Fuel treatment alternatives in riparian zones of the Sierra Nevada

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Talk Structure

- Context of study
- Study design
- Results
- Implications

- New study evaluating FPR stocking guidelines

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.	
Water Class	Class I		Class II		Class III		Class IV	
Slope Class (%)	Width Feet	Protection Measure	Width Feet	Protection Measure	Width Feet	Protection Measure	Width Feet	Protection Measure
					[see 916.4(c)] [see 936.4(c)] [see 956.4(c)]		[see 916.4(c)] [see 936.4(c)] [see 956.4(c)]	
<30	75	BDG	50	BEI	See CFH		See CFI	
30-50	100	BDG	75	BEI	See CFH		See CFI	
>50	150[2]	ADG	100[3]	BEI	See CFH		See CFI	

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

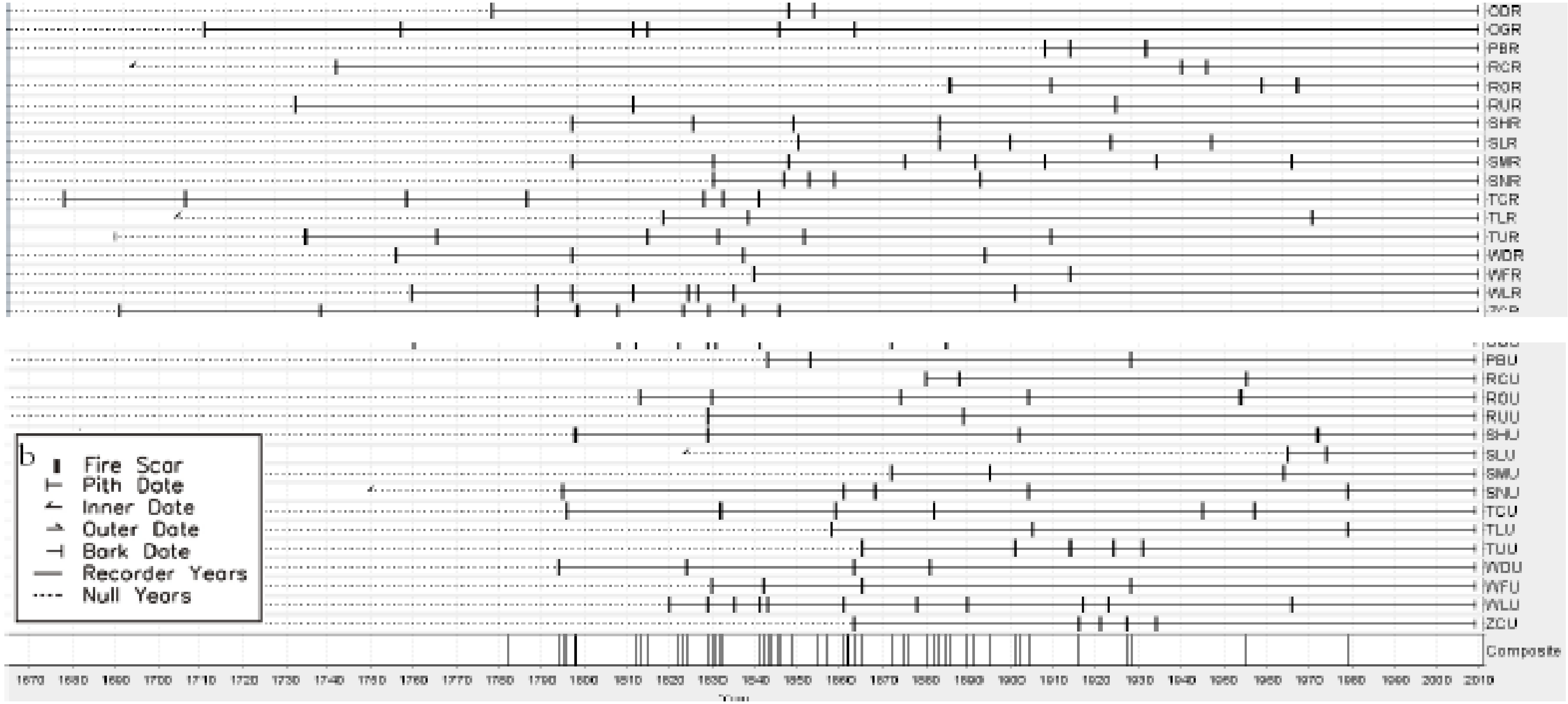
Watercourse and Lake Protection Zone (WLPZ) means a strip of land, along both sides of a Watercourse or around the circumference of a lake or spring, where **additional practices** may be required for protection of the quality and beneficial uses of water, fish and Riparian wildlife habitat, other forest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

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

Should it mean “additional practices?”

Fire history in Riparian areas

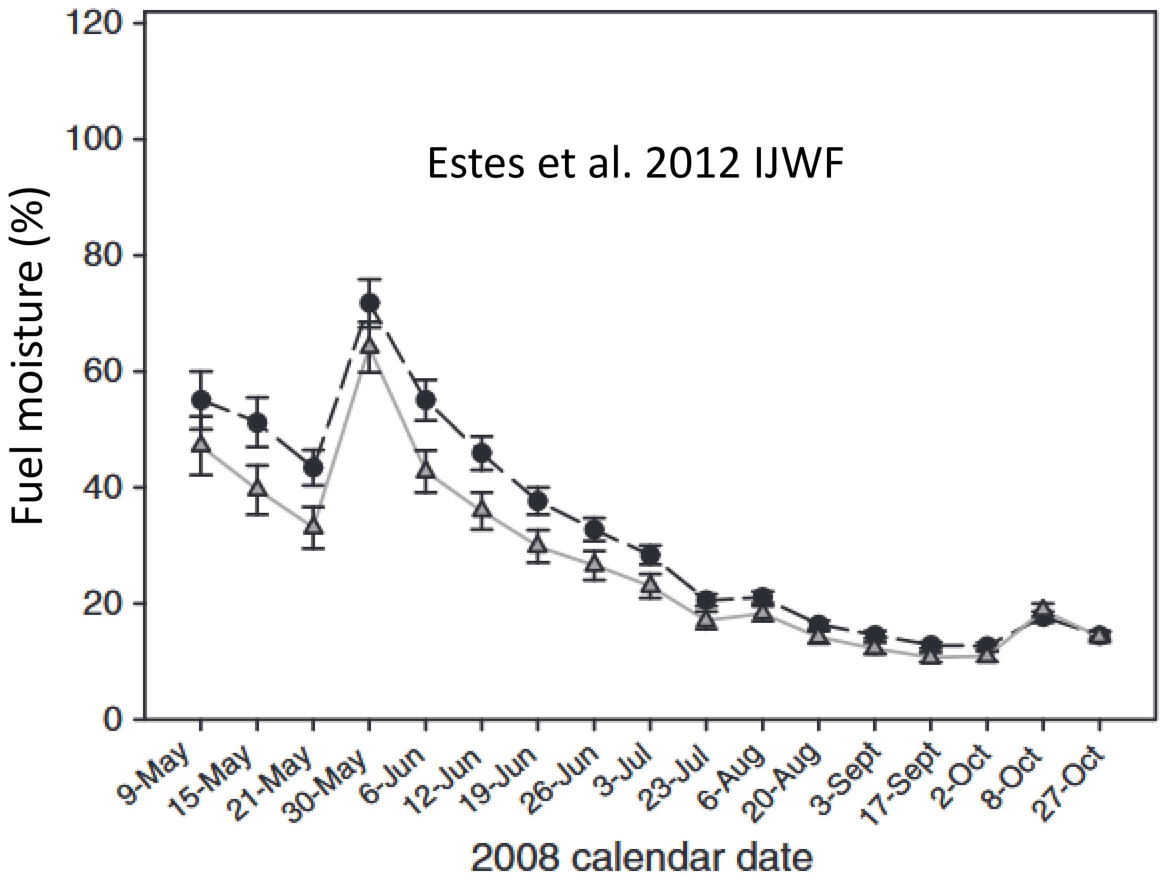
Good body of support for frequent fire in riparian areas: Agee 1998; Dwier and Kaufmann 2003; Everett et al. 2003; Pettit and Naiman 2007; Skinner 2003; **Van de Water 2011**



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

How can fire's burn hot in "wet areas?"

