Fuel treatment alternatives in riparian zones of the Sierra Nevada

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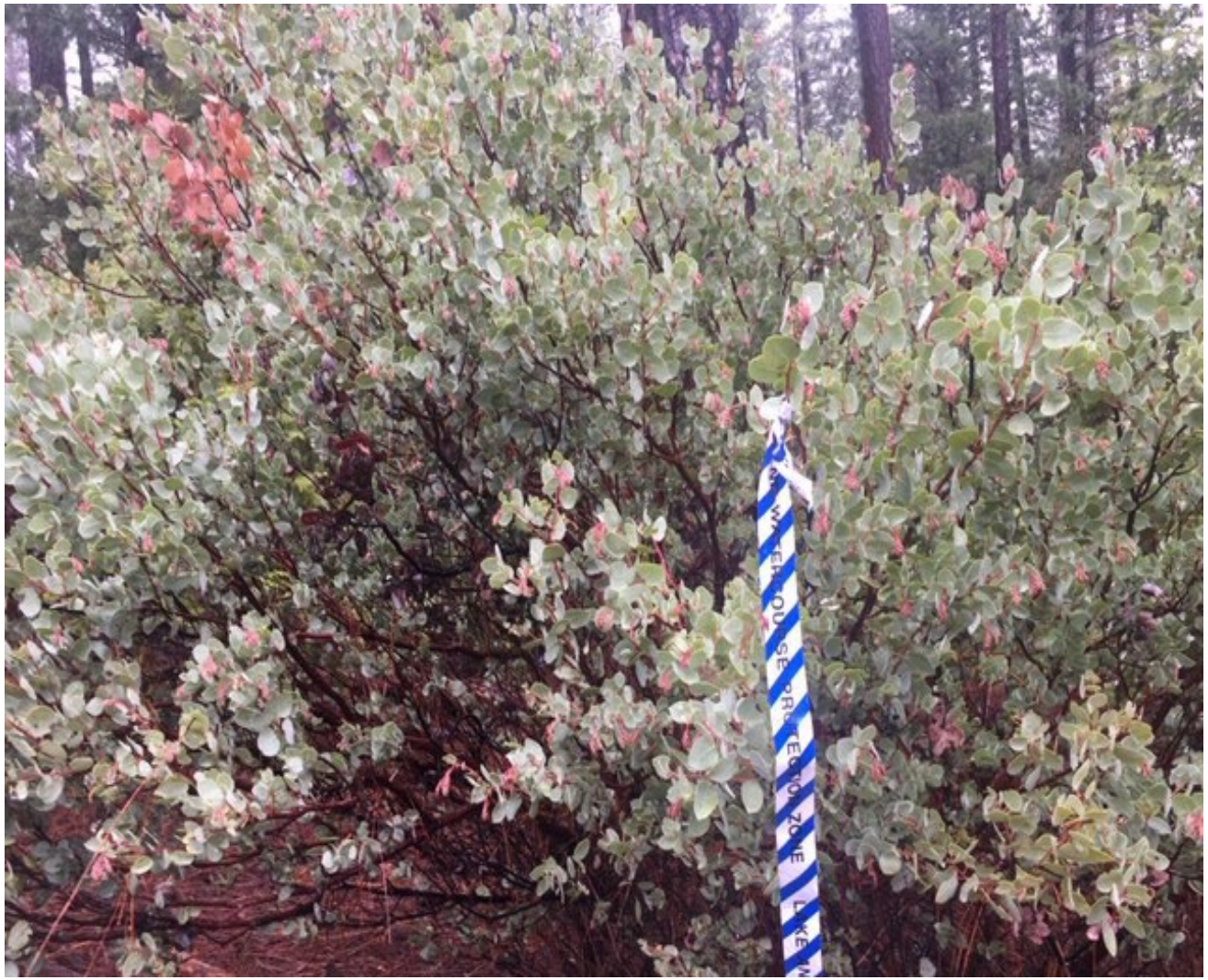
Proposed to EMC in 2017

King Fire- higher severity in riparian zone compared to upslope

Is there an *illusion of protection* in riparian zones?



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 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 2) Aquatic habitat for nonfish aquatic species. 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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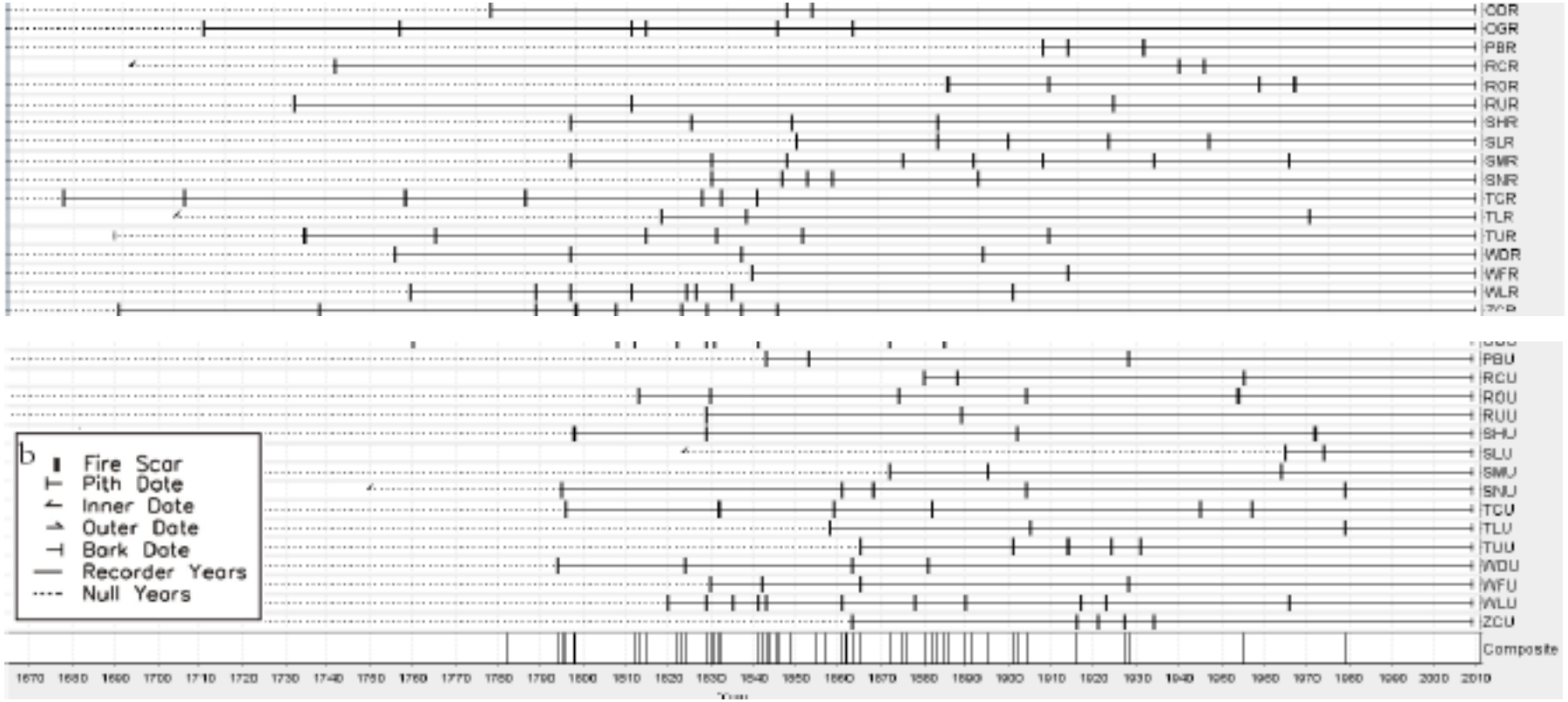
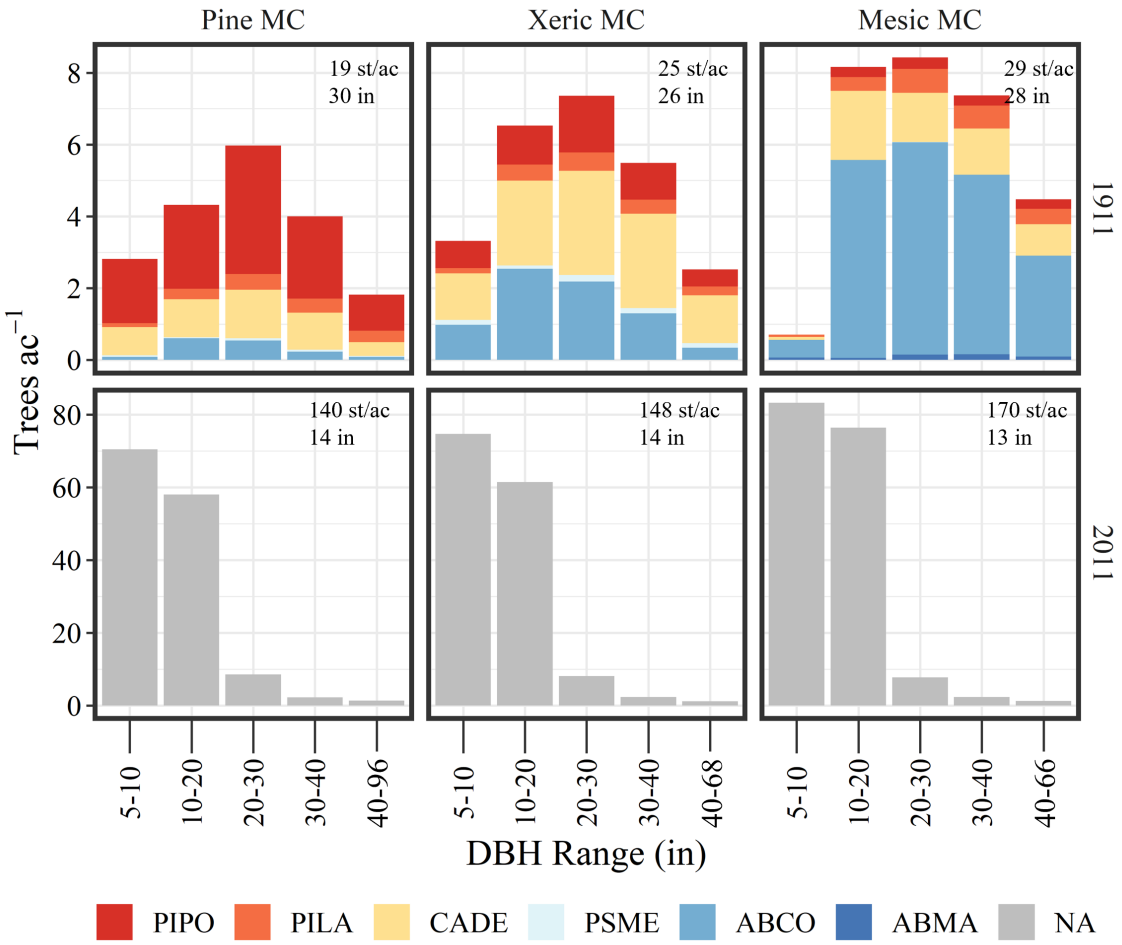
Fire history in Riparian areas

