# Fuel treatment alternatives in riparian zones of the Sierra Nevada

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# Talk Structure

- Context of study
- Original study design
- Actual study design
- Results
- Future directions

# What is a Riparian Forest?

- What the public tends to think about:

# What is a Riparian Forest?

- What we (RPF's) tend to think about:

**Procedures for Determining Watercourse and Lake Protection Zone Widths and Protective Measures[1]**

| Water Class Characteristics or Key Indicator Beneficial Use | 1) Domestic supplies, including springs, on site and/or within 100 feet downstream of the operations area and/or<br><br>2) Fish always or seasonally present onsite, includes habitat to sustain fish migration and spawning. | | 1) Fish always or seasonally present offsite within 1000 feet downstream and/or<br><br>2) Aquatic habitat for nonfish aquatic species.<br><br>3) Excludes Class III waters that are tributary to Class I waters. | | No aquatic life present, watercourse showing evidence of being capable of sediment transport to Class I and II waters under normal high water flow conditions after completion of timber operations. | | Man-made watercourses, usually downstream, established domestic, agricultural, hydroelectric supply or other beneficial use. | |
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| >50 | 150[2] | ADG | 100[3] | BEI | See CFH | | See CFI | |

# Does a hands-off or an EEZ approach “protect” beneficial uses?

**Watercourse and Lake Protection Zone** (WLPZ) means a strip of land, along both sides of a Watercourse or around the circumference of a lake or spring, where **additional practices** may be required for protection of the quality and beneficial uses of water, fish and Riparian wildlife habitat, other forest resources and for controlling erosion.

“additional practices” has come to mean “hands-off”

Should it mean “additional practices?”

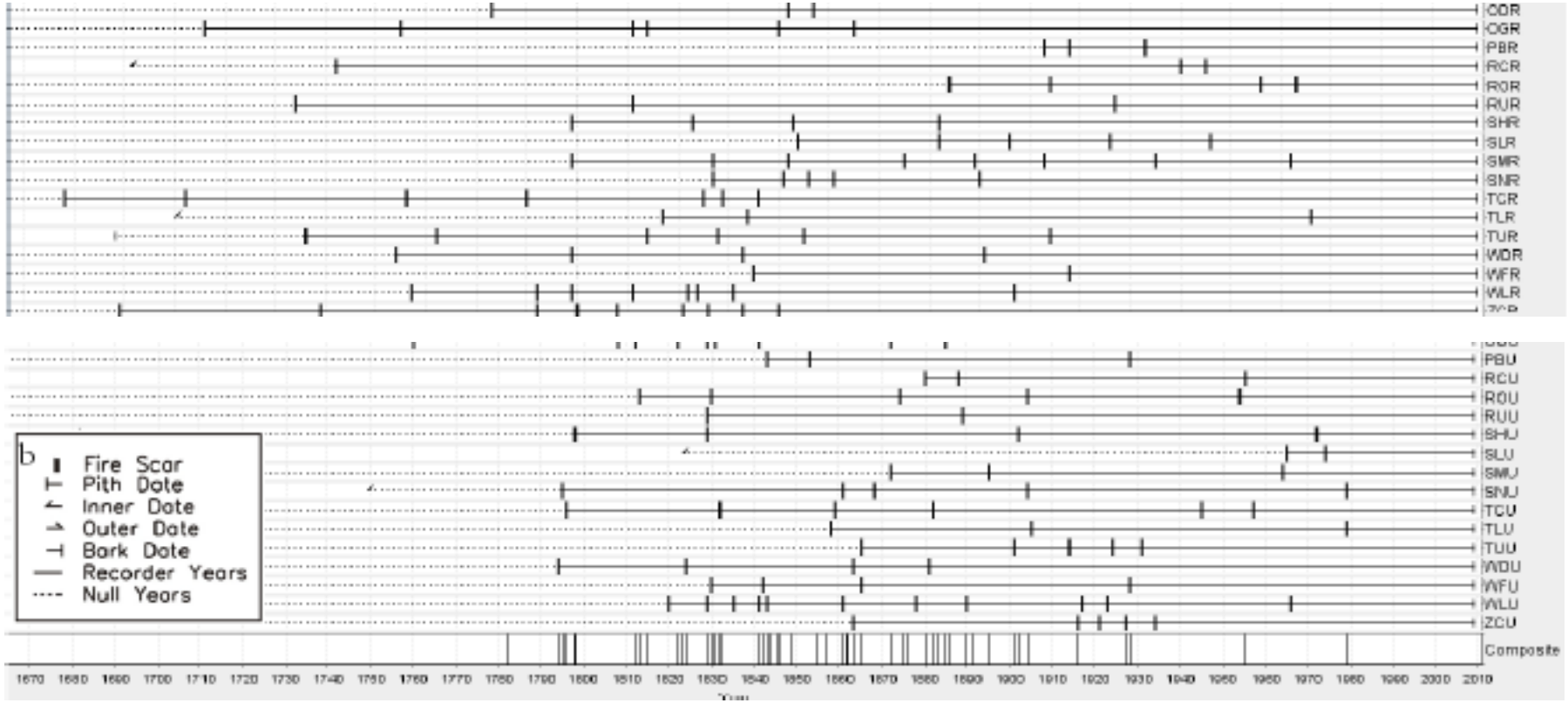
# Paradox of protection in Sierra Nevada Forests

Can’t protect forests from both high severity fire and foresters

# Fire history in Riparian areas

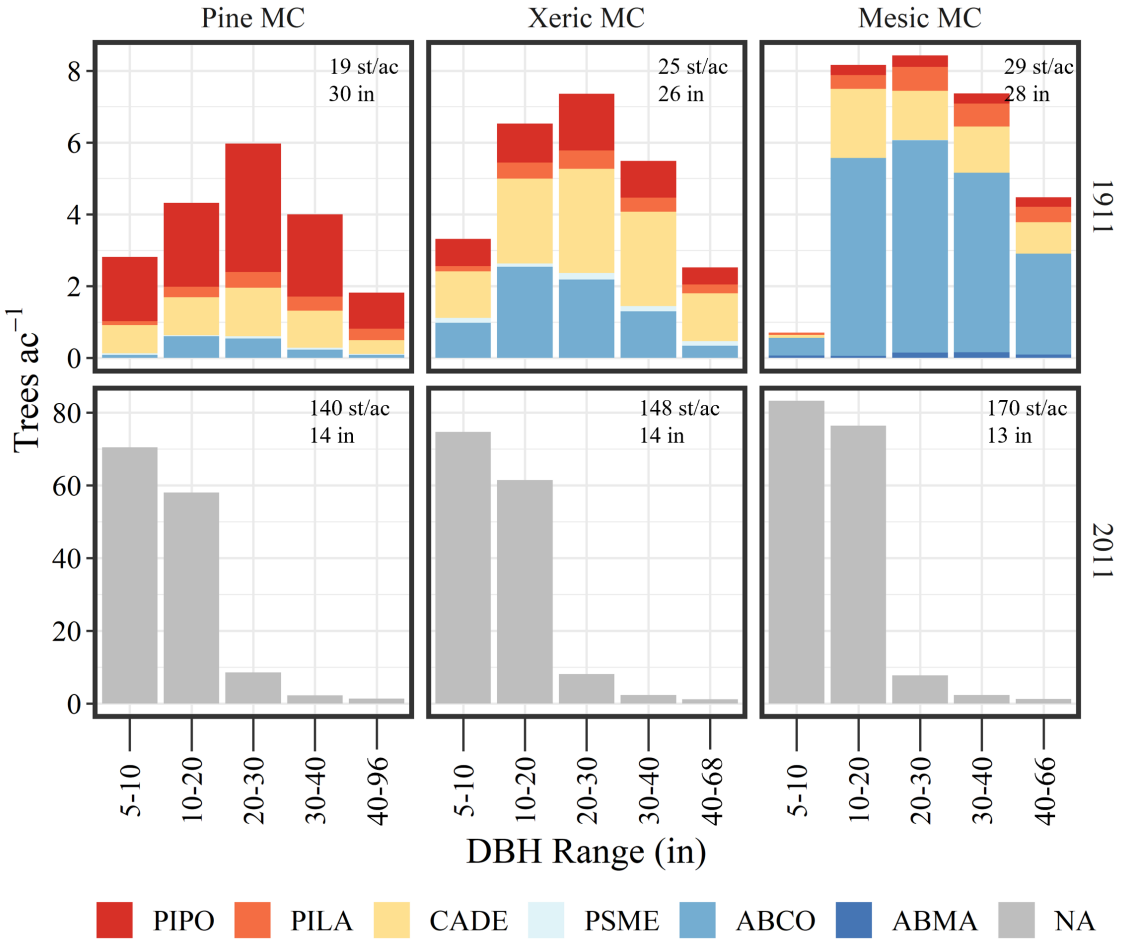
Good body of support for frequent fire in riparian areas: Agee 1998; Dwier and Kaufmann 2003; Everett et al. 2003; Pettit and Naiman 2007; Skinner 2003; **Van de Water 2011**

Pop quiz: Can anyone guess why the scars go back further in riparian areas?