- Because they are productive (lots of fuel)
- Because they are not actually wet during the dry season



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

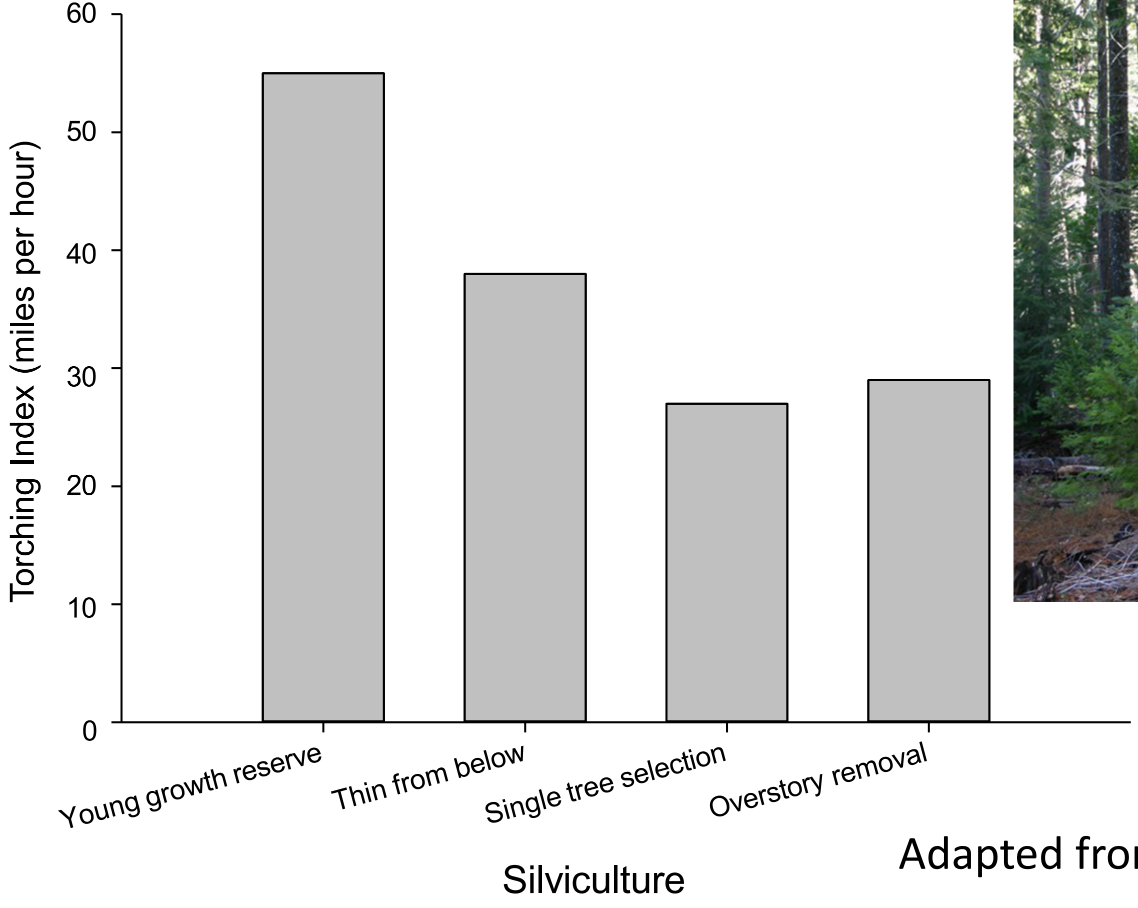
P-Torch = 0.76
Surface fuel = 45 tons/acre

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) when not accompanied by a *legit* fuel treatment

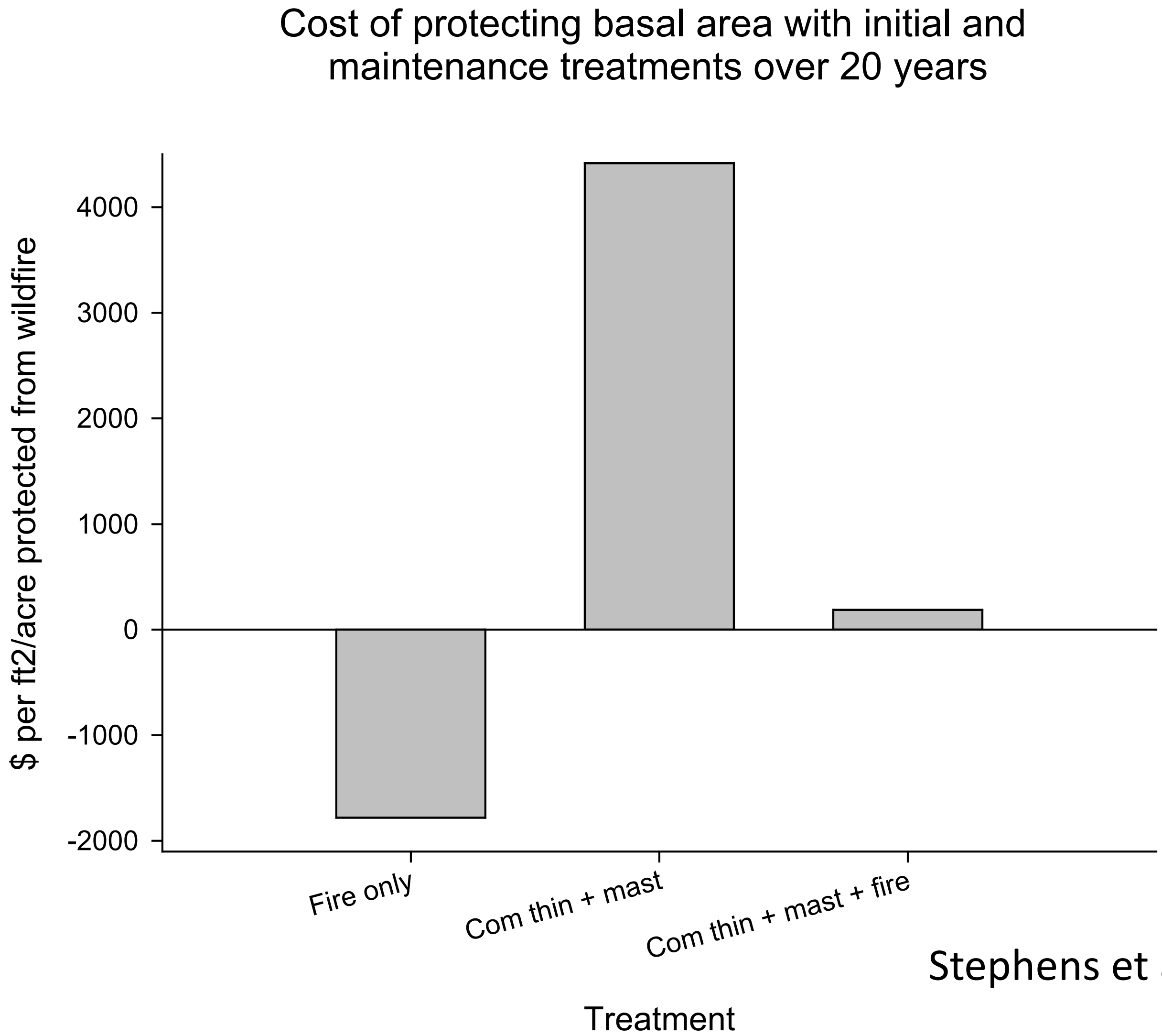


Adapted from Stephens and Mogghadas 2005

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

Too expensive to be sustainable

Public grants notwithstanding, who will pay for them?



Stephens et al. 2023

Research

Objective:

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

Do this over here

Long term study plan

Phase 1:

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

Phase 2:

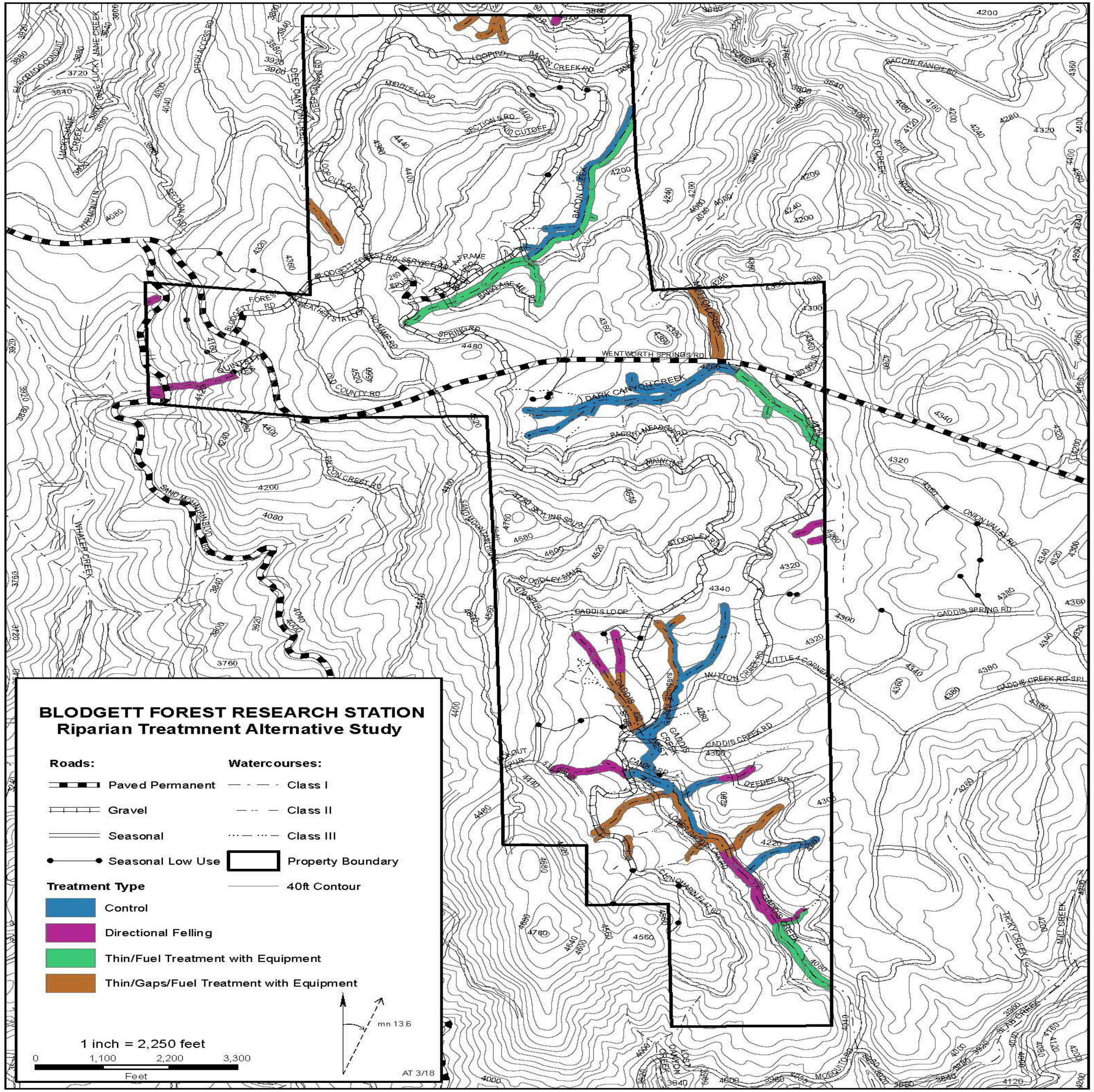
- Expand the study to several sites

Phase 3:

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

Study area:

- Blodgett Forest Research Station
- Central Sierra's, representative of Class I mixed conifer forests
- 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?"

Until a high severity wildfire occurs:

- Protection of large trees (compared to status quo)
- Limits radiation input (protects water temps)

Treatment 2 – The status quo

Selective harvest, using current WLPZ standards

- No heavy equipment
- "Get value" but comply with "The table"

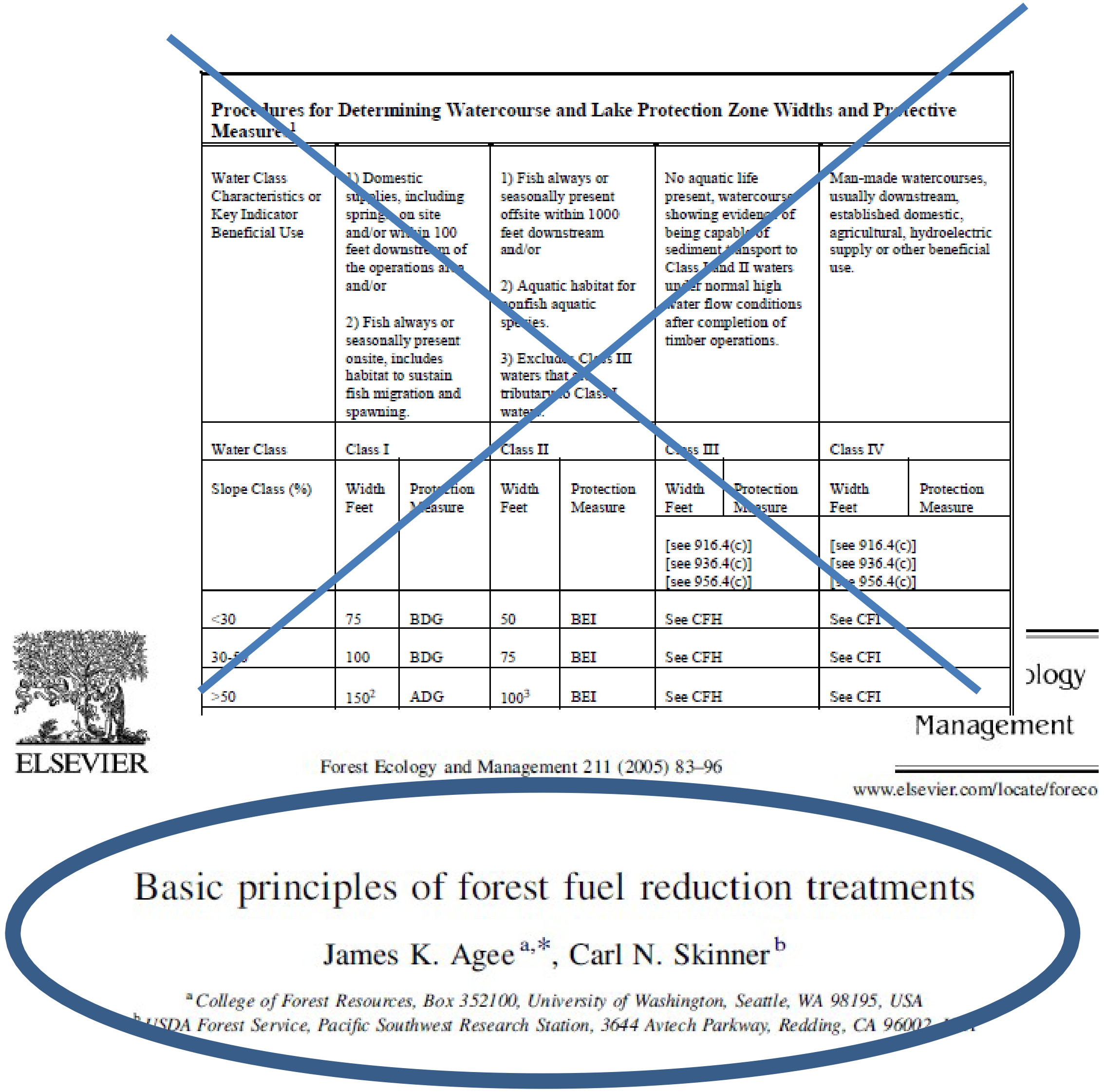
How might it be best?

- Revenue
- Density reductions

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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Forest Ecology and Management 211 (2005) 83–96

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Management

www.elsevier.com/locate/foreco

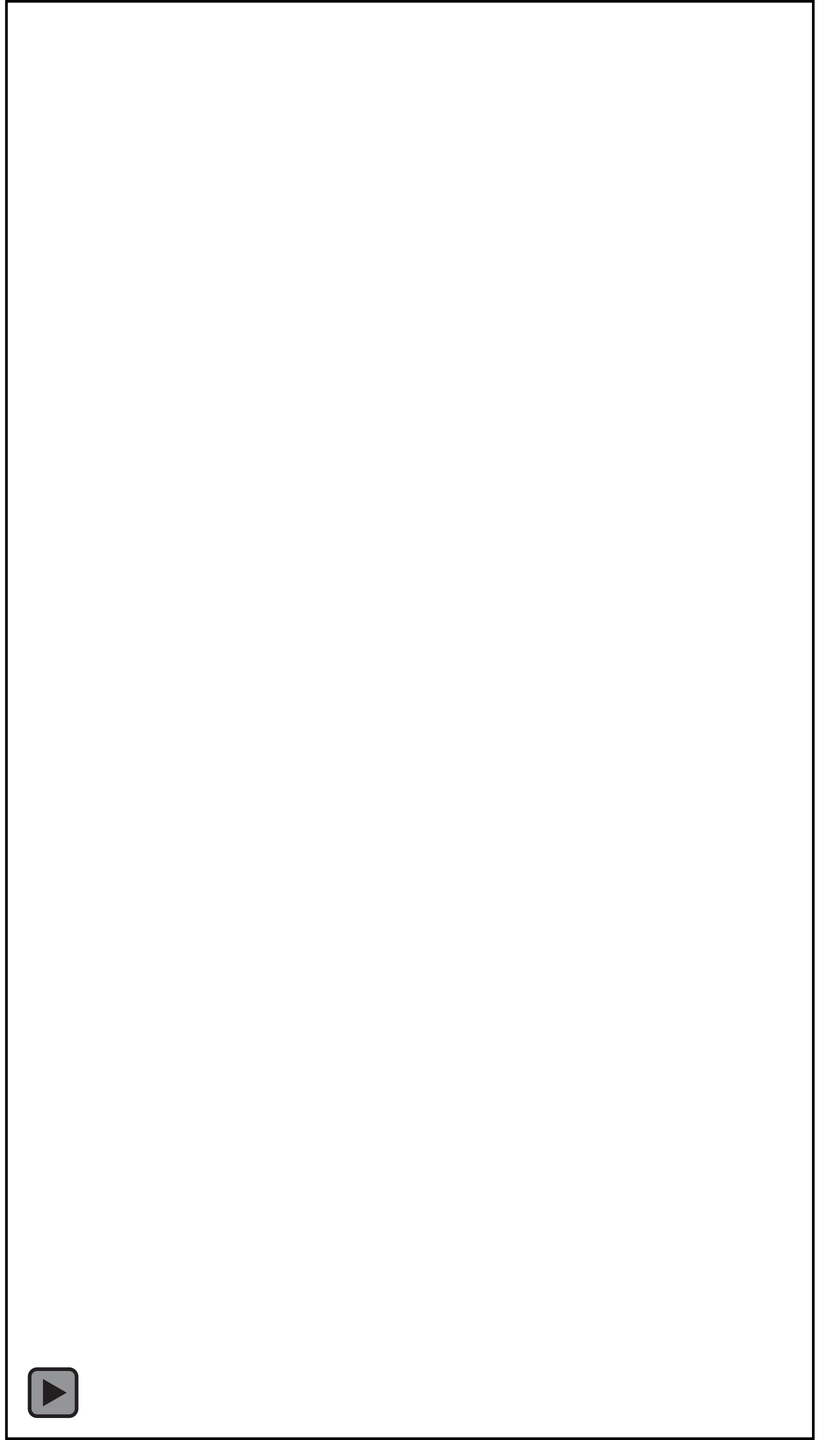
Basic principles of forest fuel reduction treatments