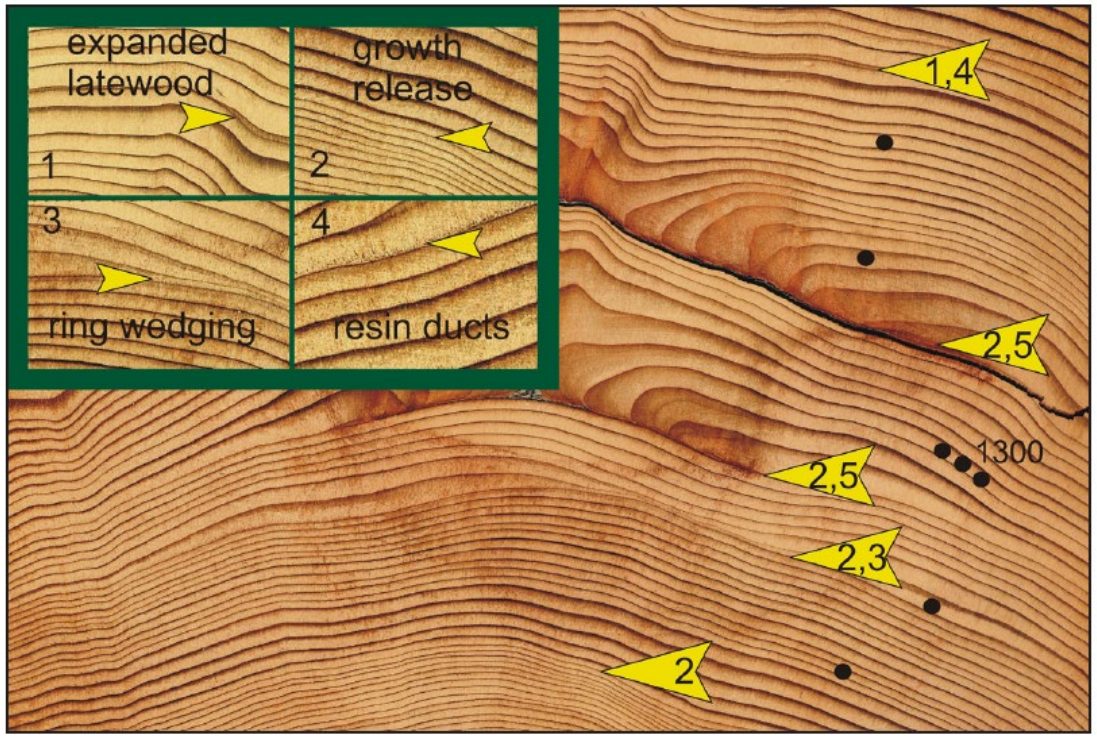
Good body of support for frequent fire in riparian areas: Agee 1998; Dwier and Kaufmann 2003; Everett et al. 2003; Pettit and Naiman 2007; Skinner 2003; **Van de Water 2011**



- 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





Riparian zones are unique, but their fire-influenced forest 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

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

Is there an *illusion of protection* in riparian zones?

Paradox of protection in Sierra Nevada Forests

Can’t protect forests from both fire and foresters

Why consider treatments in WLPZ's?

1. DREGS – Disturbance REgime Guided Silviculture

Can't practice DREGS with the current REGS

Why consider treatments in WLPZs?

