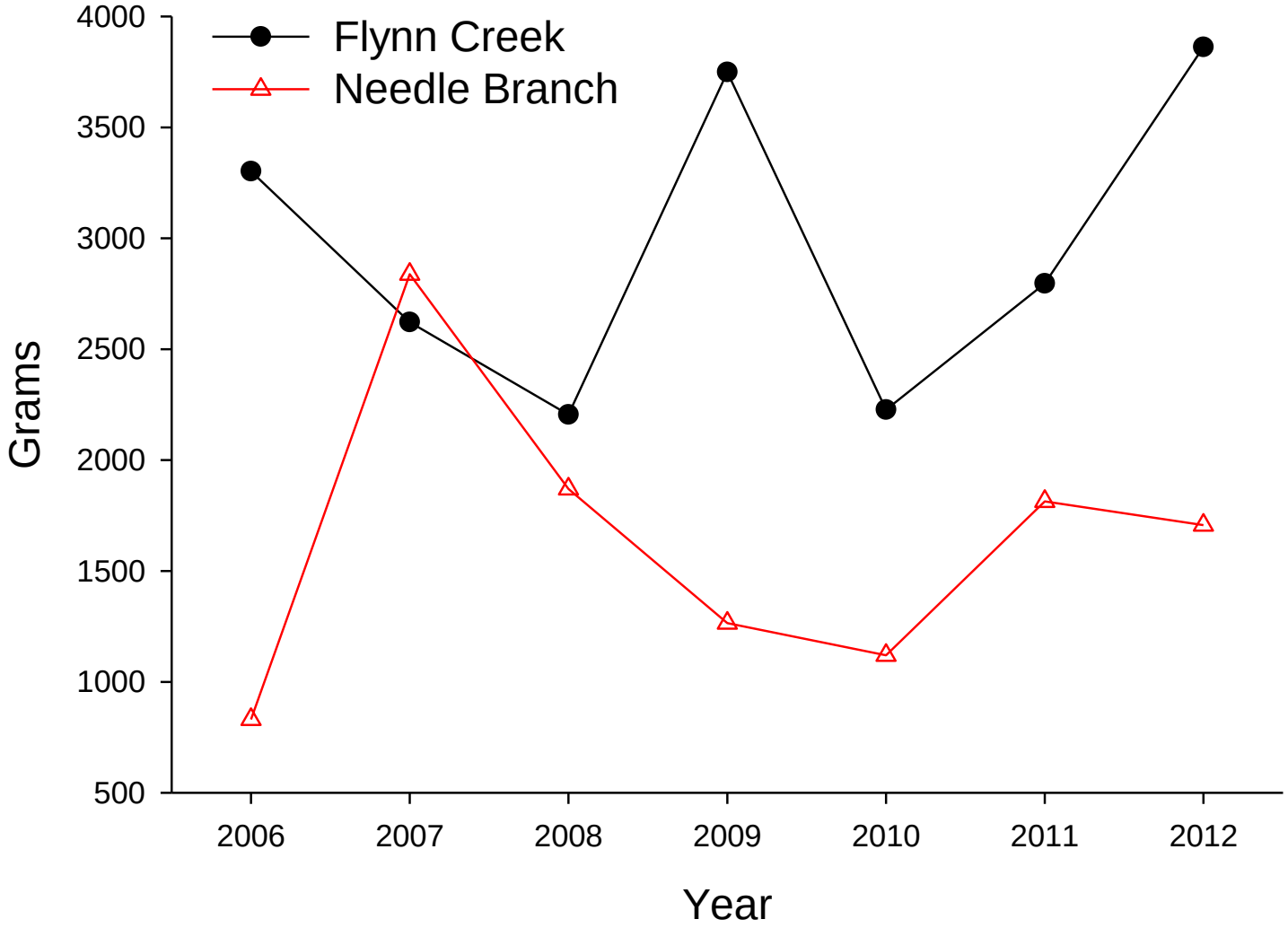
Cutthroat Trout



Age 1+ Steelhead: Total Biomass by Year for the North and South Forks of Hinkle Creek