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: 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

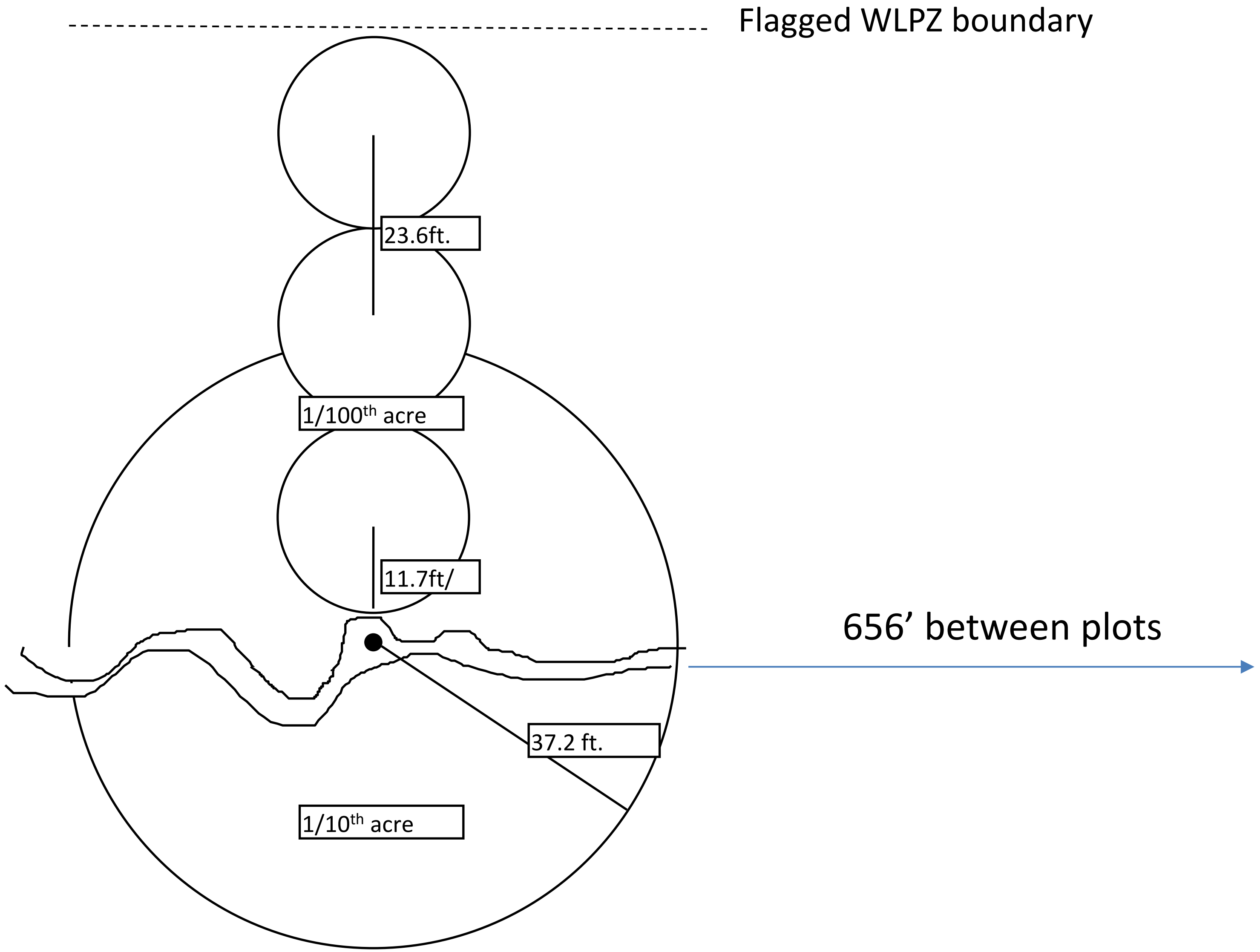
Phase 1 Measurements

Reporting here:

Change in radiation input (%TTR)

