Mid-term fuel treatment impacts on forest structure and fuel loads in California

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Background

- Many empirical studies quantify the effect of fuel treatments on fuel loads and stand structure before and right after treatment
- Most also assess the effectiveness to reduce potential fire behavior
  - Treatments that couple thinning and burning are the most effective, b/c change to both stand & fuels
- Few have also shown treatments are effective via post-wildfire studies

Background

Very few studies look beyond initial effects on stands structure & fuel loads directly

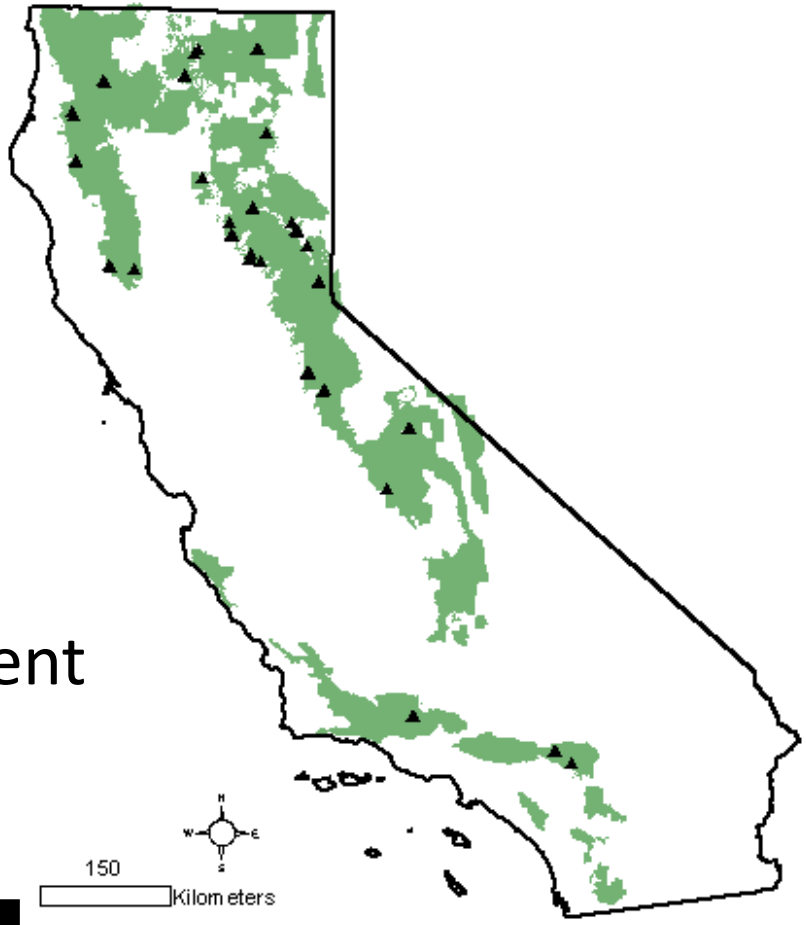
- Keifer et al. 2006 – Rx fire YNP & S&KNP
  - Fuel loads returned near pre by 10 yr, different distribution
  - Well exceeded by 31 yr post
- Stephens et al. 2012 – Rx, Mech & both, SN
  - Rx slight recovery of fuel loads by 7 yr
  - Mech initial increases in fuel loads now decreasing
  - Mech changed stand char more than fire, but changes fairly stable
- Chiono et al. 2012 – Mech, SN
  - No set trends over time, but included more midterm samples
  - Mixed conifer forests maintained lower total fuel loads than Jeffrey pine
- Few on vegetation response & mortality/regeneration
  - van Mantgem et al 2011 & Chiono et al 2012

Project Background

- Fuel treatment effects & effectiveness monitoring project in R5 started in 2001
- Solicit upcoming fuel treatment projects from all NF in CA
- Initially just Rx fire, then mechanical as well
- Pre-treatment data collected on 50 fuel projects on all NF in CA in many vegetation types
- Present treated plots from conifer systems