Total Grams Coho by Year from Flynn Creek and Needle Branch



Relative increase

No detectable effect

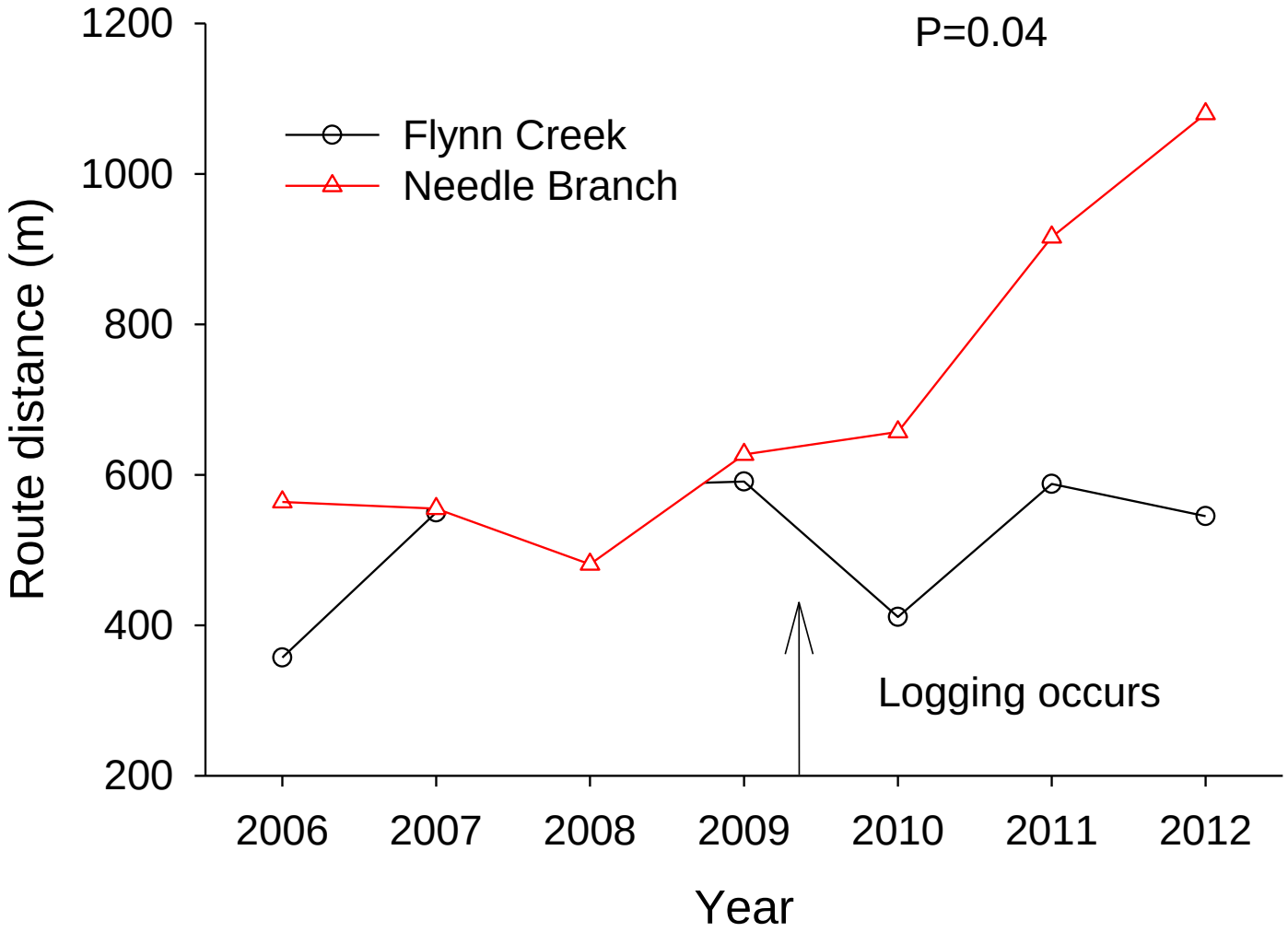
Relative decrease

Stream	Treatment	Scale	Variable	1+ CT	Trout	1+ ST	Coho
Hinkle	Post_1	Catchment	Biomass				NA
			Growth		NA	NA	NA
			Size			NA	NA
			Condition			NA	NA
			Survival			NA	NA
			Behavior		NA	NA	NA
		Tributary	Biomass			NA	NA
			Size			NA	NA
			Condition			NA	NA
			Survival		NA	NA	NA
Hinkle	Post_2	Catchment	Biomass				NA
			Growth		NA	NA	NA
			Size			NA	NA
			Condition			NA	NA
			Survival	IP	NA	NA	NA
			Behavior		NA	NA	NA
		Tributary	Biomass			NA	NA
			Size			NA	NA
			Condition			NA	NA
			Survival	IP	NA	NA	NA
Alsea	Post_1	Catchment	Biomass			NA	
			Growth		NA	NA	NA
			Size			NA	
			Condition			NA	
			Survival	IP	NA	NA	NA
			Behavior		NA	NA	NA