Yield and revenue

Forest structure



Results

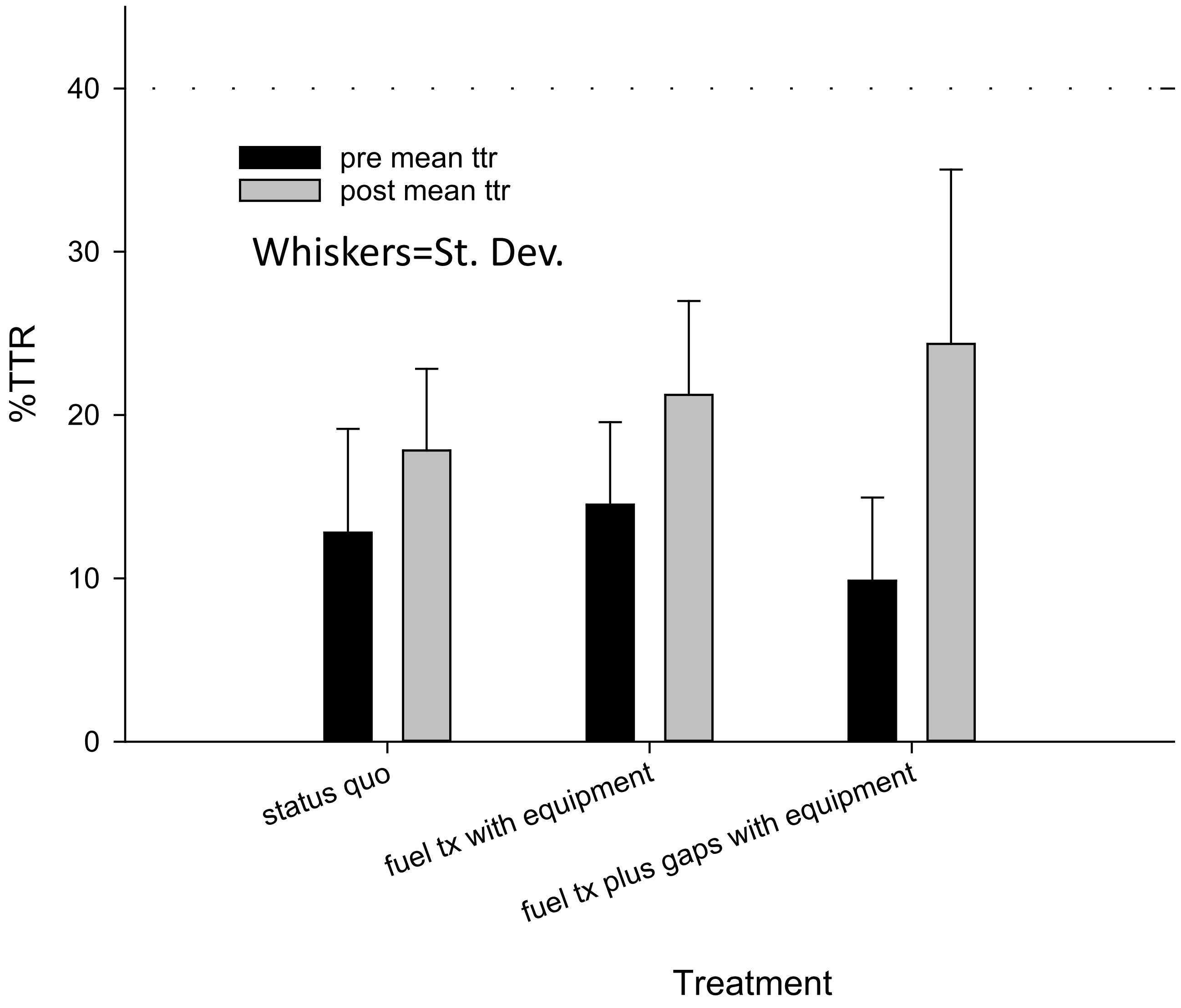
Treatment effects on radiation

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

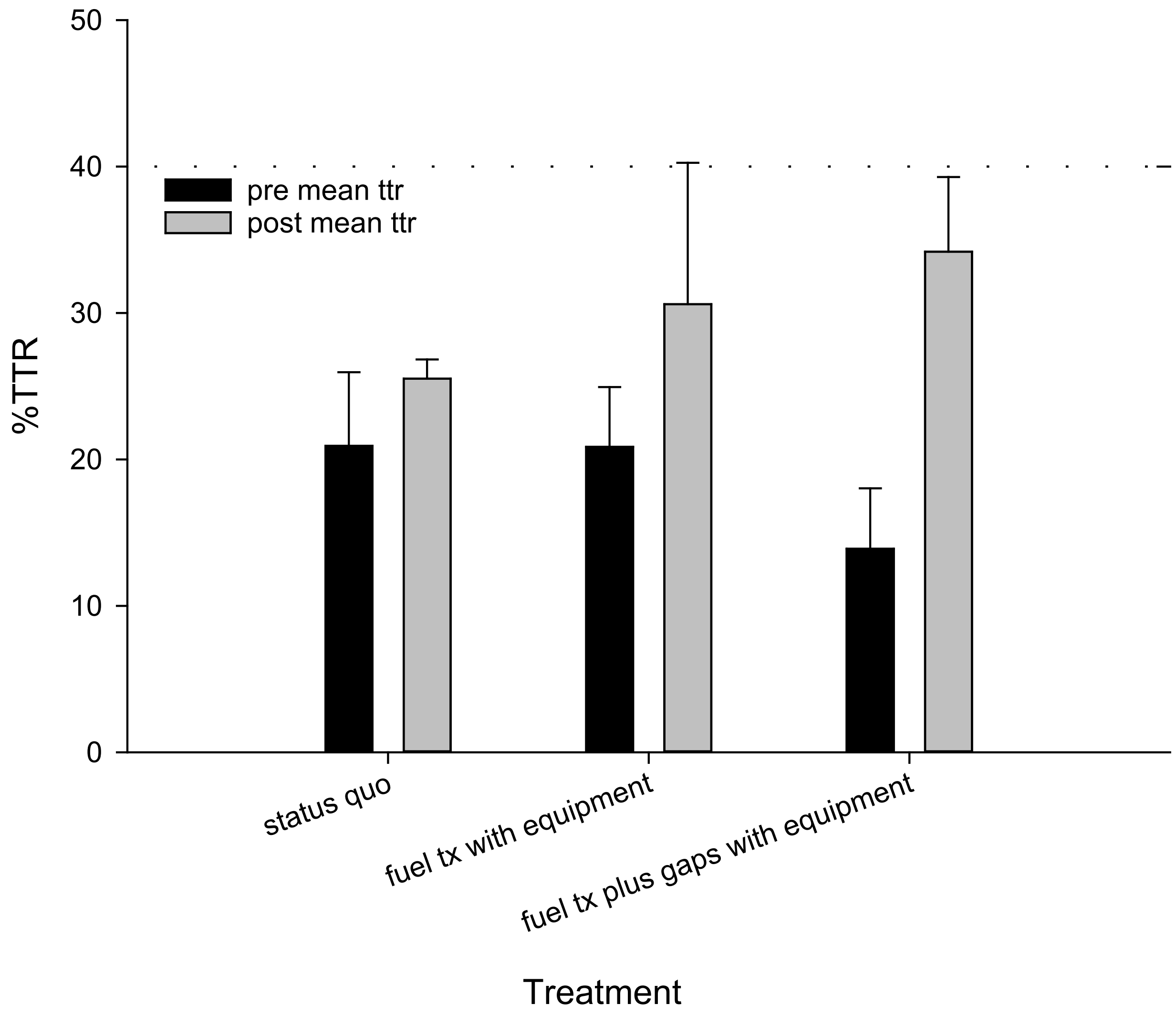
- Overall, light input is still low across all treatments when considering that 40% TTR is the minimum for P. pine regeneration



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

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

Treatment effects on yield

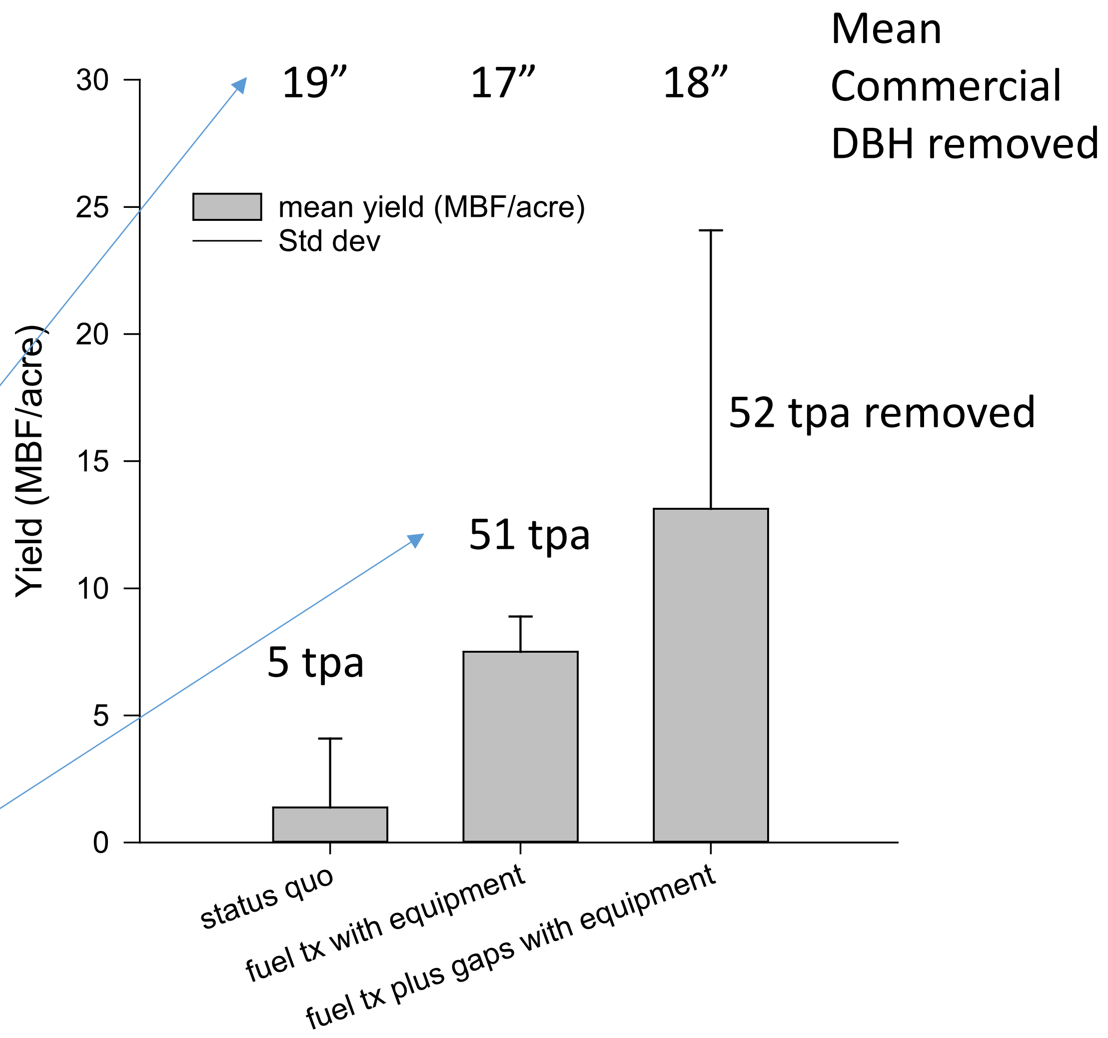
Volume removed increased as equipment was allowed into WLPZ stretches and as canopy gaps were created ($p=0.04$)

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 timber markets
- Treatments reduce surface fuels
- High-grading does not occur

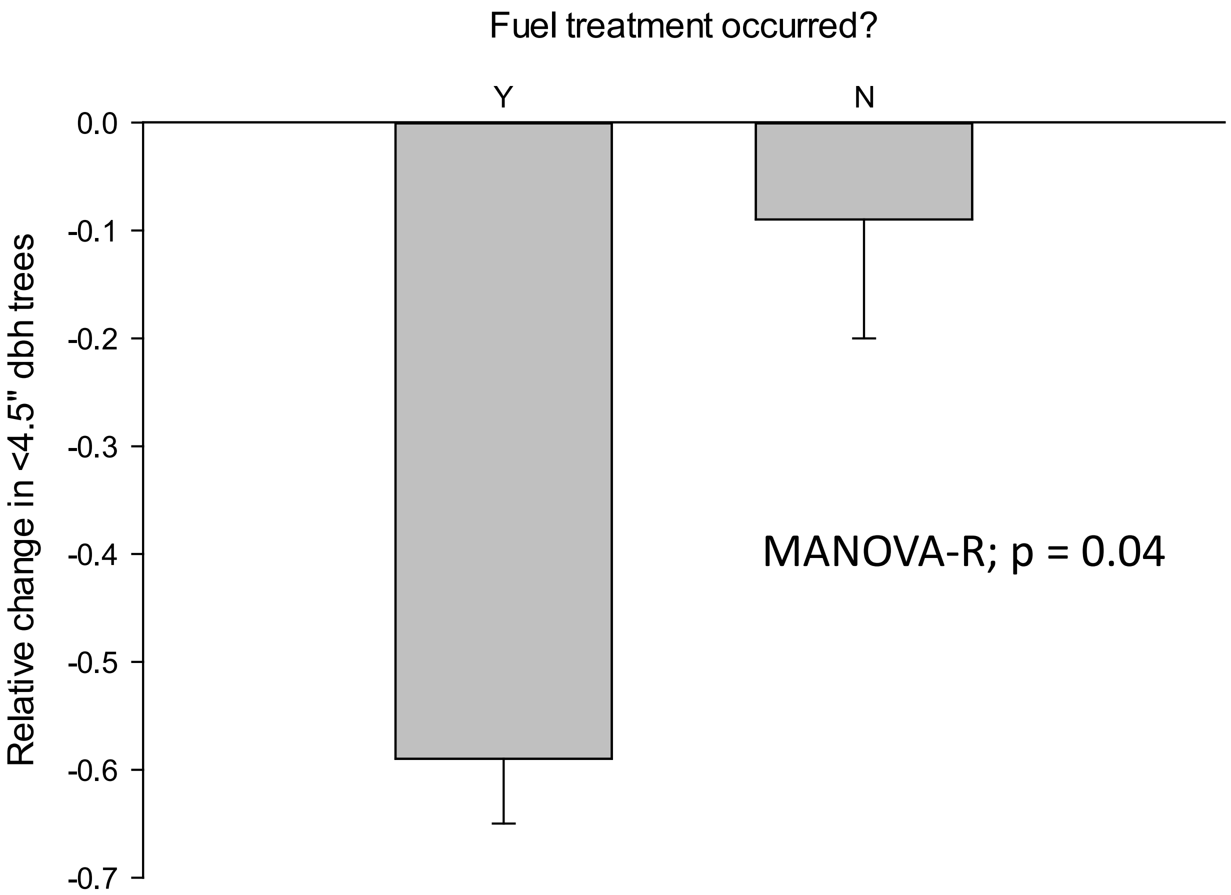
THEN

- We have economic sustainability

Status quo v. fuel treatments: small tree density

Operational demonstration:

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



Structure Impacts

Heavy equipment + fuel treatments reduced fire hazard

Status quo made it worse

Key takeaways

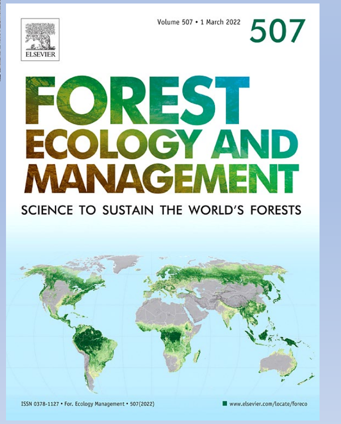
Allowing heavy equipment in WLPZ’s had **several benefits,** both ecological and economic

Allowed for the implementation of a **silvicultural system** that can build resilience

Are there other aspects of the FPR’s that constrain silvicultural systems that can focus on resilience?

Stocking Retention…

Managing density to resist multiple stressors in mixed conifer forests



Operational resilience in western US frequent-fire forests

North, M.P., R.E. Tompkins, A.A. Bernal, B.M. Collins, S.L. Stephens, and R.A. York. 2022. Forest Ecology and Management 507: 120004.

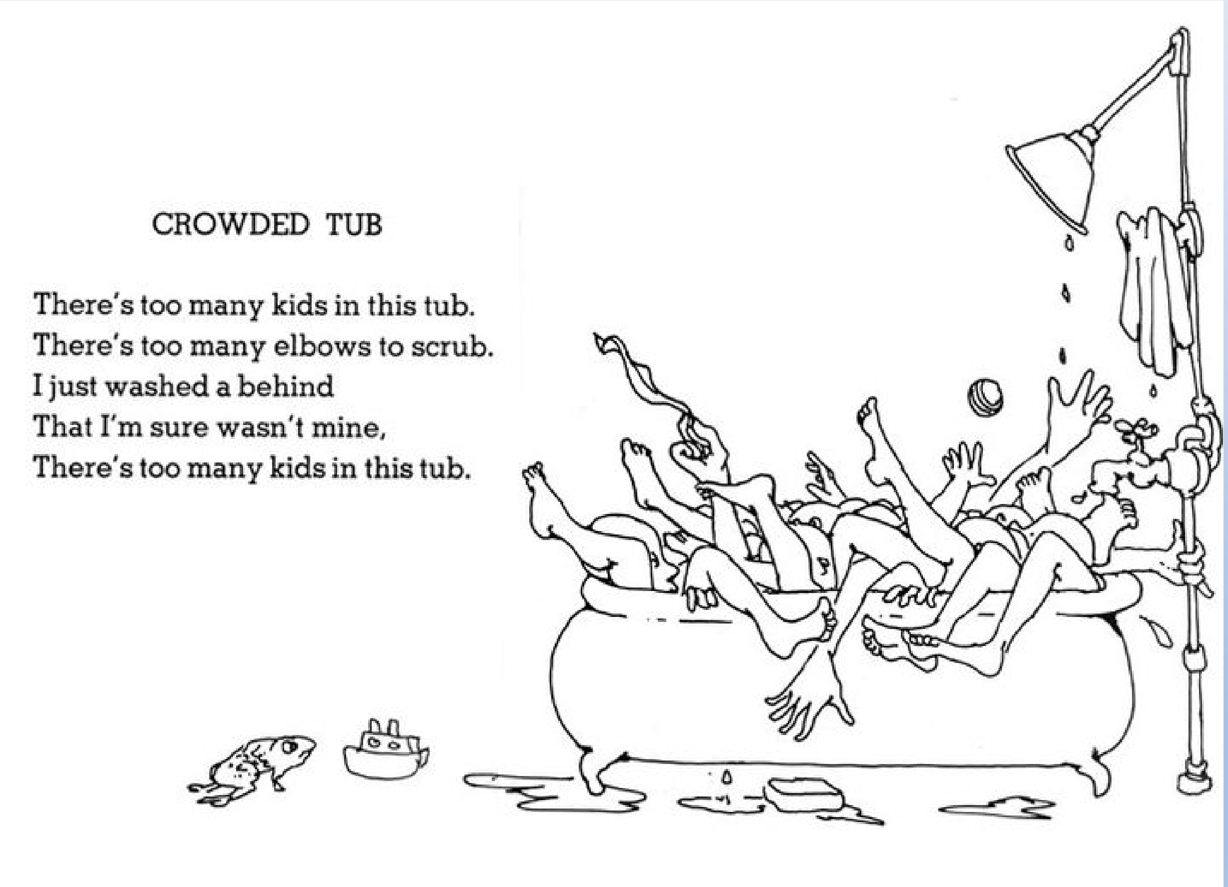
What level of stocking is "resilient?"

First, look to the past

Then see if past conditions are an adequate target given today's challenges (wildfire and drought)

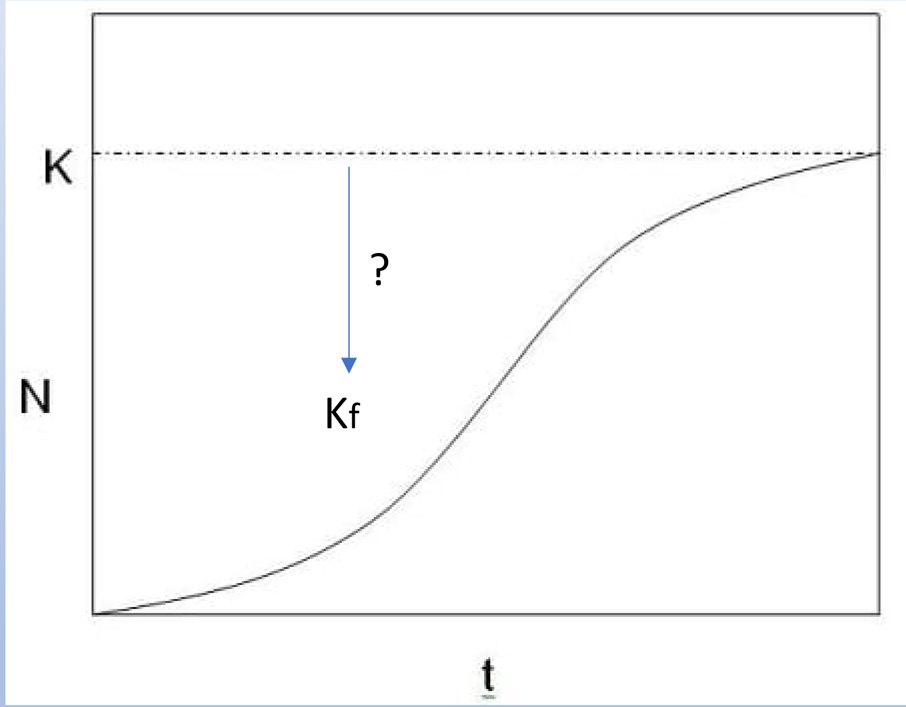
Over the past decade, numerous archived data sets have been found