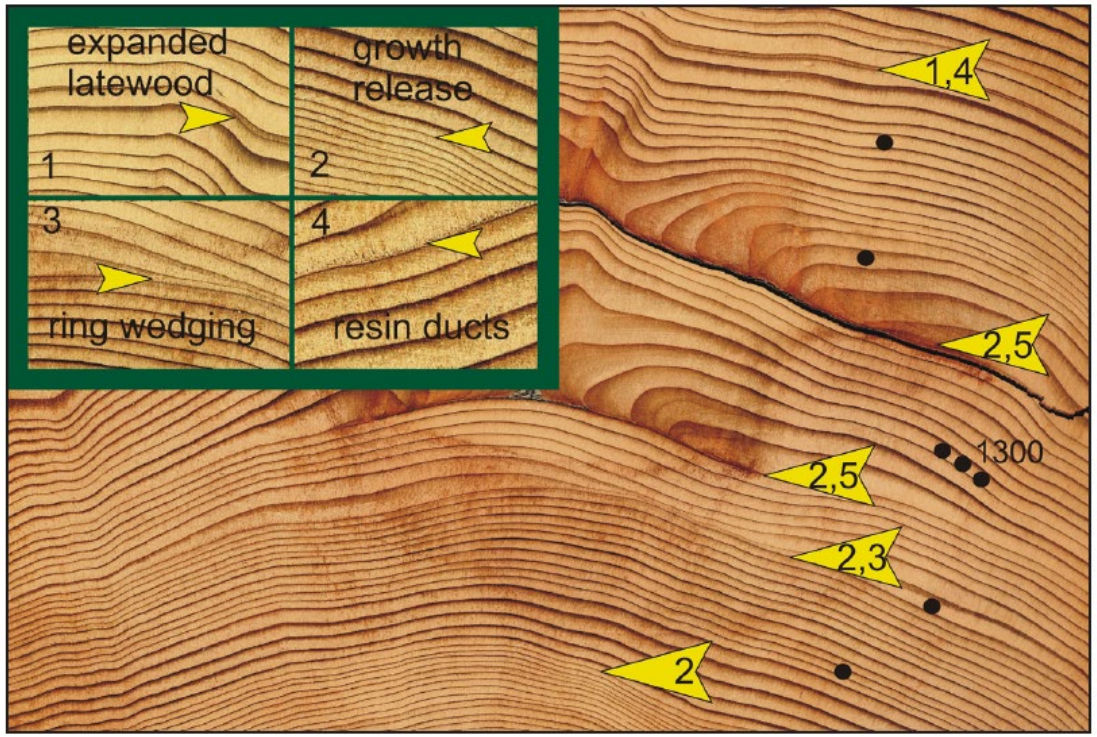



- Riparian FRI = 16.6 yrs; Upslope = 16.9yrs
- Seasonality also similar- both occurred in late summer-early fall dormant season

# Structure- versus Process-based restoration




Van de Water 2011: reconstructed riparian basal area = 124
reconstructed upslope basal area = 93




Riparian zones are floristically unique, but their fire-influenced overstory structures were *probably* not terribly different

# Despite evidence that riparian zones are disturbance-dependent, we tend to protect them from disturbances

## Riparian v. upland area management: An example

# Predicted fire behavior

Up-slope of WLPZ

WLPZ

P-Torch = 0.16
Surface fuel = 13 tons/acre

Mosquito fire was welcome here

P-Torch = 0.76
Surface fuel = 45 tons/acre

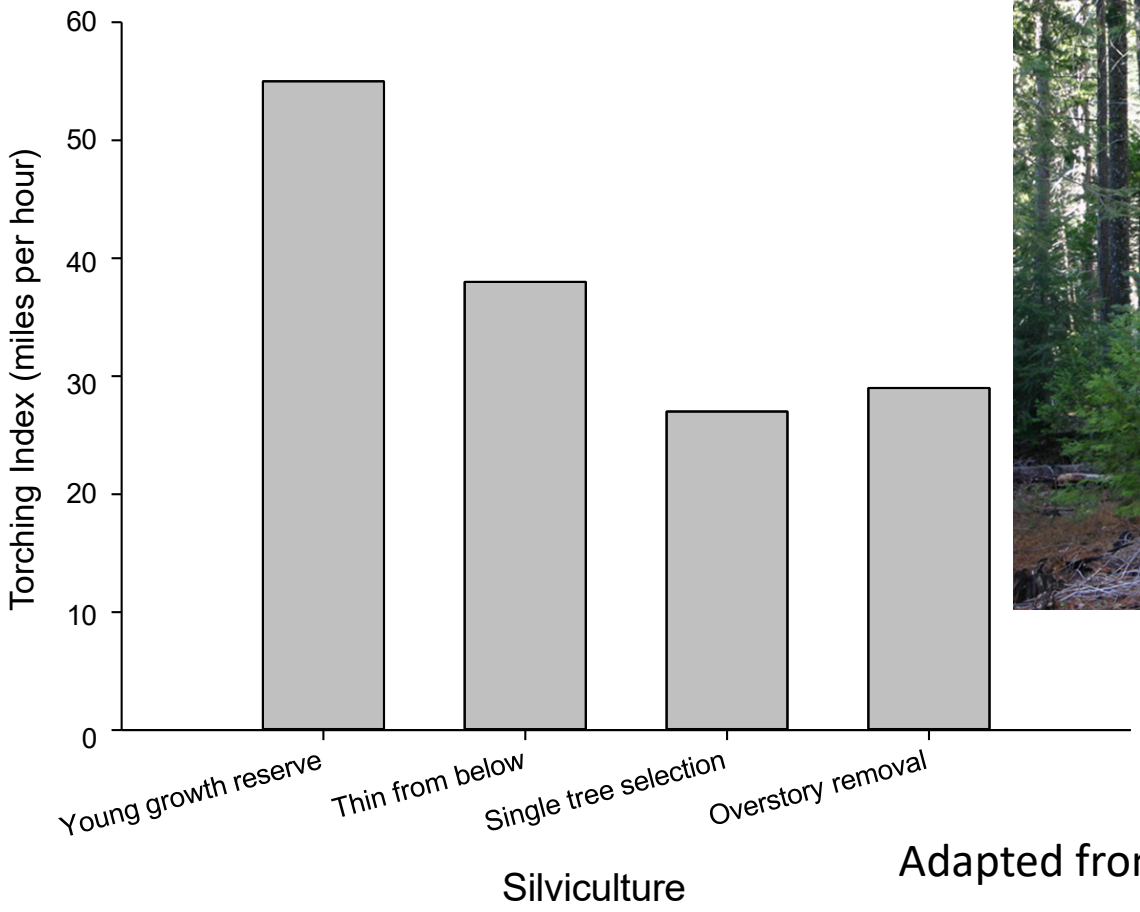
but not welcome here

# But aren’t some operations allowed?

Yes, but EEZ’s limit options and are arguably counter-productive

Directional felling of individual trees:

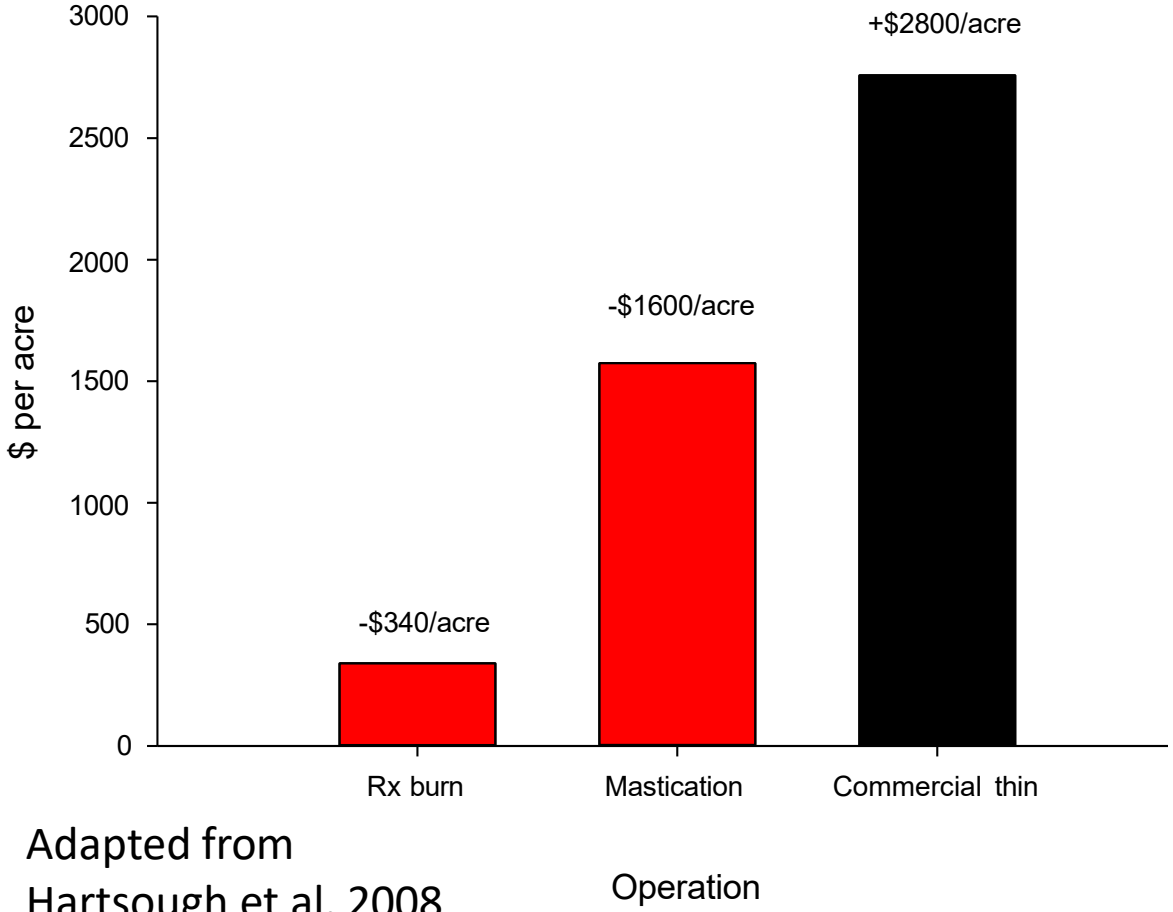
- Often **worse** than doing nothing)