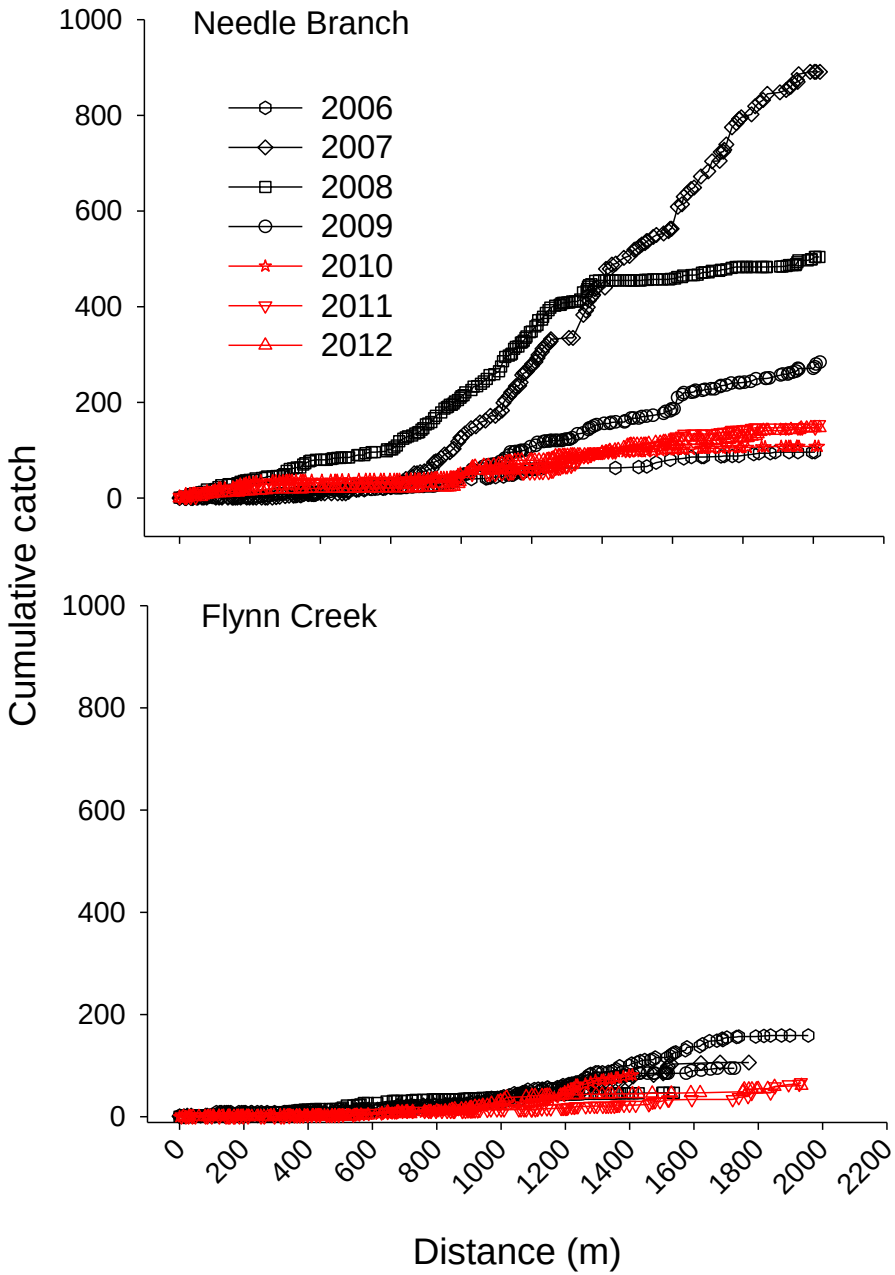
Positives!