2. Objective-based silviculture

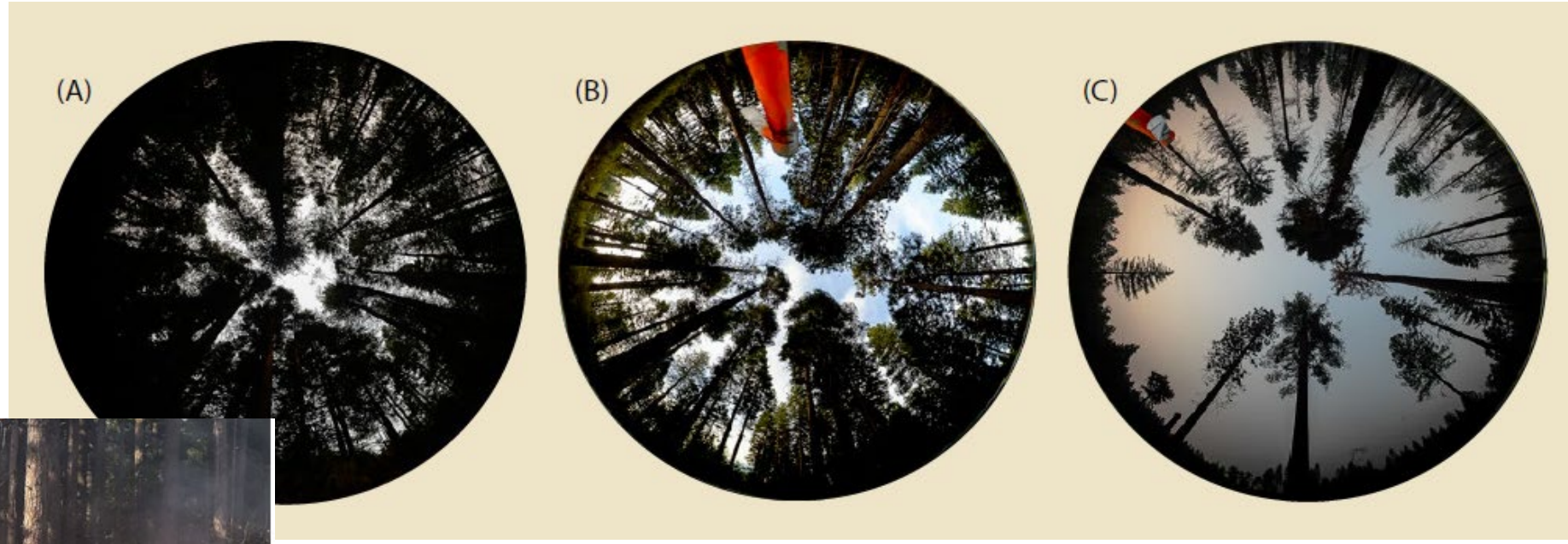
- Reduce high severity fire

3. Restoration of structure

Year	Total basal area ($ft^2\ ac^{-1}$)	Number of trees > 6” (ac^{-1})	Shrubs (% cover)
1911	70	19	65
2013	248	225	30

Collins et al. 2011

3.5 Restoration of process



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

4. Restoration of composition

Bio-Indicators of *localized* high severity disturbance:

- Ponderosa pine
- Alder

Alder- a closer look

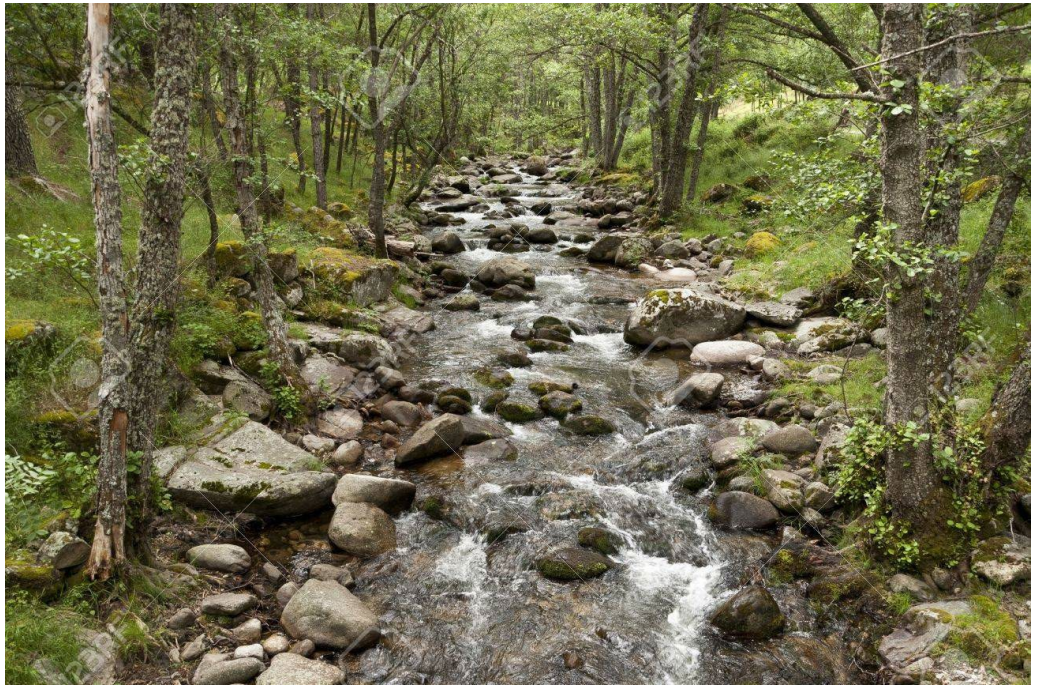
Science
AAAS

Widespread Increase of Tree Mortality Rates in the Western United States
Phillip J. van Mantgem, *et al.*
Science **323**, 521 (2009);
DOI: 10.1126/science.1165000

Mortality rates of conifers increased from 0.5 to ~1.5% per year

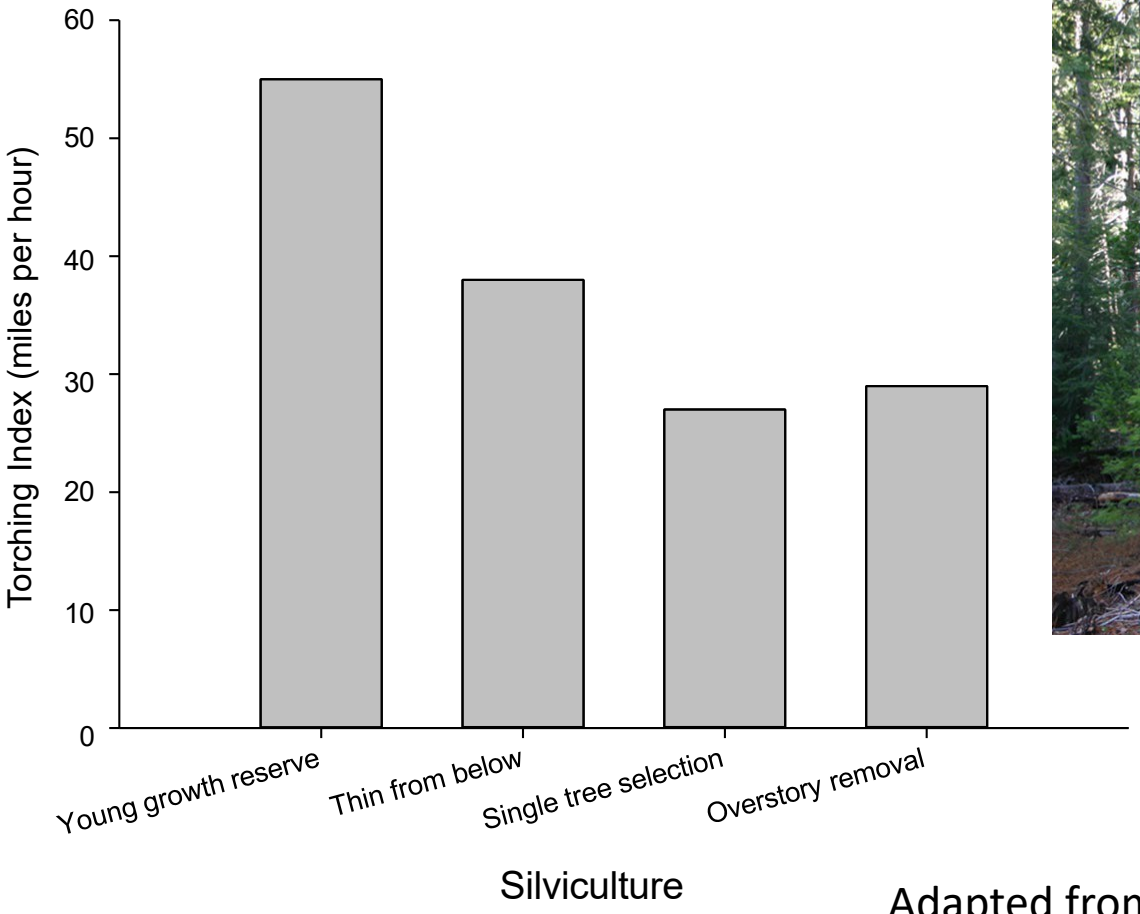
Alder at Blodgett:

- Mortality = 2.8% per year
- Recruitment = 0% per year



5. To have an alternative to the status quo

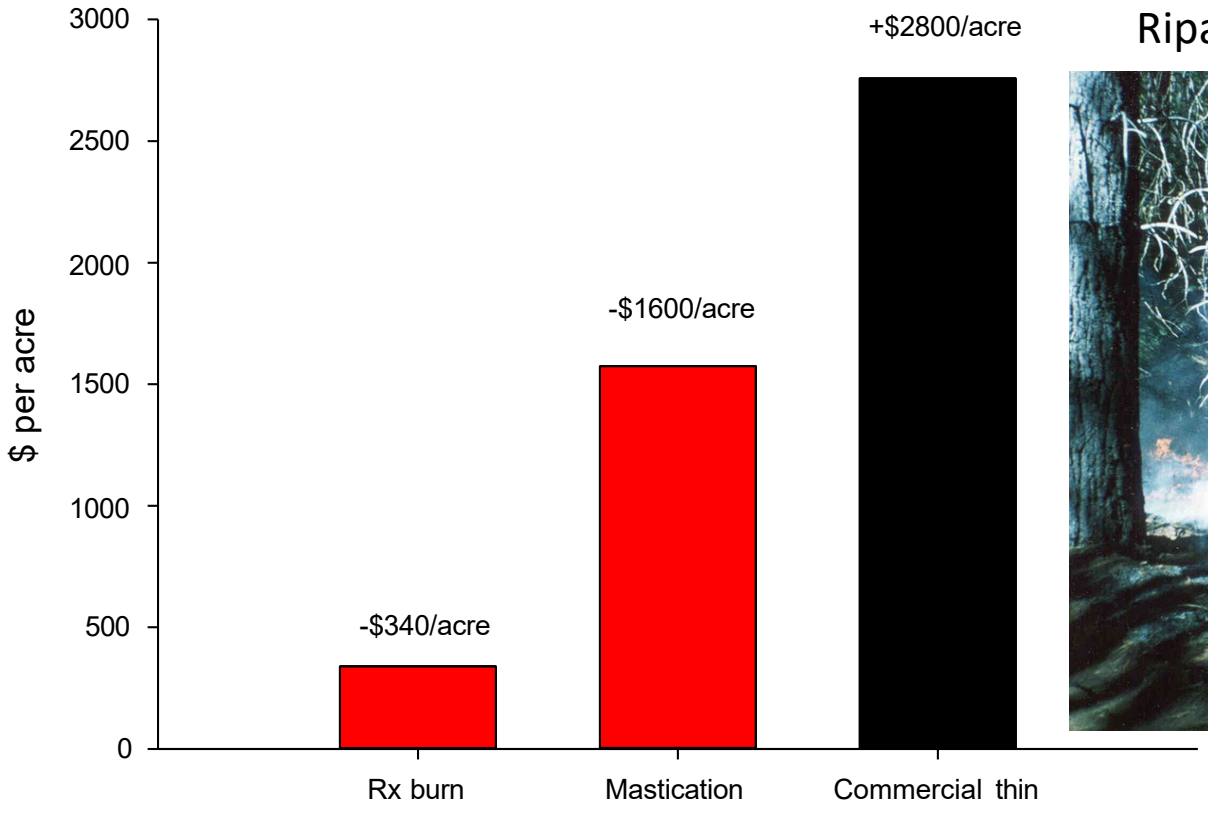
Selective harvesting without fuel reduction



Adapted from Stephens and Mogghadas 2005

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

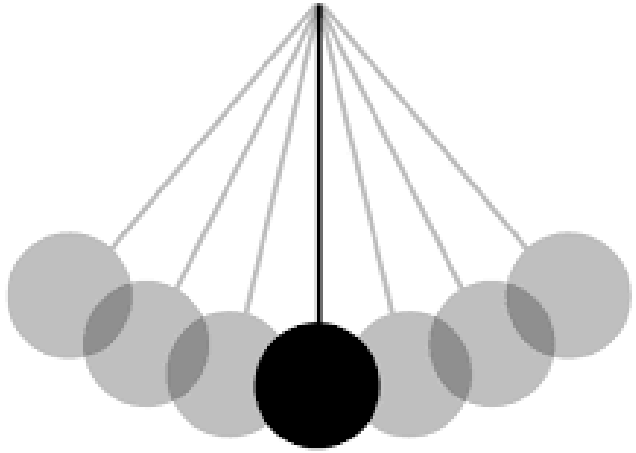
Too expensive to be sustainable



Adapted from
Hartsough et al. 2008

Riparian Rx burn

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?

- Riparian exotic invasives
- Fire-sensitive riparian species

Why *not* consider treatments?

- Heating of water from increased radiation

Research

Objective:

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

Do this over here

Long term (decades) study plan

Phase 1:

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

Phase 2:

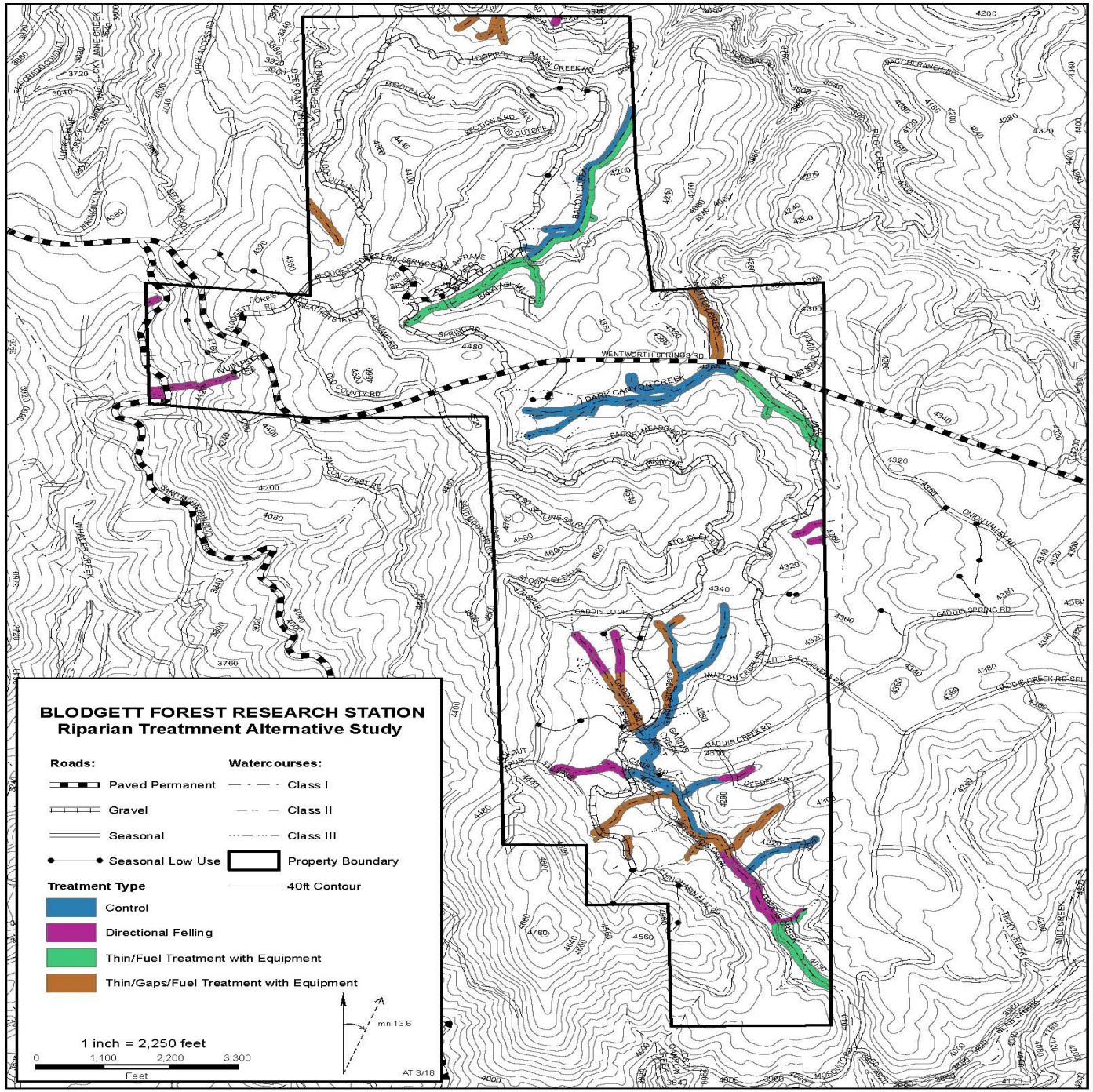
- Expand the study to several sites

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
- Protection of low light input into channels
- May be inherent drivers of lower severity during moderate fire weather conditions