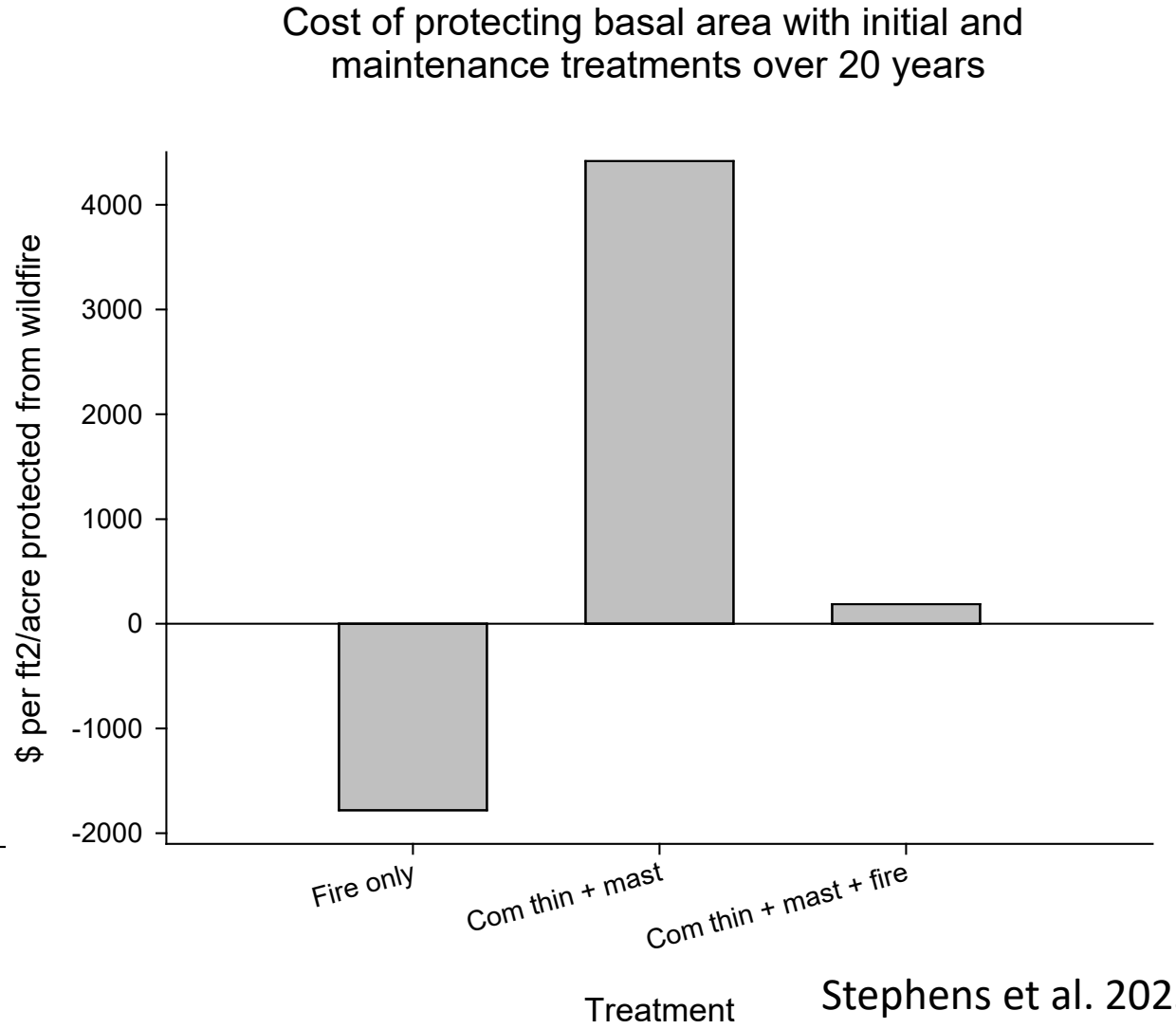

Adapted from Stephens and Mogghadas 2005

# Why not just do fuel treatments not associated with Timber Operations?

## Too expensive to be sustainable




Adapted from Hartsough et al. 2008



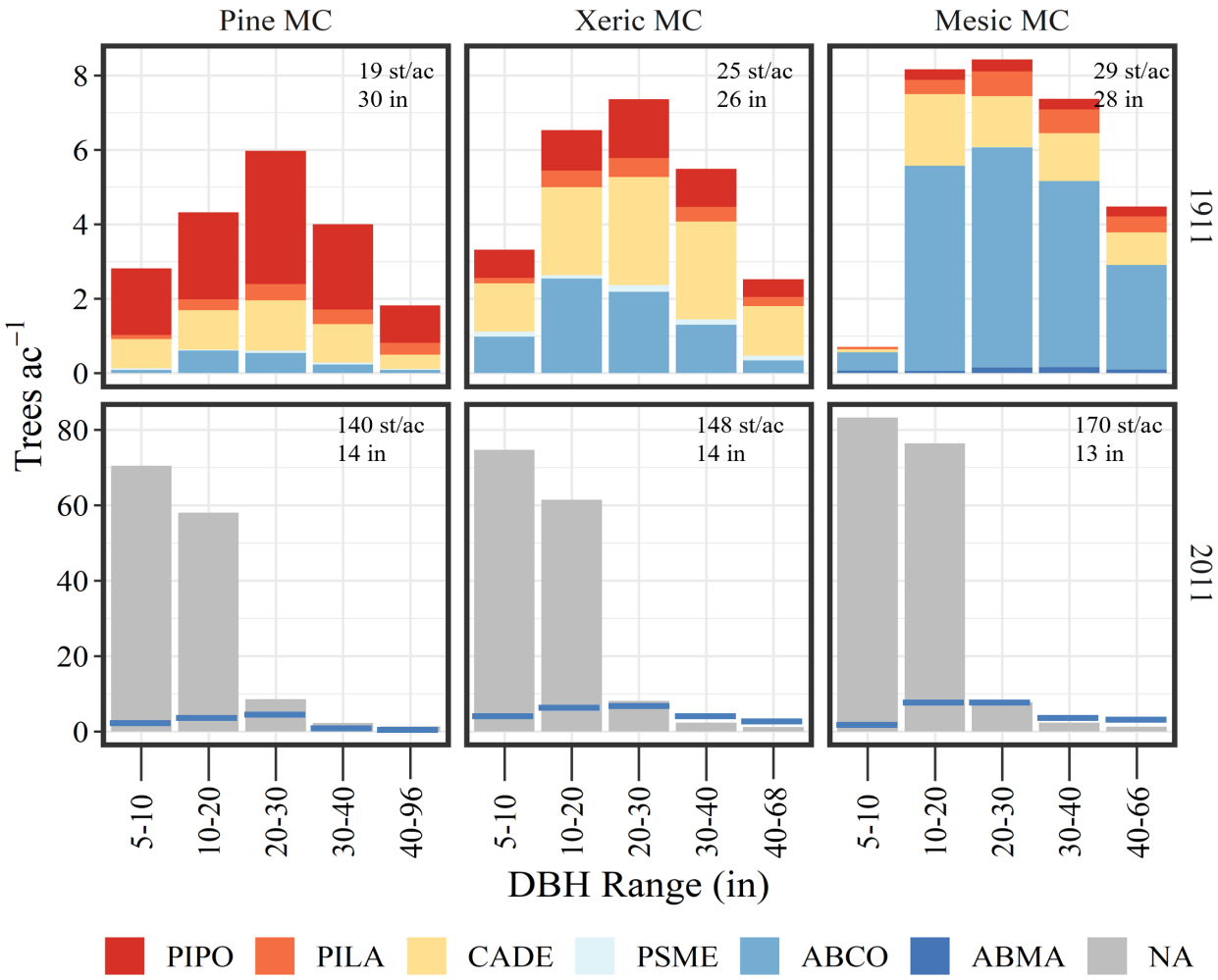

Stephens et al. 2023

# Why not just do fuel treatments not associated with Timber Operations?

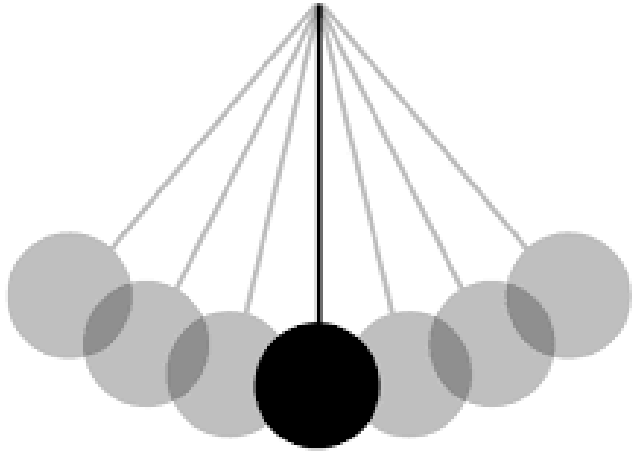
Can’t come close to structural restoration if only cutting intermediate trees

Structural restoration needed across water gradients:

Remove 5 – 20” trees (dramatically)



# Why *not* consider treatments?



# Why *not* consider treatments?

- Soil compaction from heavy equipment

# Why *not* consider treatments?

- Sediment delivery

Overland runoff from disturbed areas often contain excessive sediment in addition to water. (USGS)

# Why *not* consider treatments?

- Heating of water from increased radiation

# Research

Objective:

- Trial of treatments known to be effective
- What are the tradeoffs?