Put results of forest structure in terms of competition



Shel Silverstein

Crowded Forest



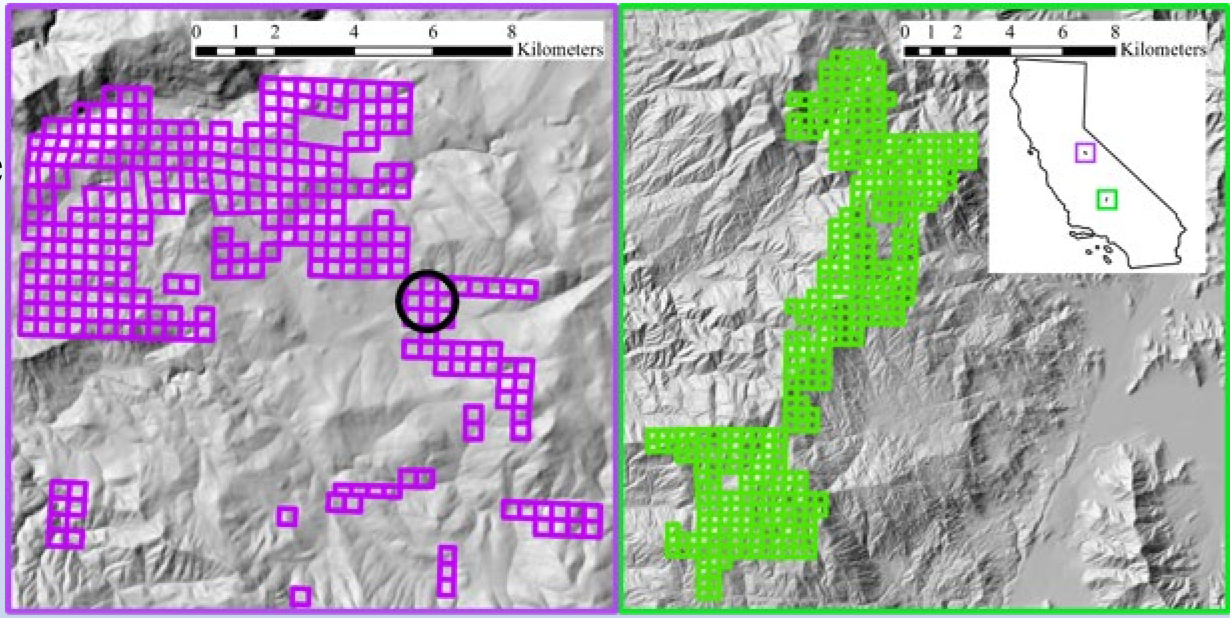
K = carrying capacity without fire

K_f = carrying capacity with fire

Study Methods

Compile studies that have reported forest structure in the early 1900's, using QQ sample scales

Each square is a 40 acre quarter-quarter (QQ) sections



Relative Stand Density Index: A tool to express density relative to the maximum

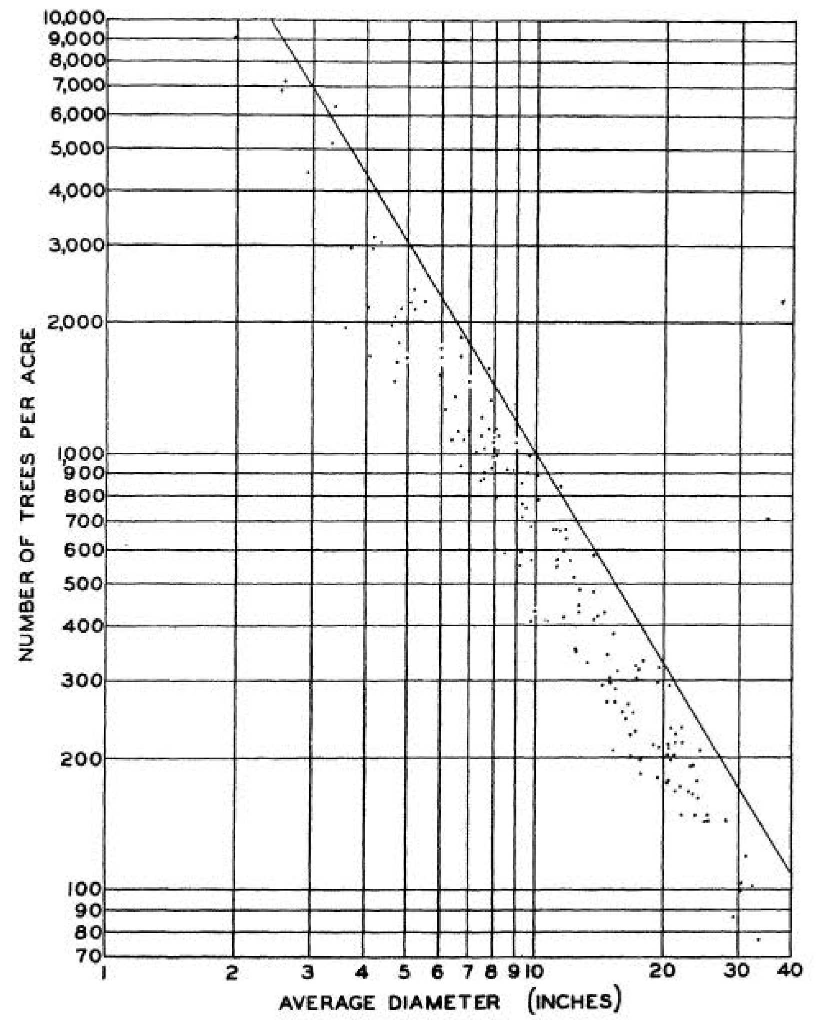
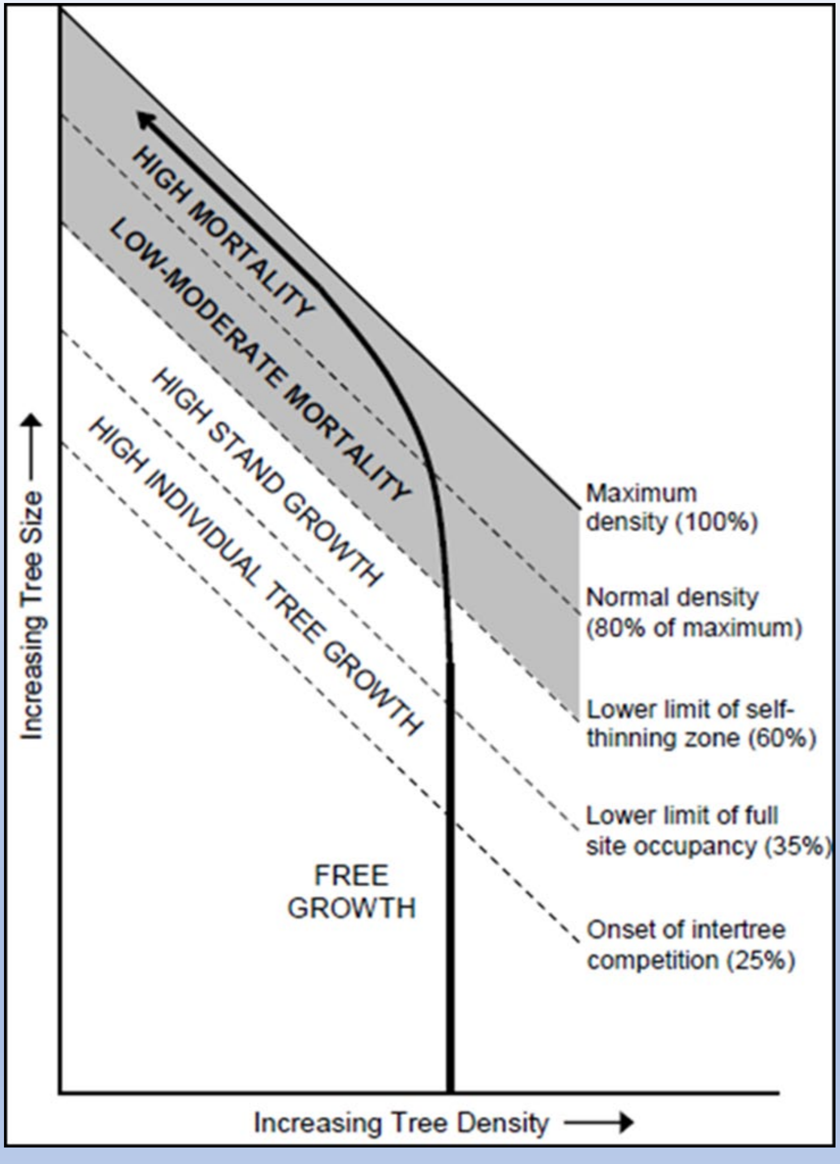