Treatment 2 – The status quo

Selective harvest, using current WLPZ standards

- No heavy equipment
- “Get value” from the stand
- Comply with “The table”

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

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

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ELSEVIER

:ology and Management

www.elsevier.com/locate/foreco

Basic principles of forest fuel reduction treatments

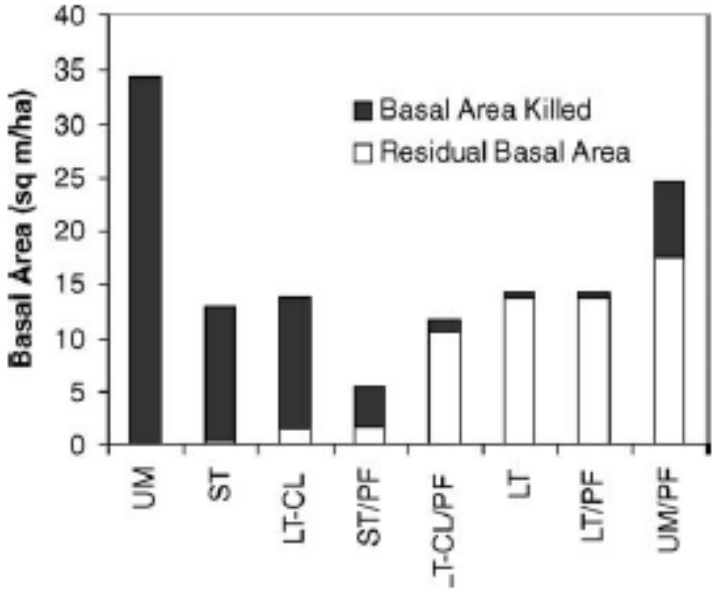
James K. Agee[a,*], Carl N. Skinner[b]

[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, USA

Treatment 3 – *Legit* fuel treatment

- Heavy equipment allowed during timber operations
- Thin from below to 150ft2/acre
- Improve spacing, vigor, tree size
- Follow-up with a ladder and surface fuel treatment:
  - Pile and burn or broadcast burn