- Hinkle Creek spatially very large relative to previous studies
- North and South Fork Hinkle are an excellent pair and as close to a treatment/control as is likely possible in non-laboratory environment
- There is replication at the tributary scale within Hinkle Creek
- Hinkle Creek and the Alsea streams have very different geologies and are located in different ecoregions
- Alsea has a long history for both fish and water quality parameters
- Flynn Creek is as an unharvested reference site and represents one of a very few catchments devoid of anthropogenic disturbance in the Coast Range or Oregon
- Analysis is at the catchment rather than at the reach scale
- Data are collected in a spatially explicit manner allowing analysis at multiple spatial scales

Distance from Downstream End of Flynn Creek and Needle Branch Mainstems to Point Where 50% of Age 1+ Cutthroat Biomass was Captured



Cumulative Catch Age 0 Trout from Mainstems of Needle Branch and Flynn Creek



Summary

- Cutthroat Trout
  - increased biomass and abundance post harvest driven by increased number of age 1+ individuals
  - distribution of biomass shifted upstream post-treatment suggesting effects from harvest are localized
  - no detectable change in behavior
- Age 0 Trout
  - no evidence of treatment effect on abundance or biomass but some decline in mean fork length post-treatment in Needle Branch

Summary

- Coho
  - no evidence for a treatment effect on abundance, biomass, mean or 90th percentile of fork length, distribution, or condition
- Habitat
  - Overall few detectable changes

Comparing Flynn Creek and Needle Branch to ODFW Aquatic Inventory Project Habitat Benchmarks

	Large Wood					
Stream	Pieces/100 m	% Pieces Conifer	M3/100 m	Key Pieces/100 m	Riffle Width/Depth	% Gravel
Flynn	12.5	55	49.7	2.5	16*	44*
Needle	15.8	58	36	2.3	15*	46*