Do this over here

# Long term (decades) study plan

Phase 1:

- At one site, conduct experimental trials of alternatives
- Inform management / regulatory development

Phase 2:

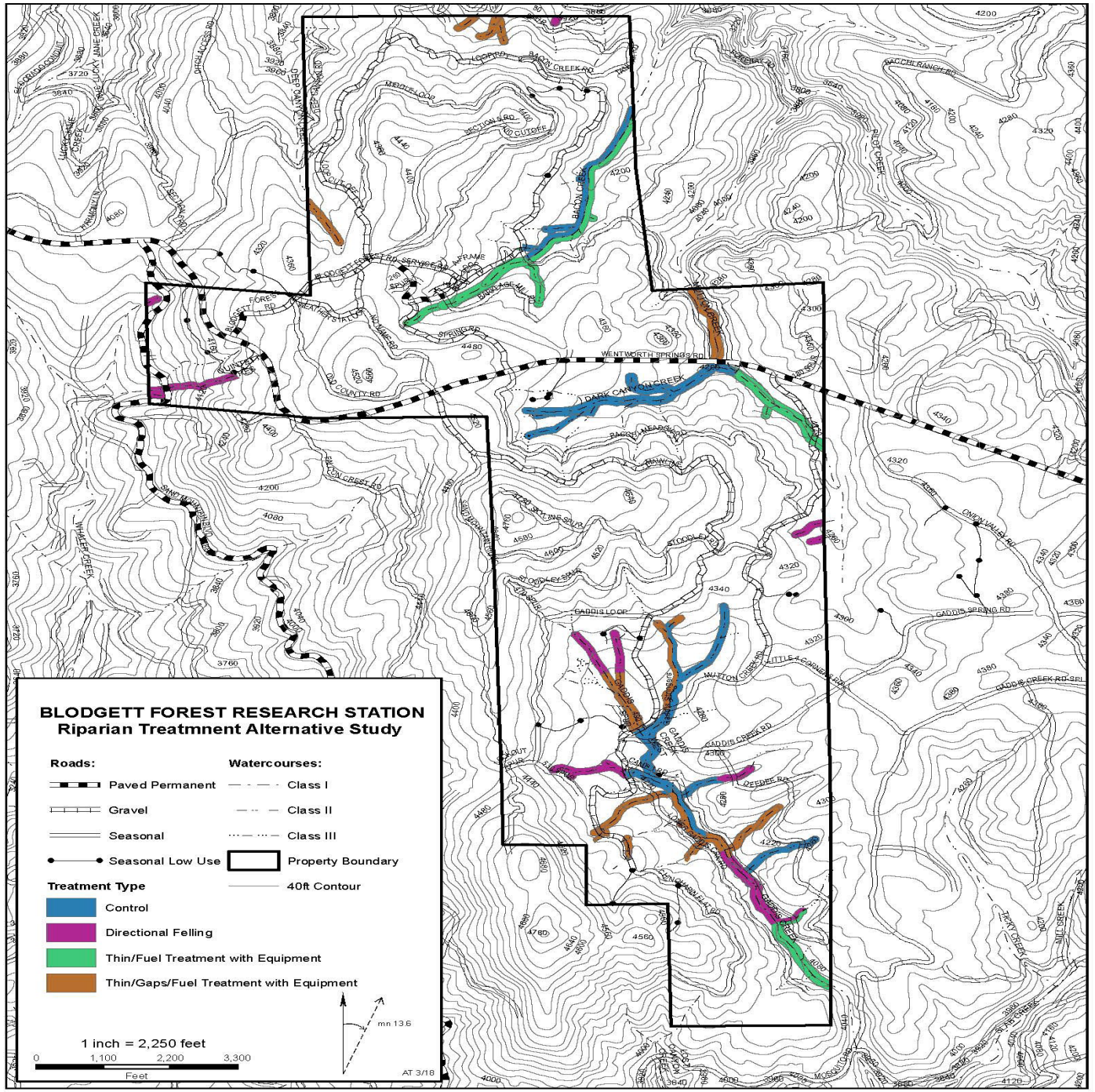
- Expand the study to several sites

Phase 3:

- Repeat treatments + long-term monitoring
- Inform policy / regulatory development again

Study area:

- Pilot phase: Blodgett Forest Research Station
- All Class I and II WLPZ's
- 7% of total area
- Random allocation to one of four treatments
- WLPZ's treated at same time as upslope areas



# Treatment 1 – Do nothing

How might it be “best?”

- Protection of large trees (compared to status quo)
- Protection of low radiation input into channels

# Treatment 2 – The status quo

Selective harvest, using current WLPZ standards

- No heavy equipment
- “Get value” but comply with “The table”

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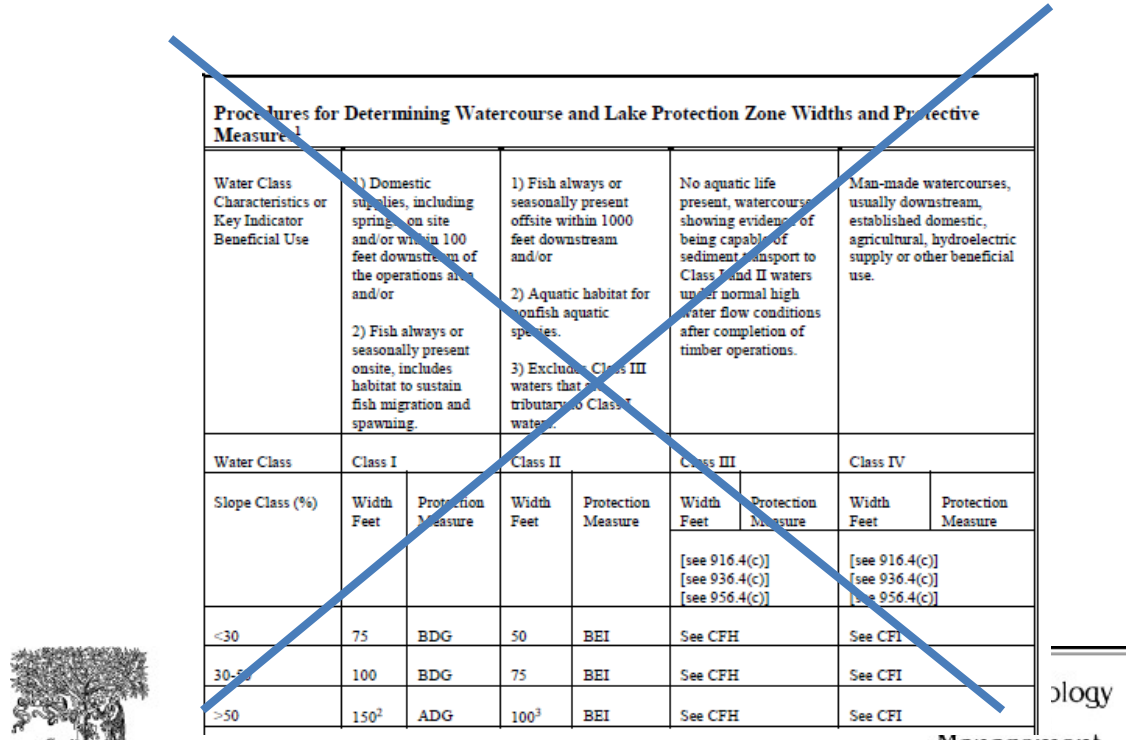
# Tx's 3 and 4: Reduce fire hazard like nobody's watching

Principles of operations:

- Be **effective** in reducing fire severity
- Be **restorative** in influencing structure and composition
- Be **sustainable** in economic operability



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ELSEVIER

Forest Ecology and Management 211 (2005) 83–96

ology Management

www.elsevier.com/locate/foreco

Basic principles of forest fuel reduction treatments

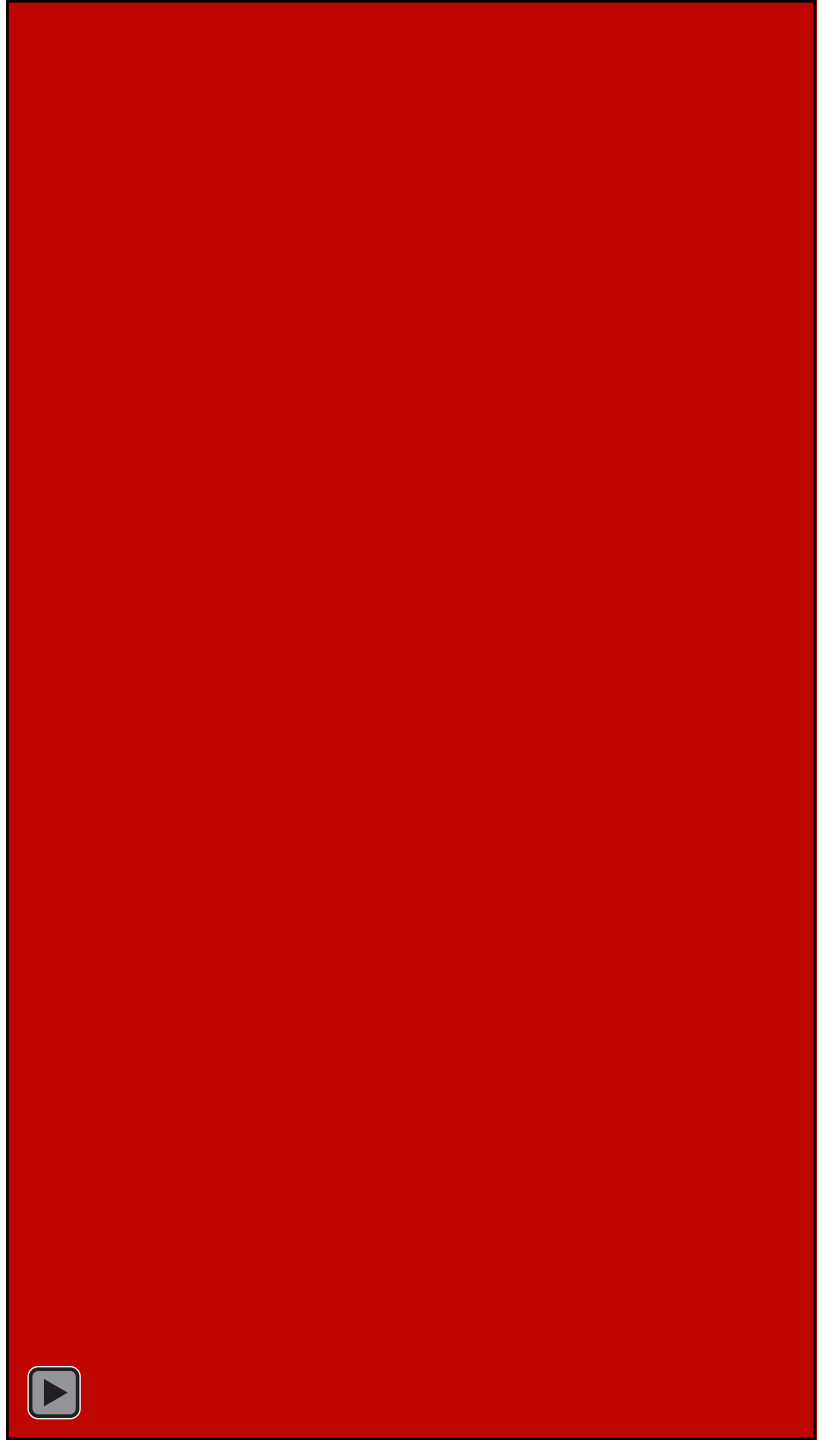
James K. Agee [a,*], Carl N. Skinner [b]