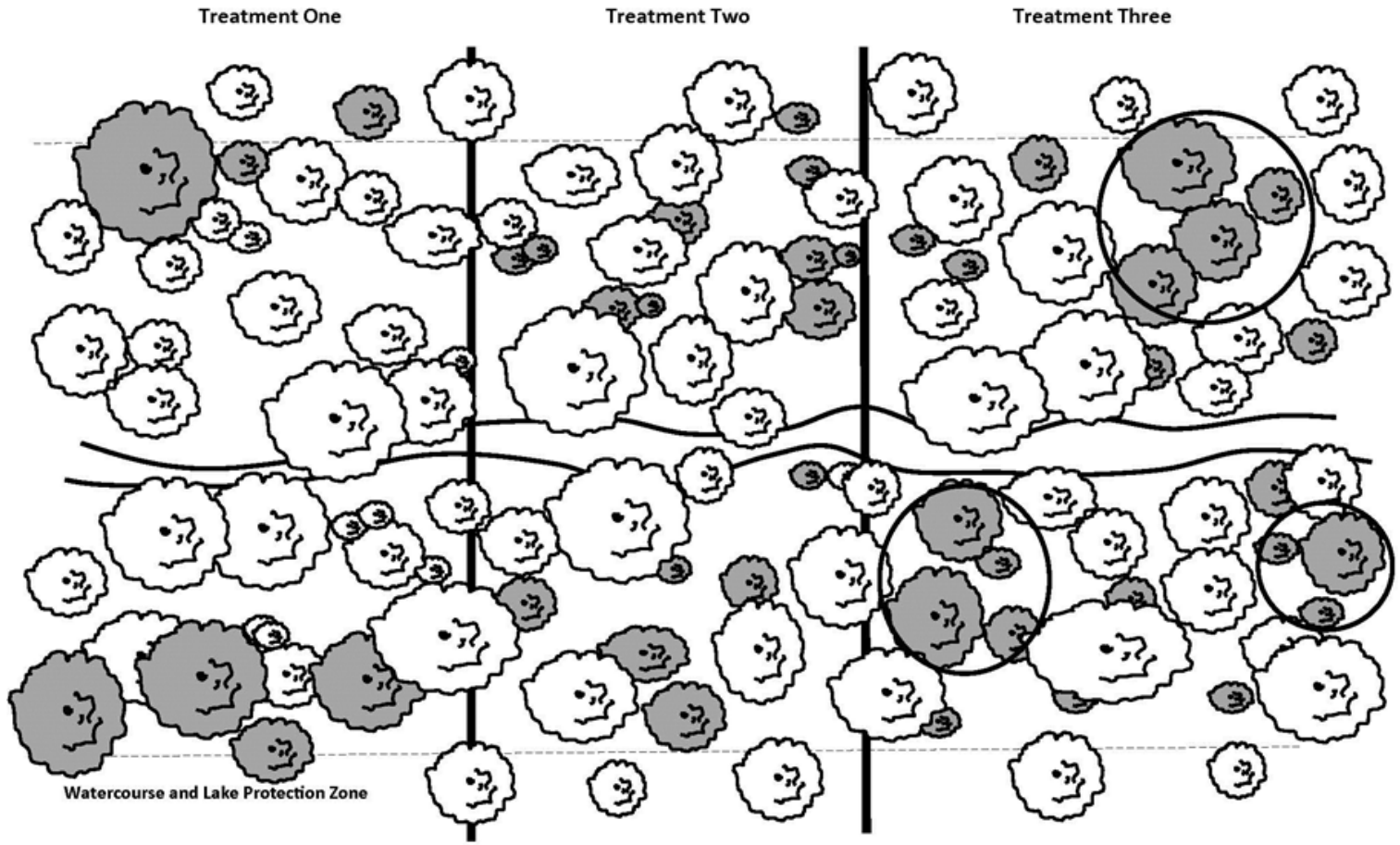


Agee and Skinner 2005

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

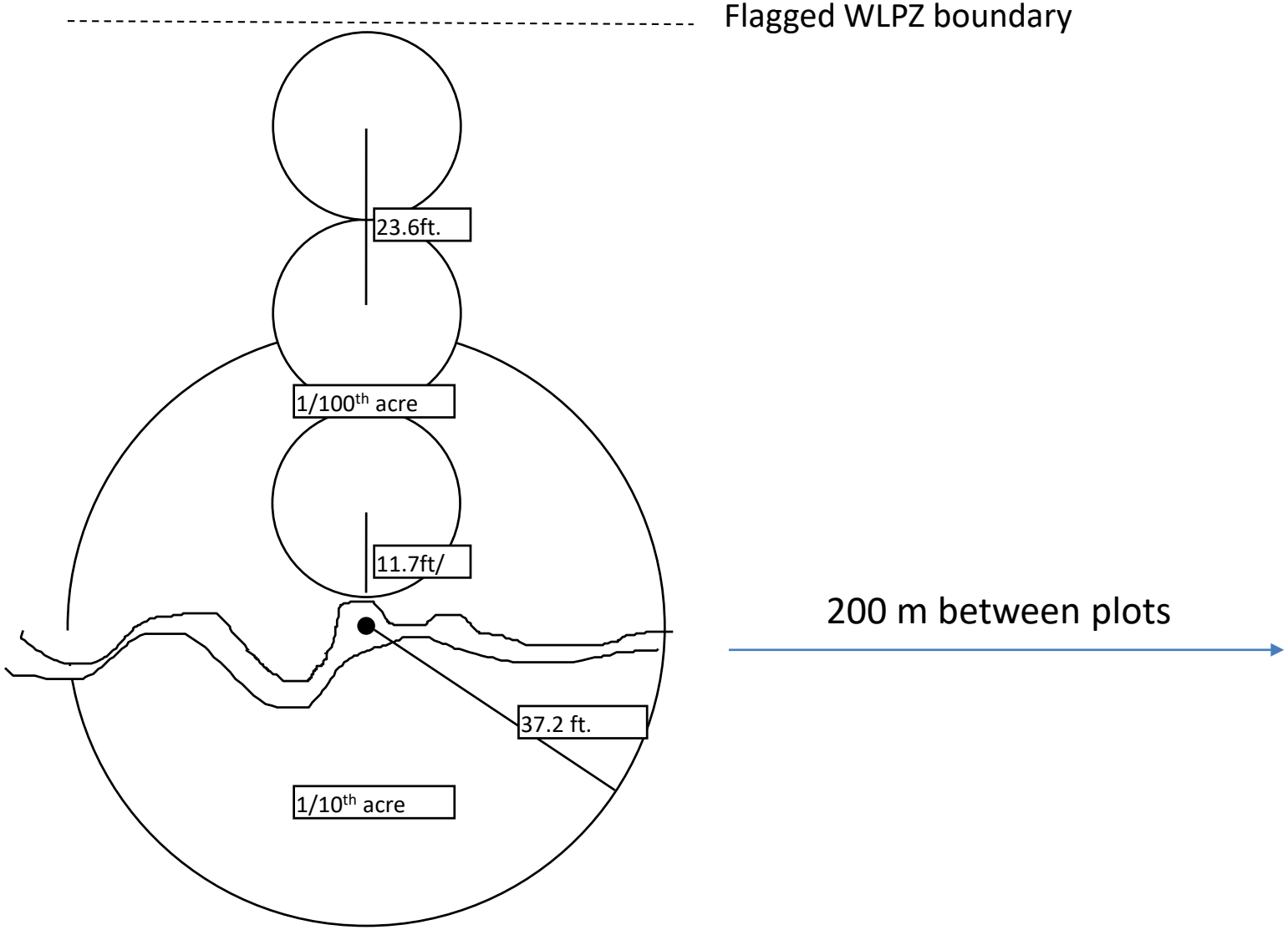
Status quo v. legit fuel treatments

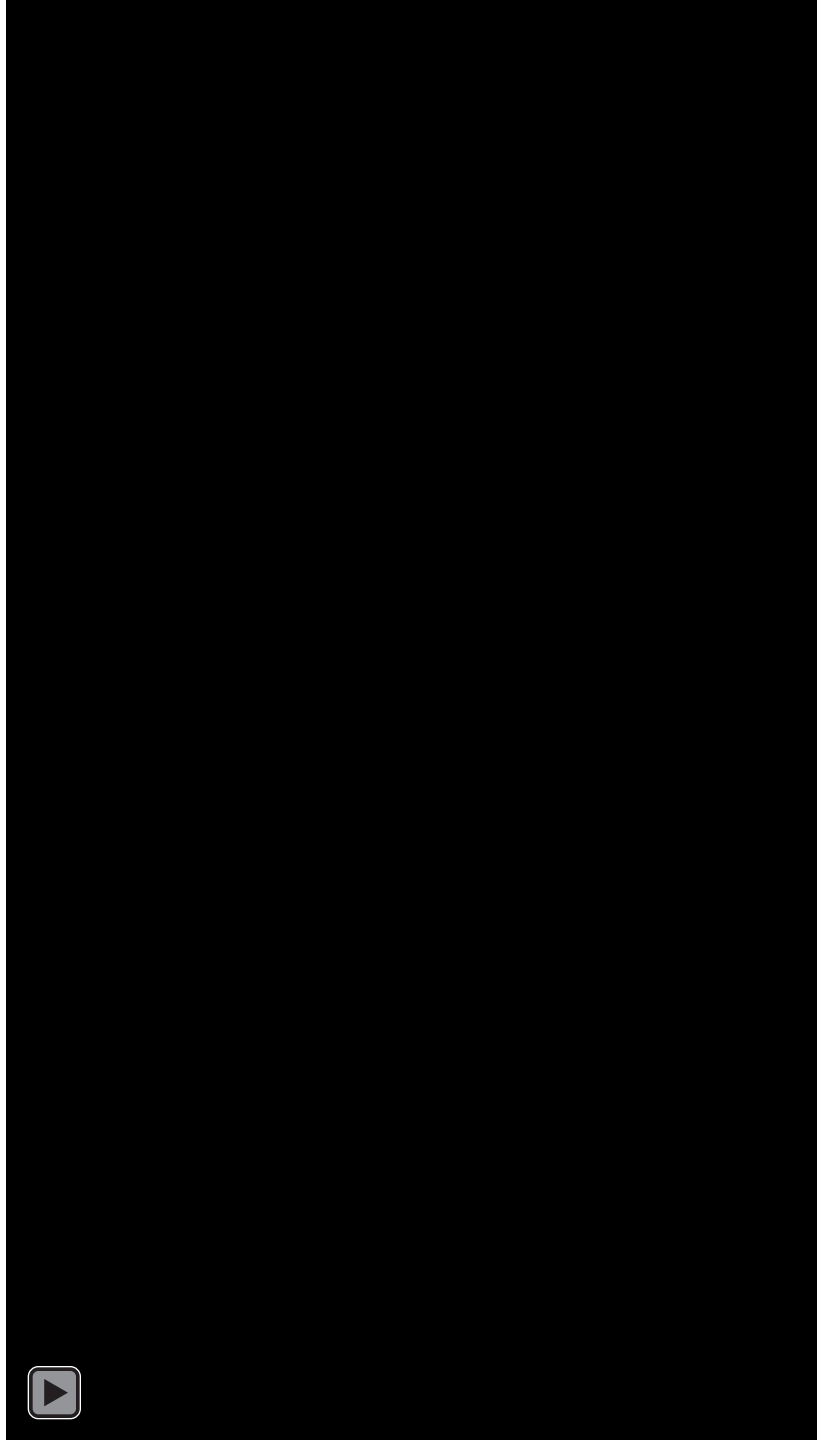


Measurements

Forest structure and composition
Light availability (%TTR)
Alder trees- 100% surveys
Revenue, yield
Sediment delivery corridors

Failed measurements
Soil strength – but got pre tx
Surface fuel- but got pre tx
Regen success of planted pine spp





Post Timber Operations Fuel Reduction

“Pile-casting” hand piles Fall 2018

~ half of piled areas broadcasted

Burning machine piles in gap
Fall 2018

Study timeline

Phase 1

- Pre-treatment measure in 1997, ~2007, 2016
- Commercial thins (2018-2021)
- Post commercial thin measure
- Fuel treatment
- Post fuel treatment measure

Phase 1 was a Shakespearian tragedy…

Covid!

Timber market collapse!