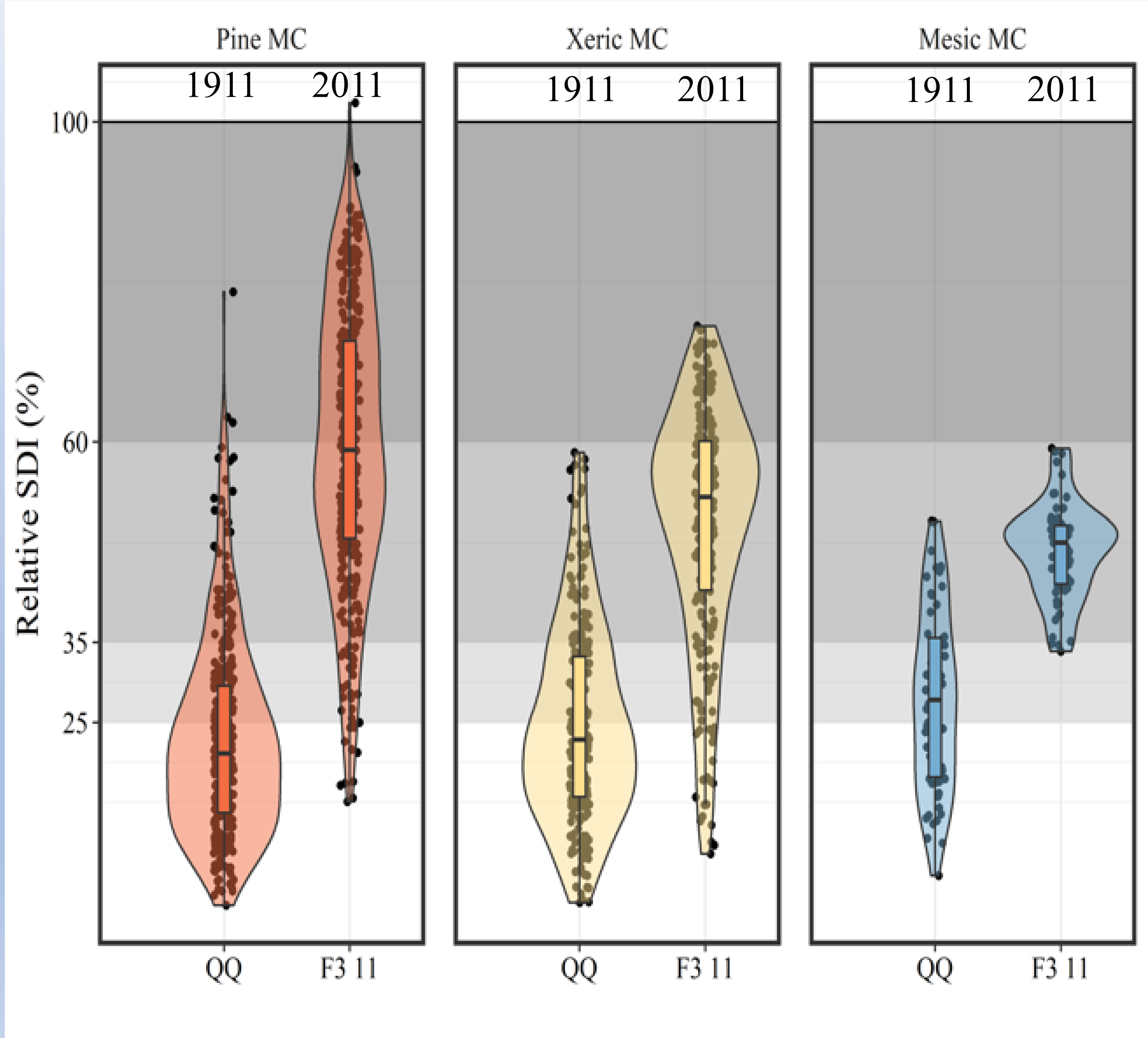
FIGURE 2.—Number of trees—average diameter relation for red fir, with reference curve defining the maxima

Reineke 1933



Stand density management diagram

Change in Forest Competitive Environment from 1911 to 2011



Imminent Mortality

Full Occupancy

Partial Competition

Free of Competition

Management challenges

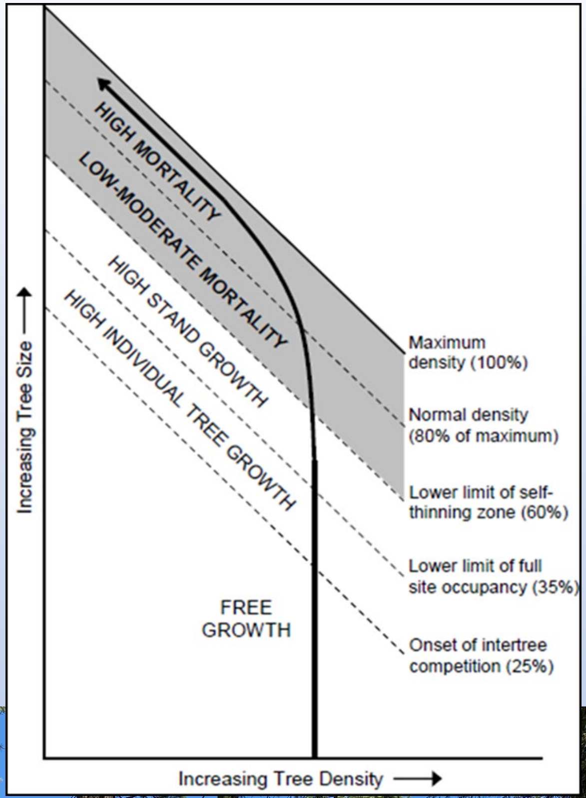
1. Managing for low-competition environments would currently or eventually require either cutting large trees (>30" dbh)

2. Even more material removed = more utilization/disposal hurdles

3. Shrub and regeneration growth would be rapid
   - How to manage (herbicide, fire, mechanical)
   - Long-term timber yields would be lower than max

4. Surface fuels are still reign supreme

5. **Retention standards on private lands**



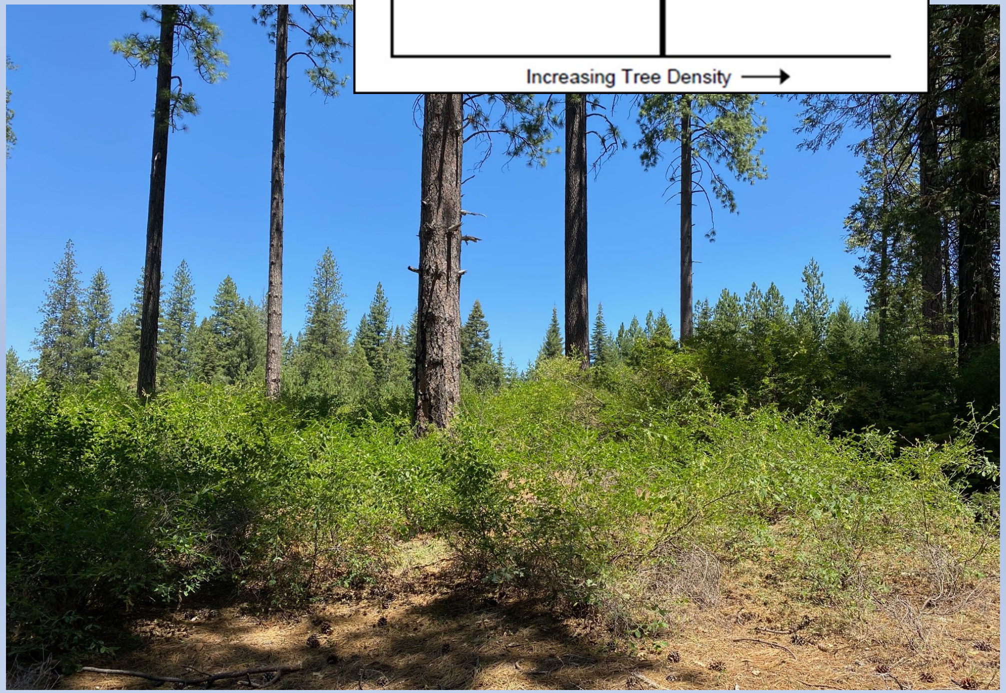


Table 1. Stocking standards for selection, thin, and transition
Do you think of these as limiting?

System	Minimum Basal Area by Site Class				Large tree retention requirements
	I	II	III	IV/V	
Commercial thin	125 or 100*	100 or 75*	75	50	Maintain or increase average dbh
Selection	100	75	75	50	Maintain “broad range of Diameter classes”
Selection Minimum**	85	50	50	50	Maintain “broad range of Diameter classes”
Group Selection***	75	50	50	33	Maintain “broad range of Diameter classes”
Group selection minimum**	57	33	33	22	Maintain “broad range of Diameter classes”
Transition****	85	50	50	50	>15 ft2/acre of retention from trees > 12” dbh (12ft2/acre for IV/V site land)

*applies if >50% of basal area is pine

The table

14 studies

Mean SDI = 27%

Study	Region	Productivity code	Year	Basal area (ft2/acre)	Relative SDI	BA < FPR's?			50%BA < FPR's?		
						I	II/III	IV	I	II/III	IV
Stephens et al. 2018	Central Sierra	Mesic	1923	188	43	Y	Y	Y	Y	Y	Y
Scholl and Taylor 2010	Central Sierra	Pine	1911	90	37	Y	Y	Y	N	N	Y
Stephens et al. 2015	Southern Sierra	Xeric	1911	129	35	Y	Y	Y	N	Y	Y
Ritchie et al. 2016	Southern Cascades	Pine	1934	91	32	Y	Y	Y	N	N	Y
North et al. 2022	Southern Sierra	Mesic	1911	--	28						
Stephens et al. 2023	Northern Sierra	Xeric	1924	80	27	Y	Y	Y	N	N	Y
North et al. 2022	Southern Sierra	Xeric	1911	--	25						
Hagmann et al. 2013	SC Oregon	Pine	1914	83	24	Y	Y	Y	N	N	Y
Collins et al. 2021	Northern Sierra	Pine	1924	72	24	Y	Y	Y	N	N	Y
North et al. 2022	Southern Sierra	Pine	1911	--	23						
Hagmann et al. 2013	SC Oregon	Pine	1914	74	21	Y	Y	Y	N	N	Y
Hagmann et al. 2013	SC Oregon	Pine	1914	57	21	N	Y	Y	N	N	N
Collins et al. 2015	Central Sierra	Xeric	1911	70	20	Y	Y	Y	N	N	Y
Stephens et al. 2015	Southern Sierra	Pine	1911	49	16	N	N	N	N	N	N

Questions for Licensed Foresters of CA

In theory, the FPR’s do allow flexibility for foresters to restore resilient structures

In Lieu practices and “explaining and justifying”

In practice, these are not used

How do I frame this?

Empirically?

Conceptually as RPF’s choosing not to use them?
Conceptually as regulators not allowing RPF’s to use them?

Thanks!

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- Ariel Roughton
- Hunter Noble
- Matt Diaz