[a] College of Forest Resources, Box 352100, University of Washington, Seattle, WA 98195, USA

[b] USDA Forest Service, Pacific Southwest Research Station, 3644 Avtech Parkway, Redding, CA 96002

# Treatment 3: Reduce density *from below*

- Heavy equipment allowed during timber operations
- Thin from below to 150ft2/acre
- Marking BMPs: Improve spacing, vigor, tree size



# Treatment 3 – *Legit* fuel treatment

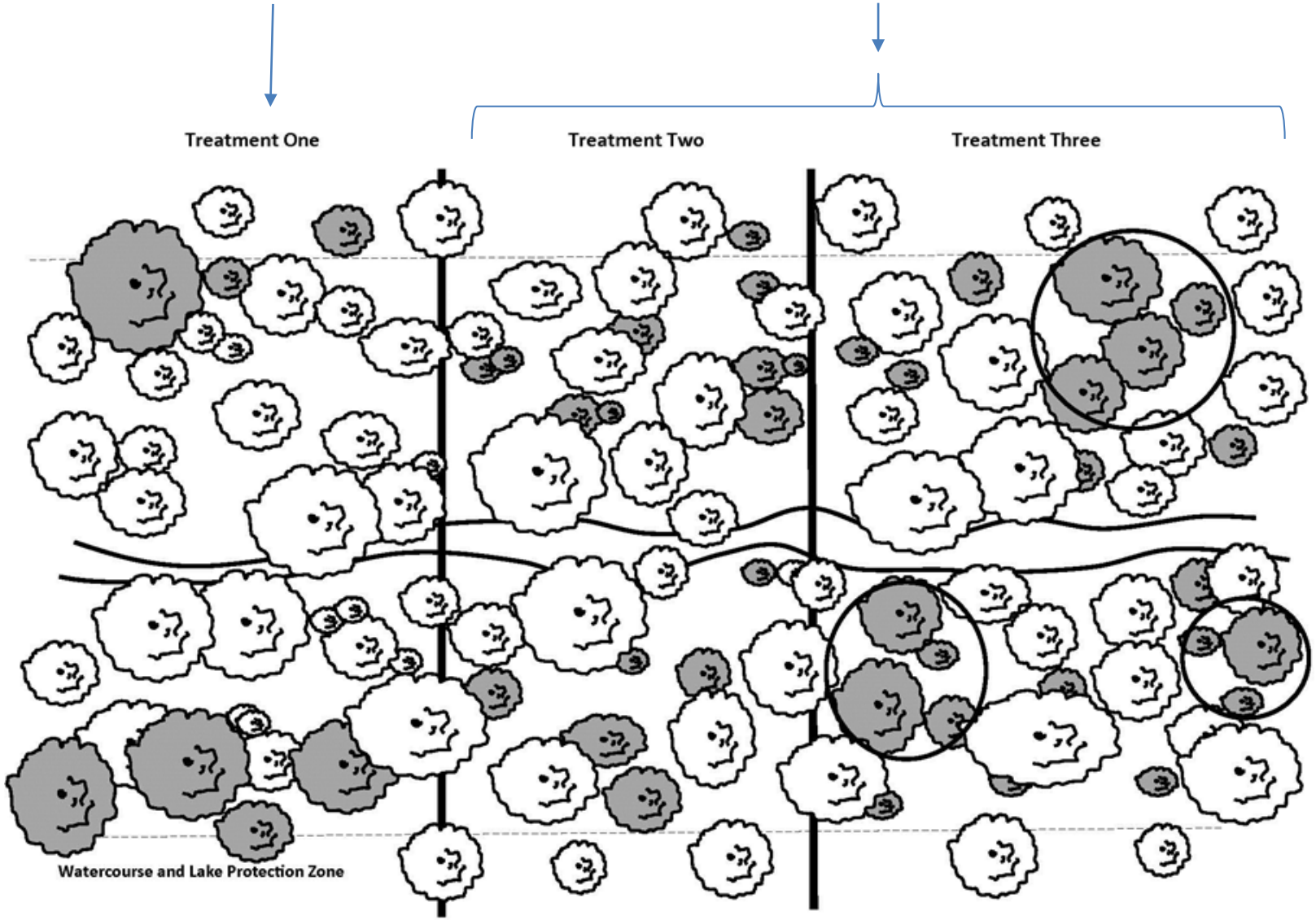
Ladder and surface fuel reduction treatment:

- Cut ladder fuels by hand
- Pile all activity fuels, plus available fine fuels
- Reduce surface fuels via burning (pile or pile-cast acceptable)

# Treatment 4 – *Legit* fuel treatment and gap creation

- Same as treatment 3 plus
- Gap-based silviculture
  - Gaps range from 0.1 to 0.4 acres
  - Post-harvest slash piling with excavator
  - Plant PP and SP
  - Prefer adjacent to alder


# Status quo v. legit fuel treatments



# Post Timber Operations Fuel Reduction

“Pile-casting” hand piles Fall 2018

~ half of piled areas broadcasted

Some project burning with LE-7 permit

Some open burning without a permit (except air quality)

# Operational feasibility of burning is pretty good

Natural containment line provided by watercourse

Often along WLPZ boundary, there is a skid trail or road to use

# Aesthetically and mentally:

Very feng shui

or

Last Air Bender vibe (fire, earth, and water benders living in harmony)

# Phase 1 Measurements

Can report now:

Change in radiation input (%TTR)

Yield and revenue

Sediment delivery corridors

Forest structure

Can report later:

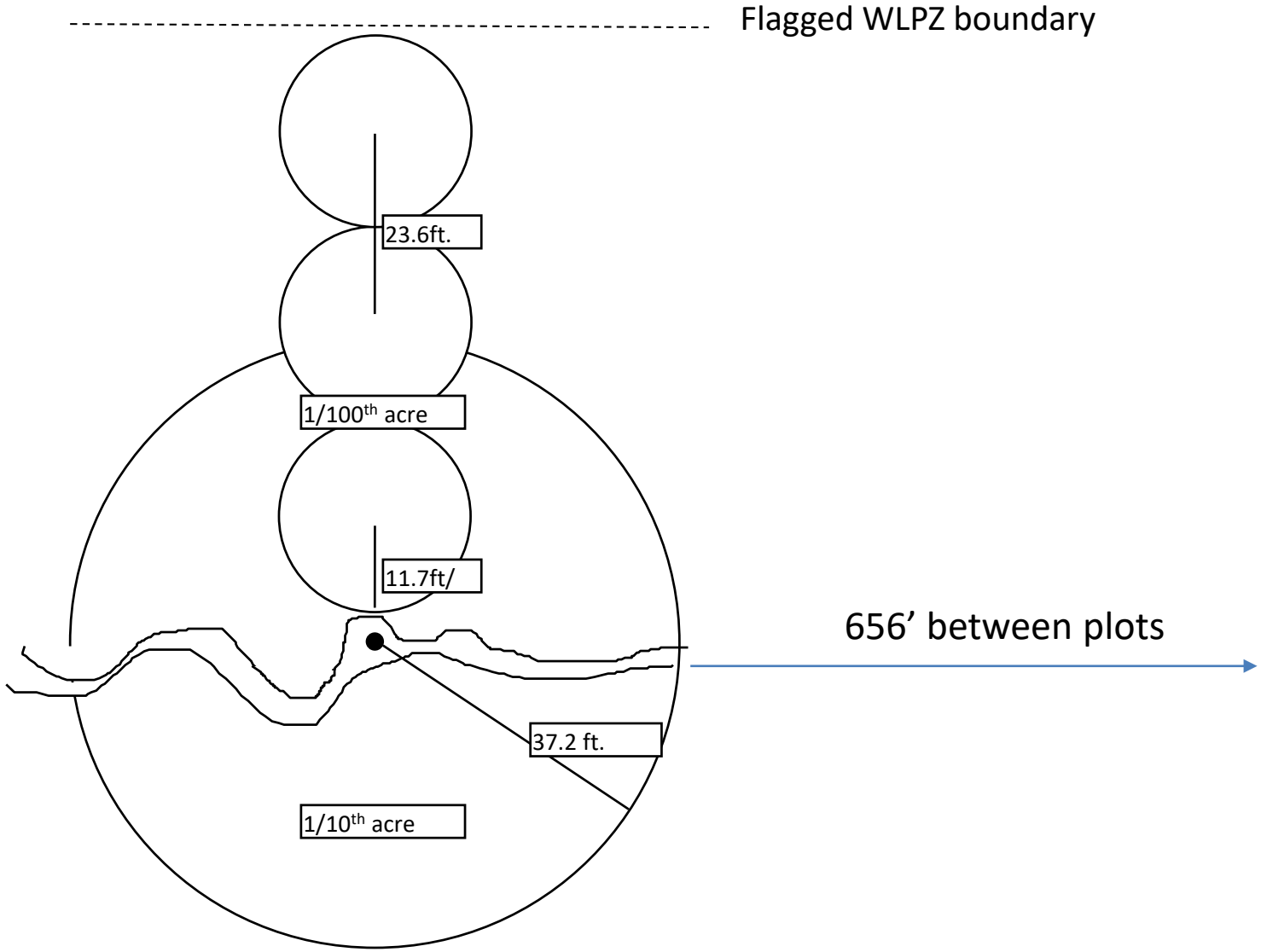
Species Composition

Surface fuel change

Soil strength

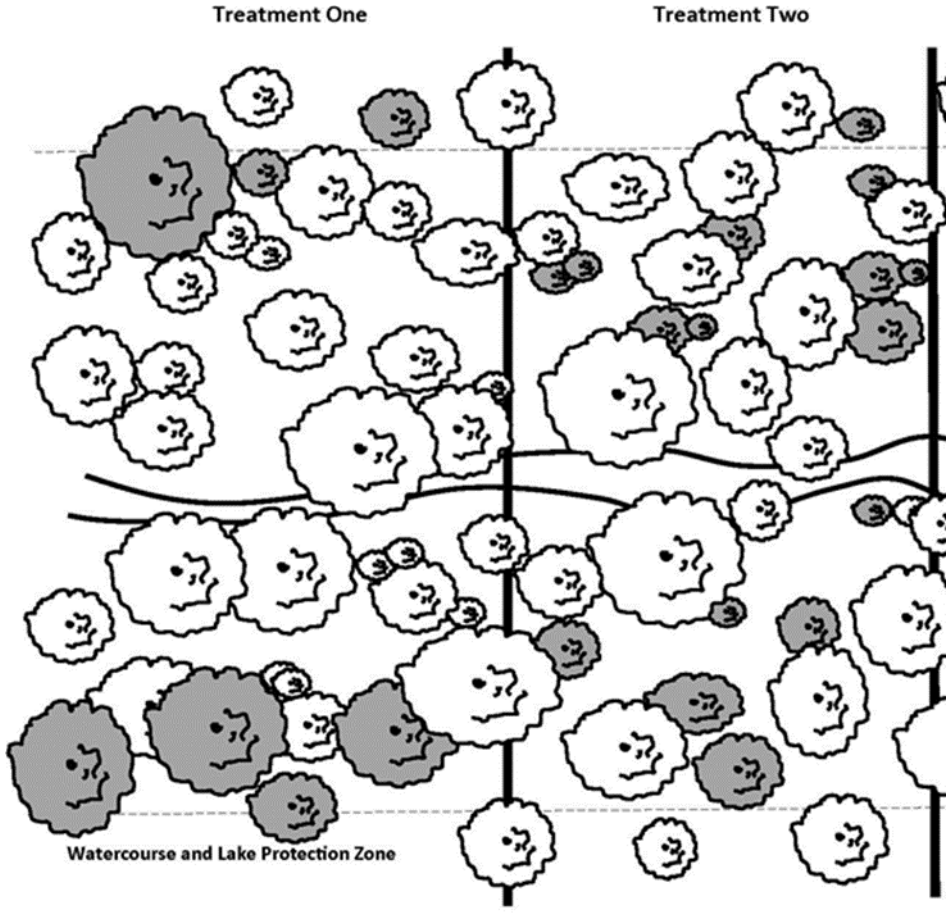
Alder tree growth and survival

Water temperature



# Key measure: change in radiation input

%TTR = Percent of Total Transmitted Radiation




# Key measure: Yield and revenue

Can revenue cover costs?

Measured from permanent plots


# Key measure: Sediment Transport Corridors

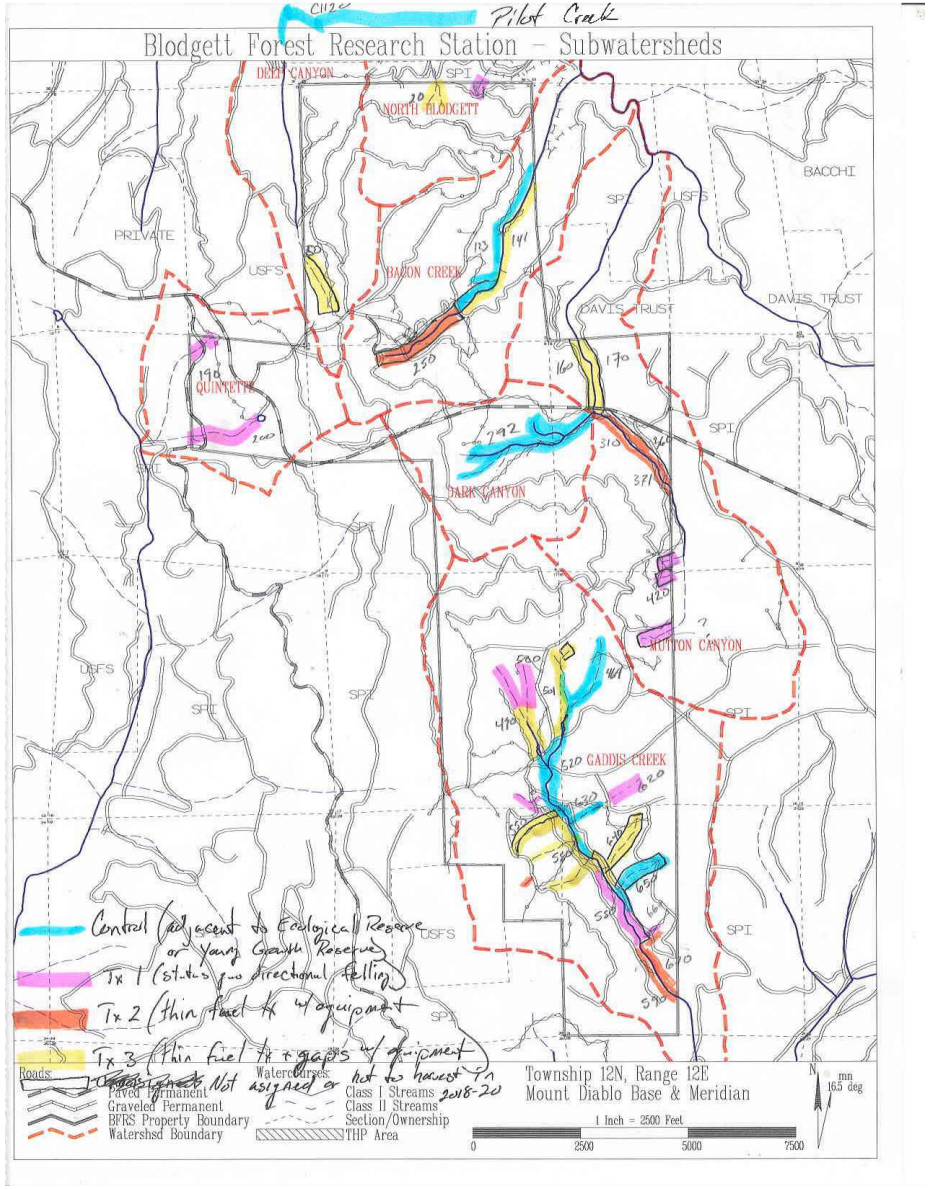
Surveyed all stretches in Oct. 2022- 6.6 miles

Defined as “evidence of sediment delivery into the channel”

If found, attributed origin to:

- Burn scar
- Fire line construction
- Road crossing
- Matrix (any other location in WLPZ)