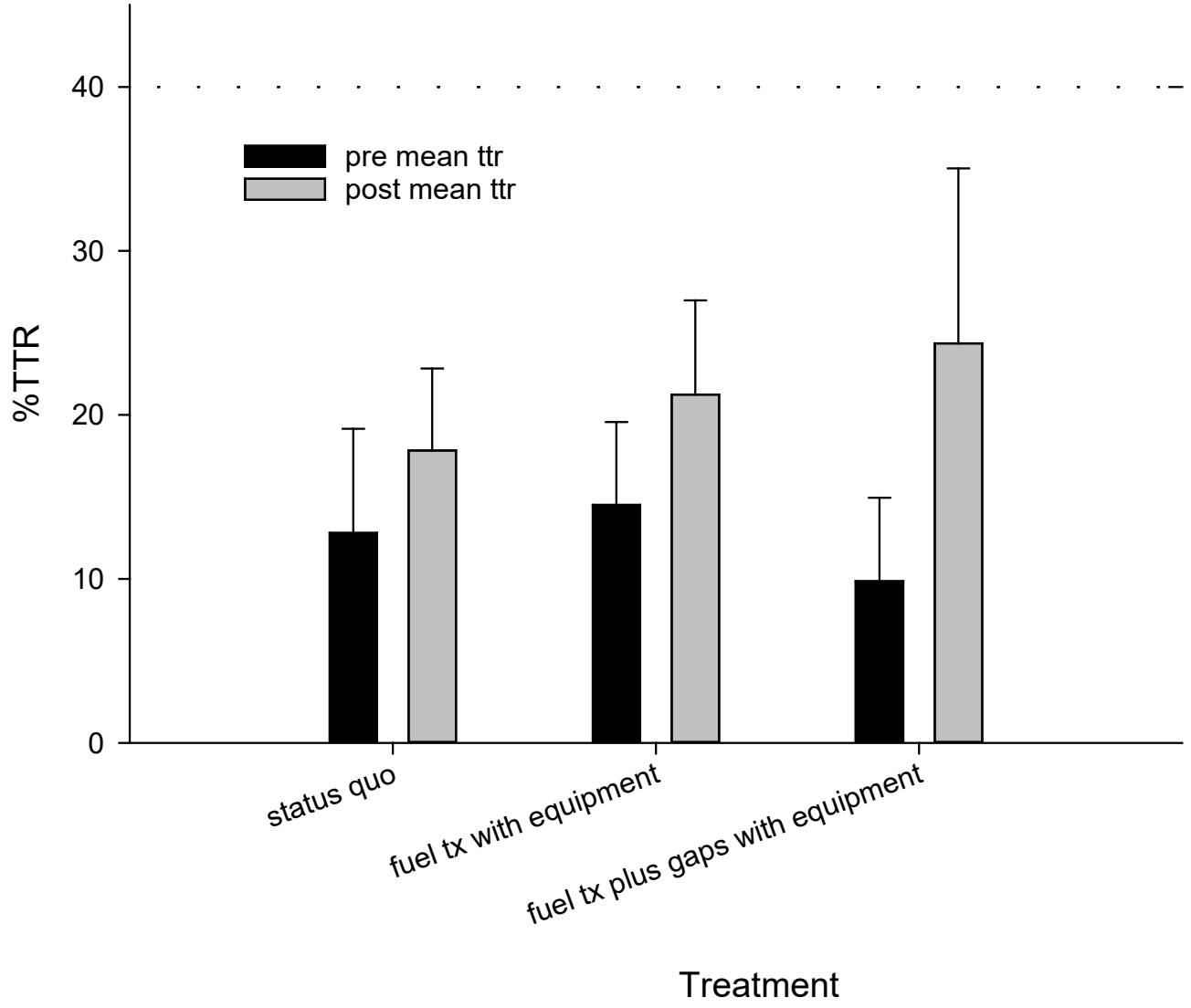
Wildfires!

Change in leadership!

Treatment effects on light availability

At stream channels:

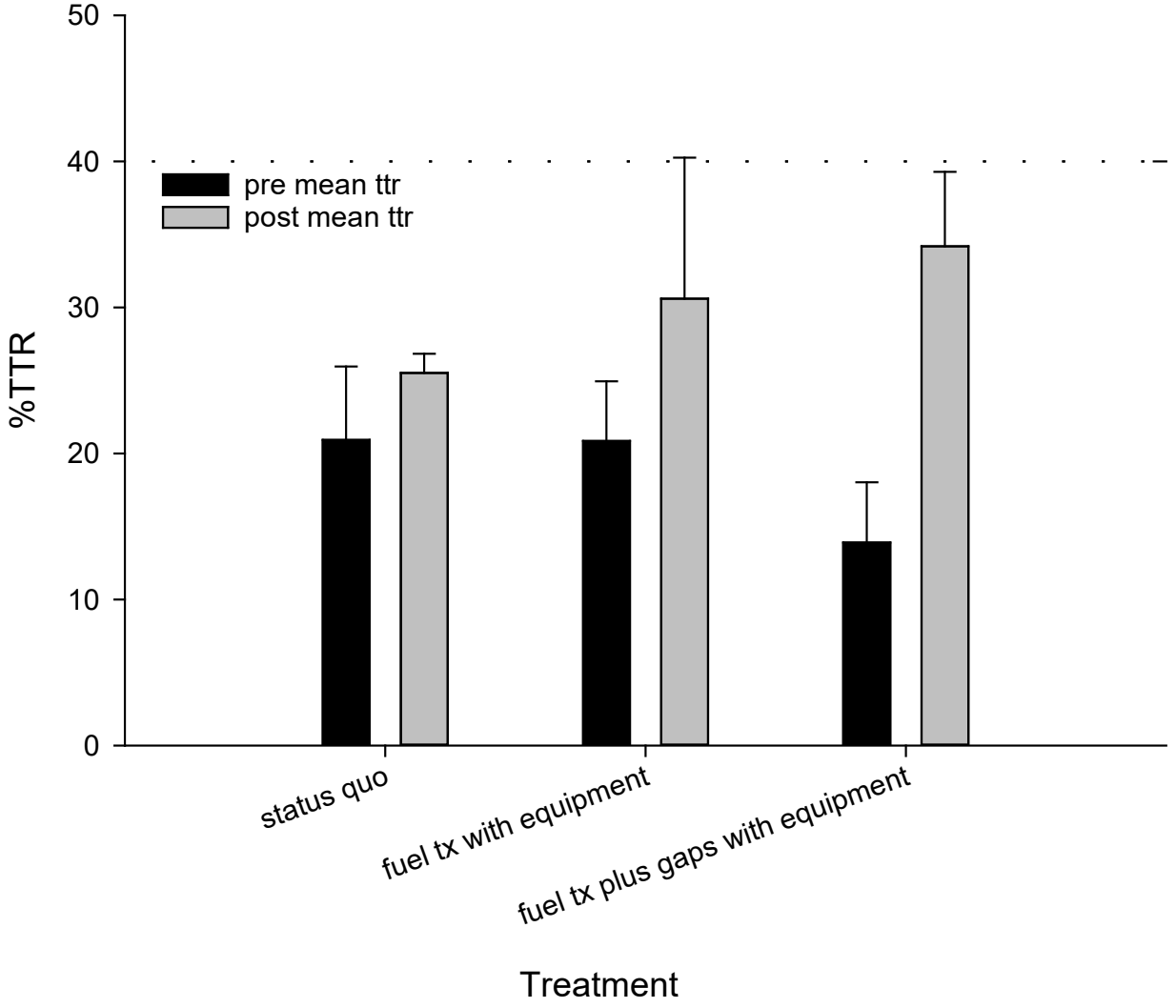
- All treatments resulted in an increase in light
- ANOVA suggests an increase in the degree of increased light input as we go from status quo to fuel tx to fuel tx+gaps
- Post-hoc comparisons suggest Status quo ~ Fuel tx < Fuel Tx+gaps
- Overall, light input is still low across all treatments when considering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



Treatment effects on light availability

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



Light availability Management implications:

- Depends on your world view and objectives:

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

- Thinning without gaps works

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

- Likely will need larger gaps or more intense thins

If your goal is heterogeneity without increasing light *substantially*:

- The thin+gap approach works

Treatment effects on yield

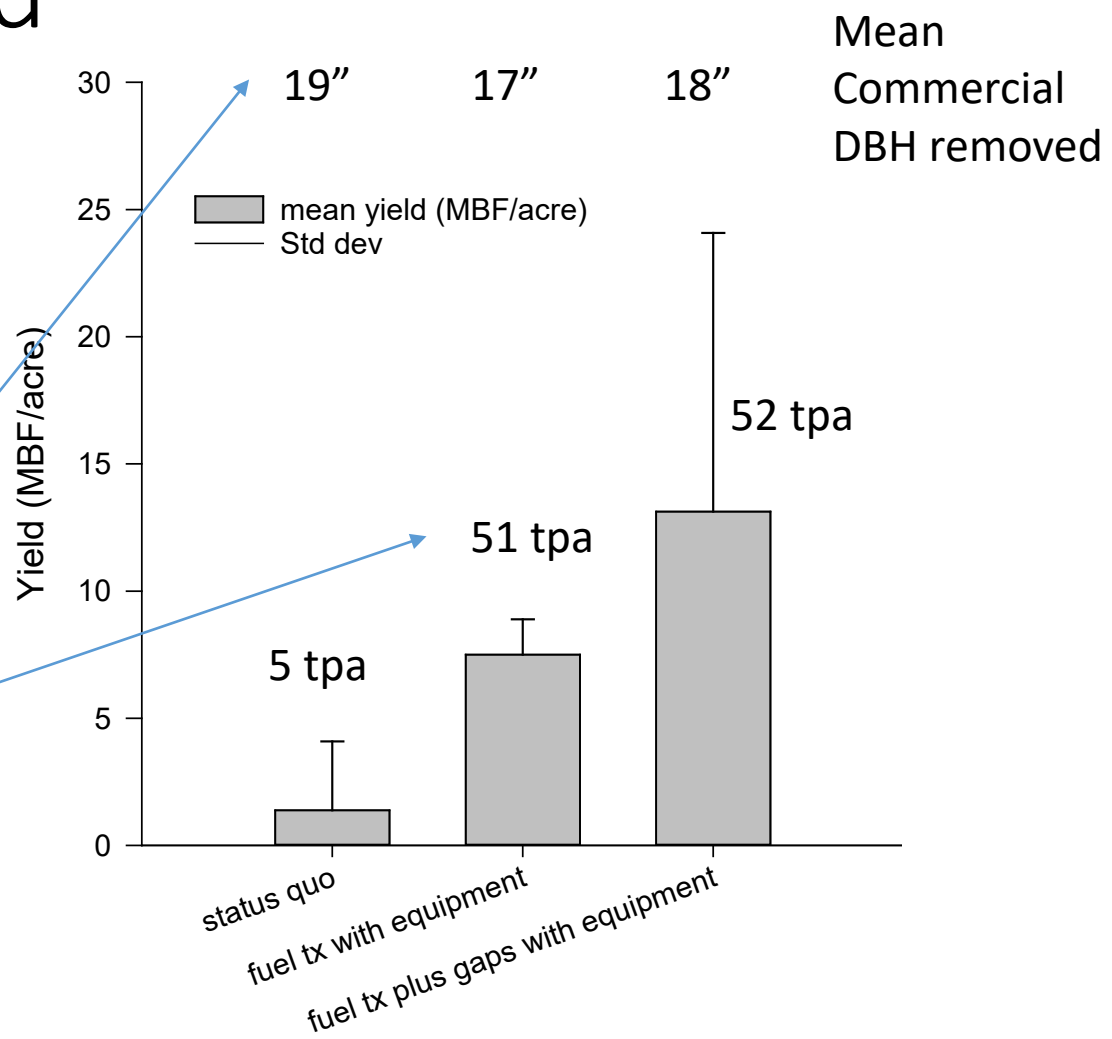
Volume removed increased as equipment was allowed into WLPZ stretches and as canopy gaps were created (p=0.04)

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

- Note that removal includes non-merchantable trees removed for fuel tx.



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!

Sediment Transport Corridors

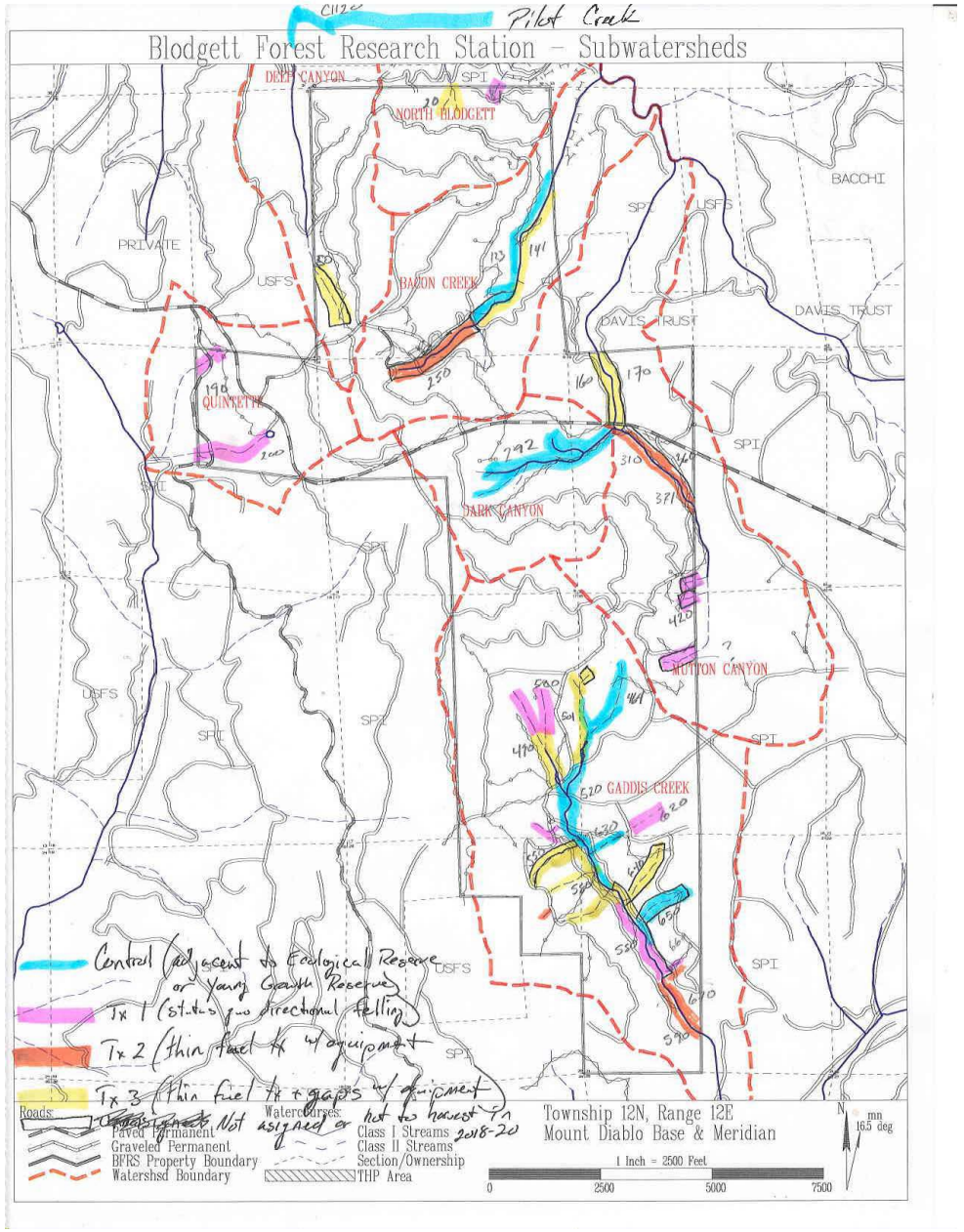
Surveyed all stretches in Oct. 2022

STC defined as “evidence of sediment delivery into the channel”

If STC 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



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- post ARO (Atmospheric River Onslaught)

Promises, promises…

Failed to:

Measure stream temperature changes

Plant/measure pine in gaps

Measure post-treatment soil strength (but still can)

Measure post-treatment fuel load adequately (but still can)

Promises kept

- Manuscript coming:
  - Light availability + Yield/revenue + Alder response
- Board of Forestry presentation
  - Coming next month
- CLFA presentation
- Many tours, including legislative staff and media
- Treatments should continue
- Most beautiful spots in the forest!

Long term (decades) study plan

Phase 1:

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

Phase 2:

- Expand the study to several sites
  - Some discussions: Flatwoods and Latour DSF

Phase 3:

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