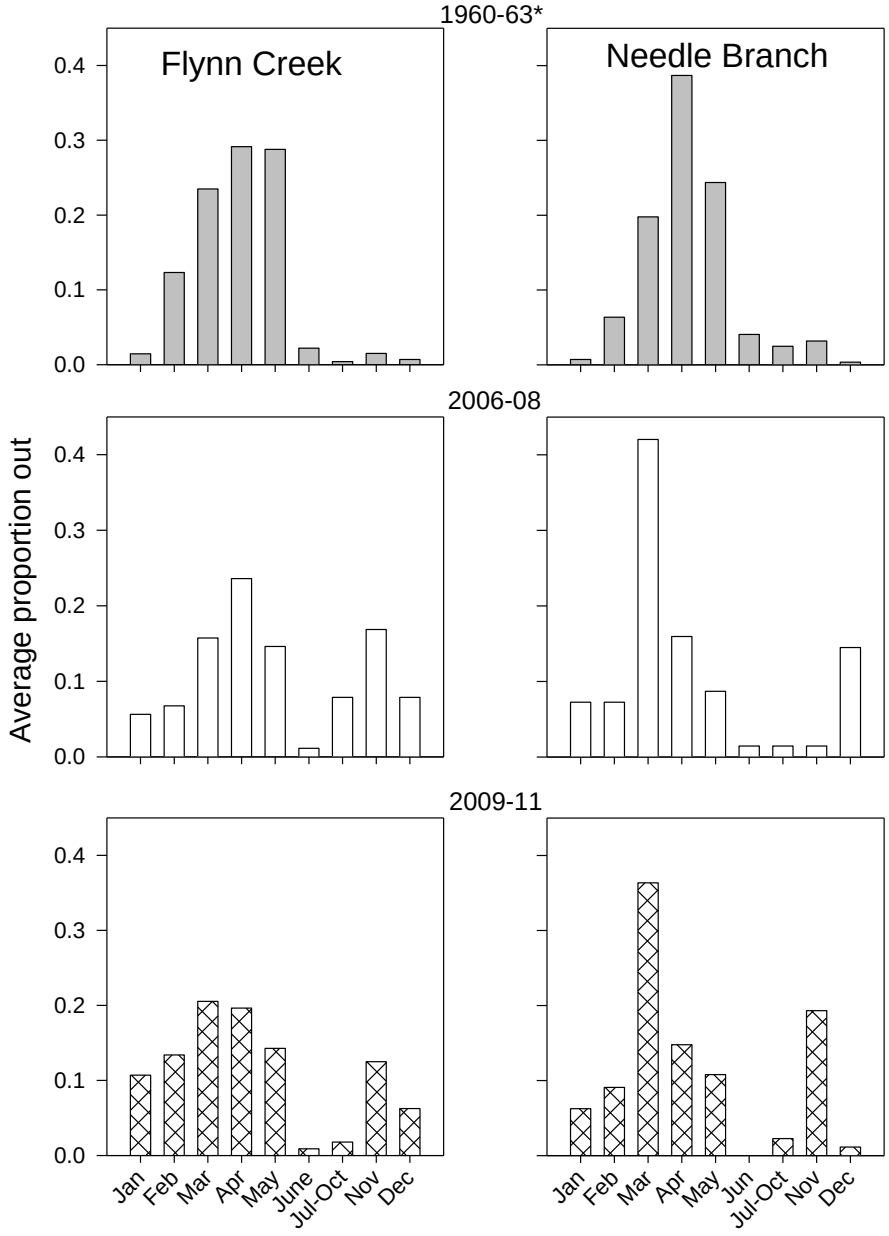
*Averaged over all years

☺ poor

☺ intermediate

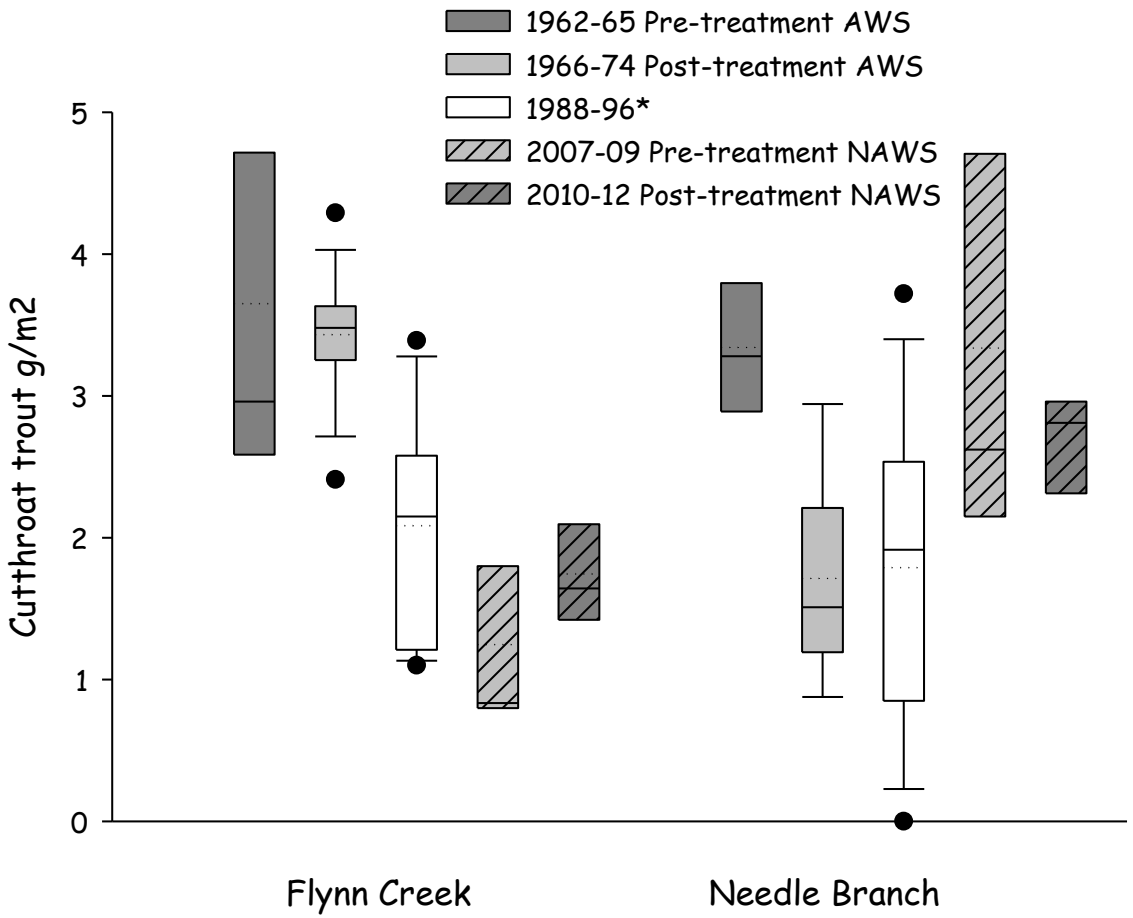
☺ good

Proportion of Outmigranting Cutthroat Trout by Month



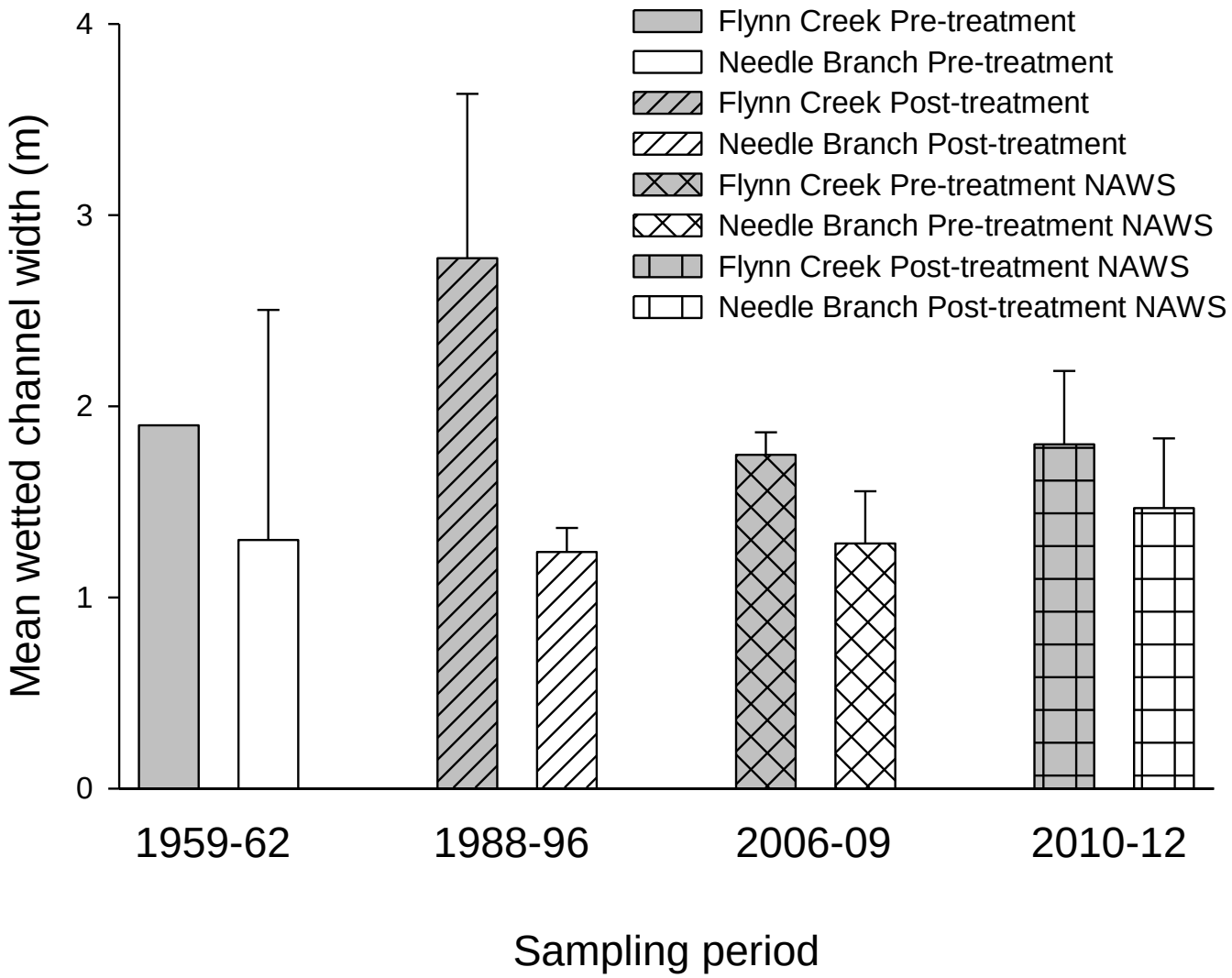
* From Lowry 1965

Alsea Watershed Study: Cutthroat Trout Biomass



* No sampling occurred in Needle Branch during 1988 due to low flows

Mean Wetted Channel Width by Sampling Period in Flynn Creek and Needle Branch



Percent Pool Based on Stream Length in Flynn Creek and Needle Branch by Sampling Period