Mosquito fire evacuation precluded measurement of amount delivered

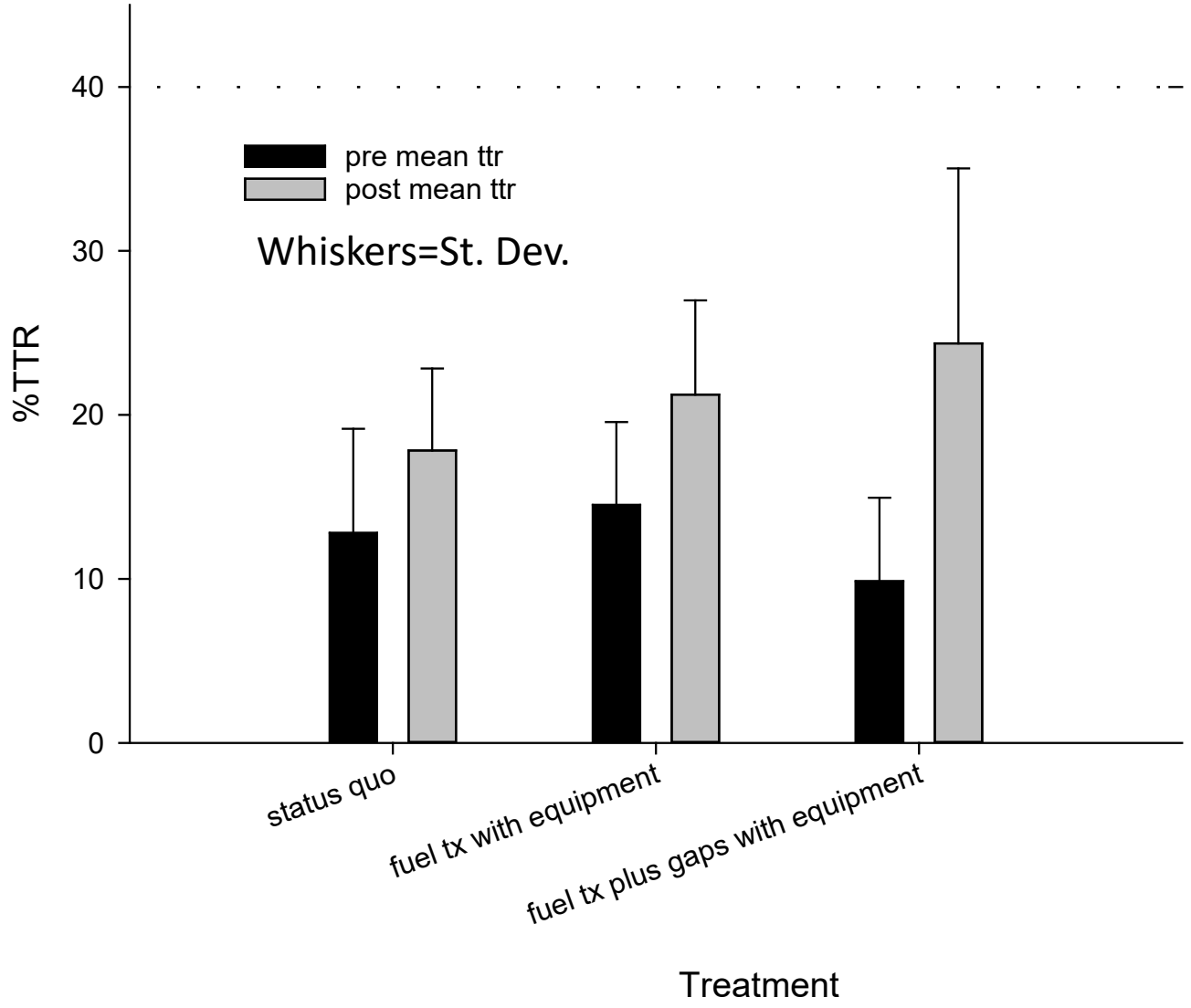


**Results**

# Treatment effects on radiation

**At stream channels:**

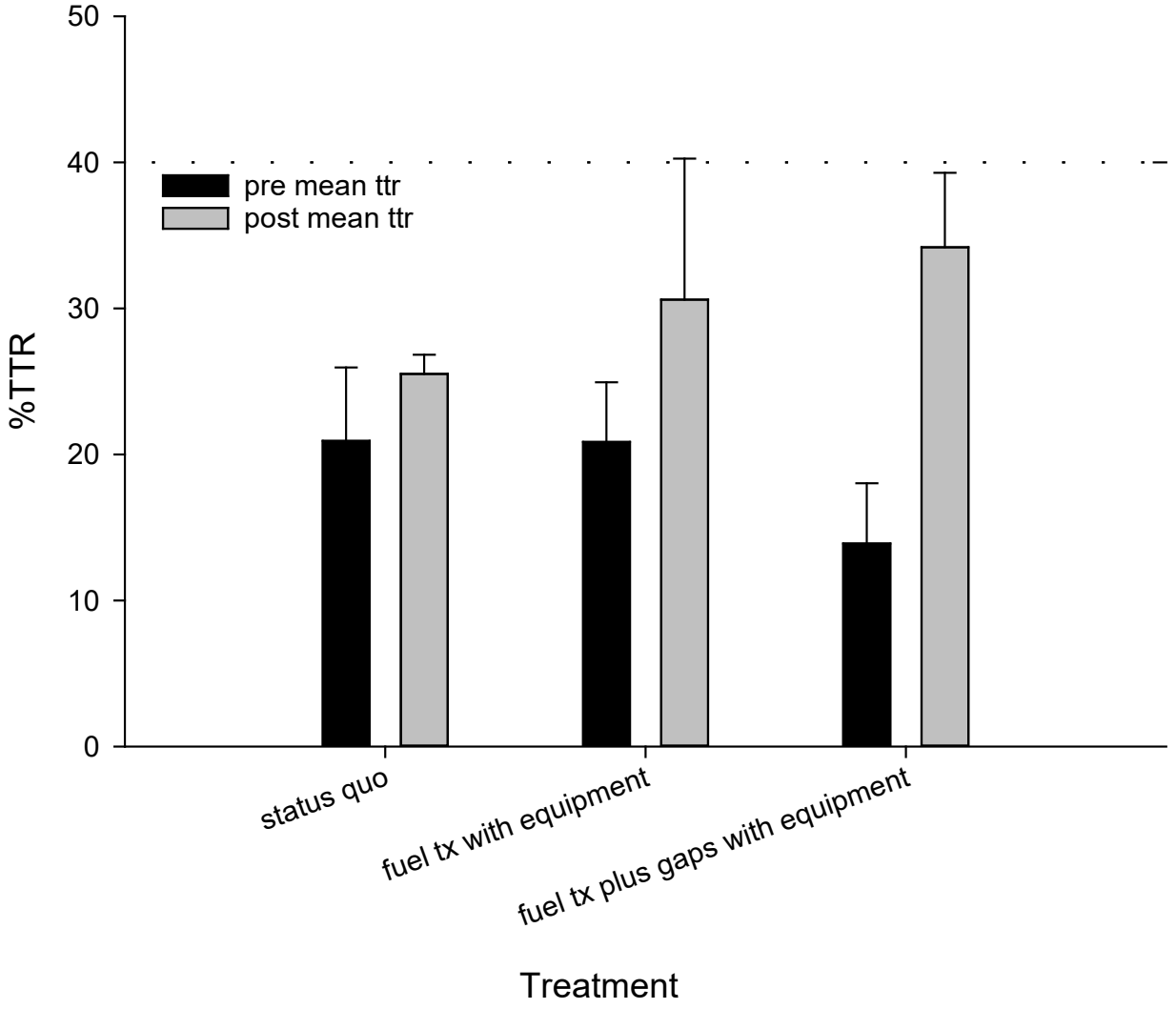
- All treatments resulted in an increase in light
- ANOVA suggests an increase in the degree of increased light input as we go from status quo to fuel tx to fuel tx+gaps
- Post-hoc comparisons suggest Status quo ~ Fuel tx < Fuel Tx+gaps
- Overall, light input is still low across all treatments when considering that 40% TTR is the minimum for P. pine regeneration



# Treatment effects on radiation

**At Protection Zone Edges:**
Very similar to stream channel results, except:

- No detectable increase in light from status quo harvesting
- Generally, edges are higher light environments pre-harvest
- Edges are higher post-harvest but still < 40% TTR
- Other stats are the same as in-channel locations



# Radiation input Management implications:

If your goal is to reduce fire hazard while minimizing light input:

- Thinning without gaps works the best

If your goal is to reduce fire hazard AND to disturb heavily enough to regenerate shade intolerants (e.g. P. pine, alder):

- Thinning + gaps works the best
- If a 10% to 25% increase in radiation input is acceptable

Operations tend to create a high to low light gradient going from WLPZ edge to center

This is likely also what fire did, according to reconstruction studies

# Treatment effects on yield

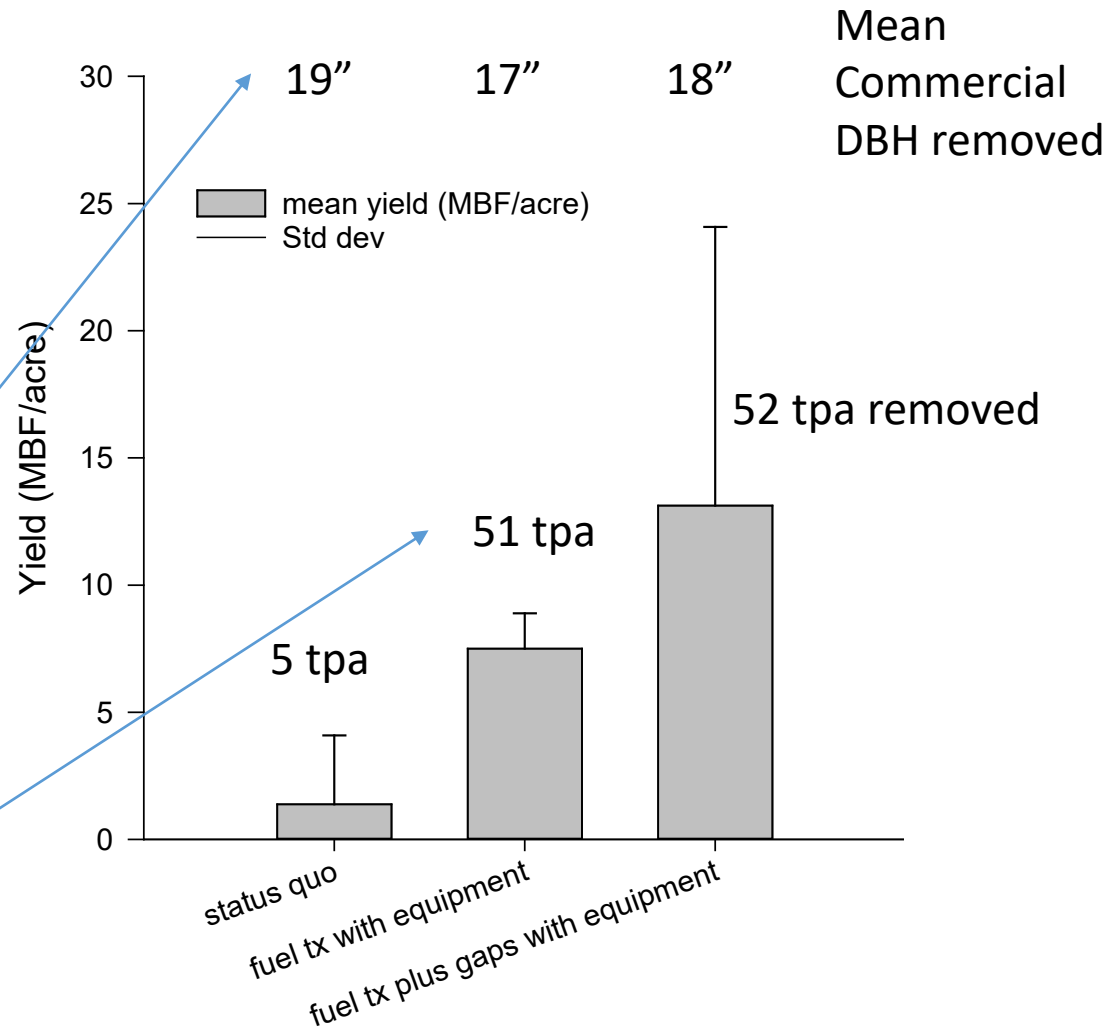
Volume removed increased as equipment was allowed into WLPZ stretches and as canopy gaps were created (p=0.04)

Comparison of means:
Status quo < fuel tx with equipment ~ fuel tx + gaps

Allowing heavy equipment increased yield by A LOT
Status quo = 1.4 MBF/acre
Heavy equipment treatments = 9.9 MBF/acre
(for reference, WLPZ stocking ~ 50MBF/acre)

Greater yield was from more trees removed, not from bigger trees removed

Large reduction in stem density in fuel treatments caused by unmerchantable tree removal



# Treatment effects on revenue

| Assumed net $/mbf | Revenue ($/acre) | | |
|---|---|---|---|
| | Status quo | Thin with equipment | Thin+gaps with equipment |
| **100** | 139 | 750 | 1312 |
| **200** | 277 | 1500 | 2624 |
| **300** | 416 | 2250 | 3936 |

Generally, revenue increases when heavy equipment is allowed since there is more yield

Net revenue is highly variable, given market fluctuations.

# Revenue implications

- If we assume that the fuel treatment costs $1000/acre, then the increased yield from allowing heavy equipment can cover this extra cost in “average” revenue years.

IF IF IF IF

- There are good forest products markets for landowners
- Treatments reduce surface fuels
- High-grading does not occur

THEN

- We have economic sustainability!

# STC results

~35,000 feet of stream length surveyed, roughly distributed evenly among treatments (control, status quo, legit fuel tx, legit fuel tx + gaps)

11 *possible* STC's found:

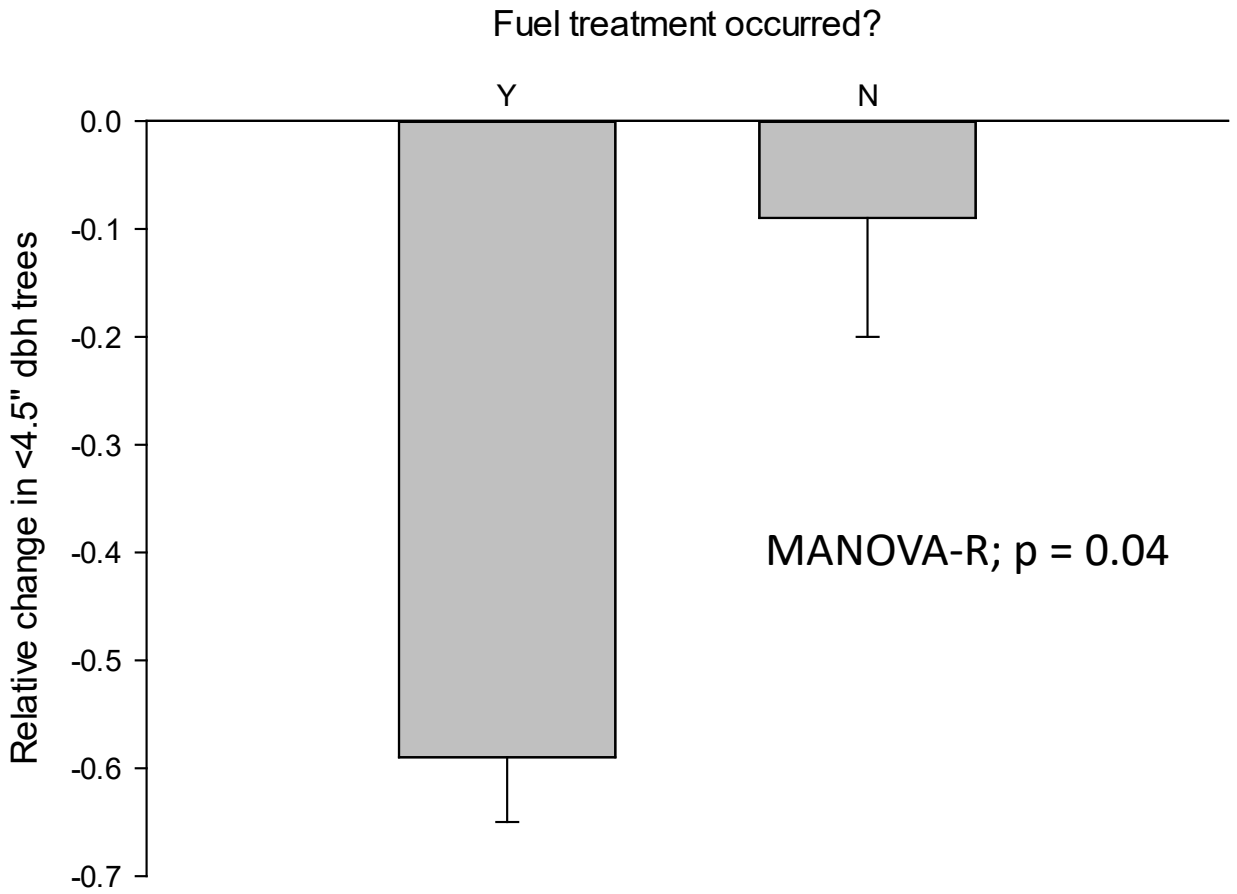
- Four in controls
- Two in status quos
- Four in legit fuel tx + gaps
- Only one, coming from a fire scar, was confirmed as real (in legit fuel tx + gap location)

Hoping to redo surveys in 2023

# Status quo v. fuel treatments: small tree density

Operational demonstration:

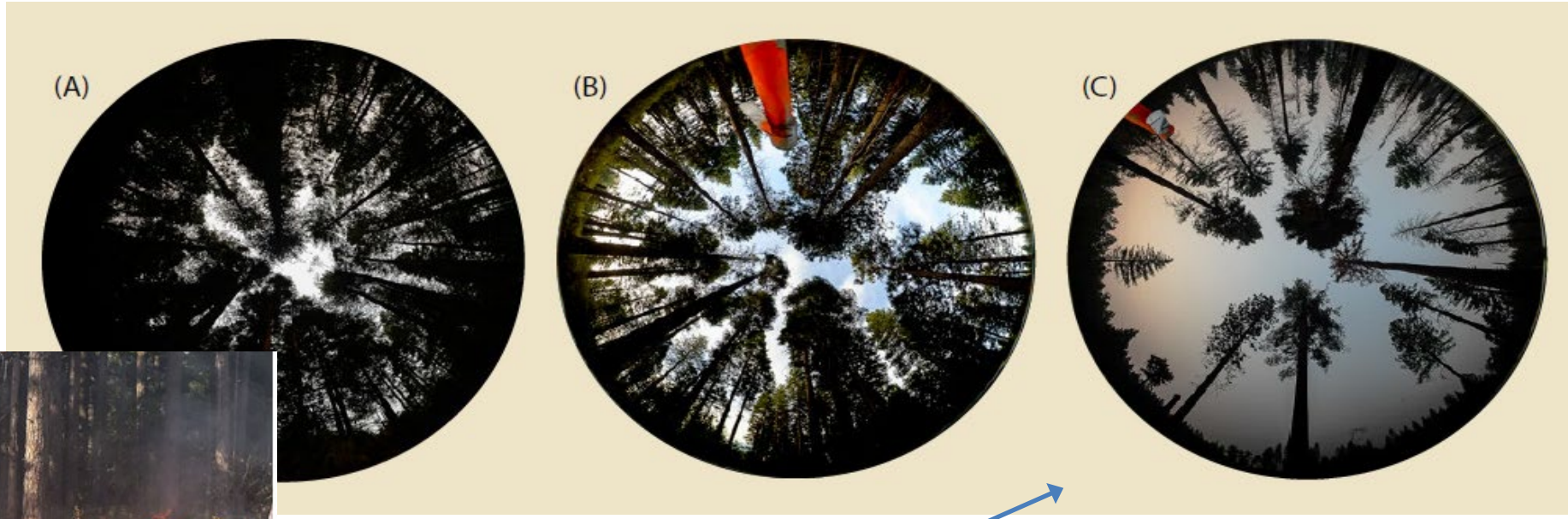
As expected, small tree density reduction much greater when they are targeted for removal



# Pyrosilviculture: Using Rx fire to meet objectives and increasing its likelihood of being used

York et al. 2019; CJFR

~ half of fuel tx areas broadcasted when piles burned





Heavily thinned canopy and midstory a lot easier to burn during permit-constrained conditions