Project Background

- 14 National Forests
- 28 fuel treatment projects
- 88 plots sampled at multiple time periods
  - Pre-treatment and **1**, **2**, 5, **8**, and 10 yr post-treatment



PRE	P1	P2/3	P7/8
88	85	78	57

Fire-only time series

Fire-only treatment in Jeffrey pine Modoc NF

Pre-treatment

1-year post

2-year post

8-year post

10-year post

Mechanical time series

Mechanical (thin and mastication) treatment in Jeffrey pine Tahoe NF

Pre-treatment

1-year post

2-year post

5-year post

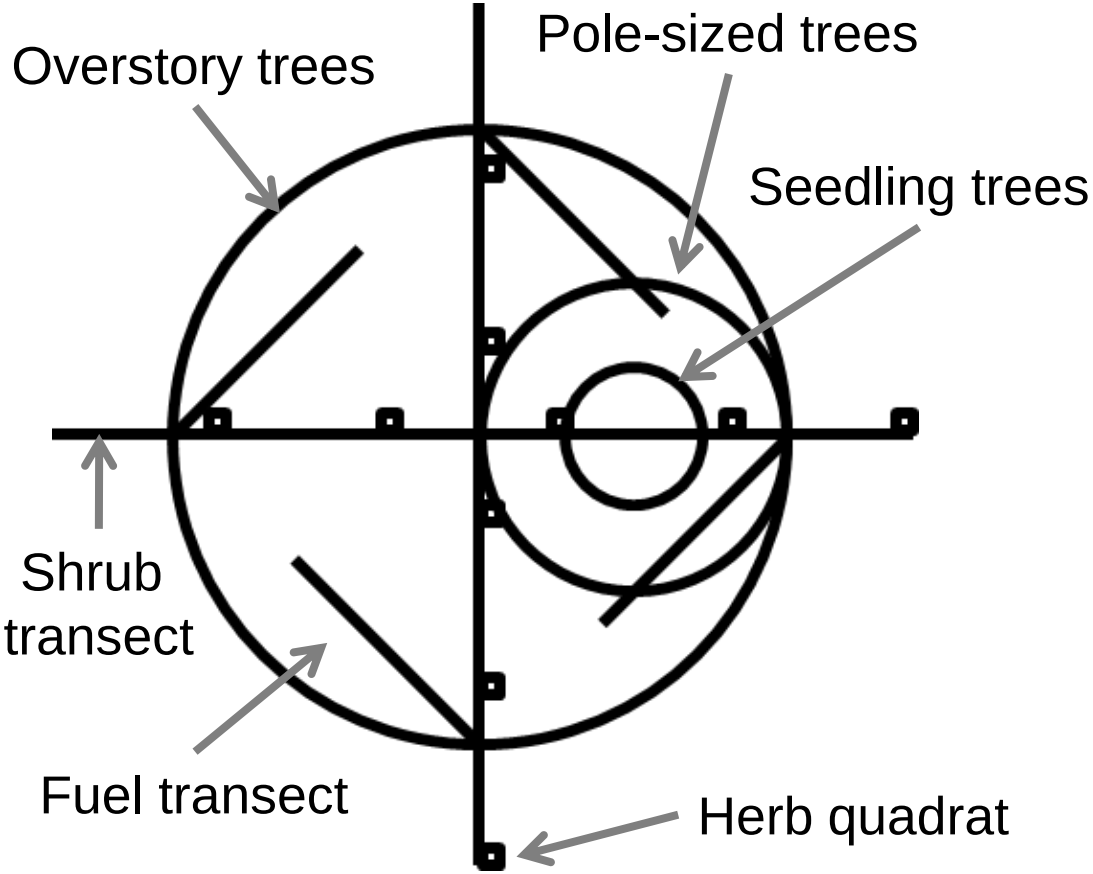
8-year post

Methods

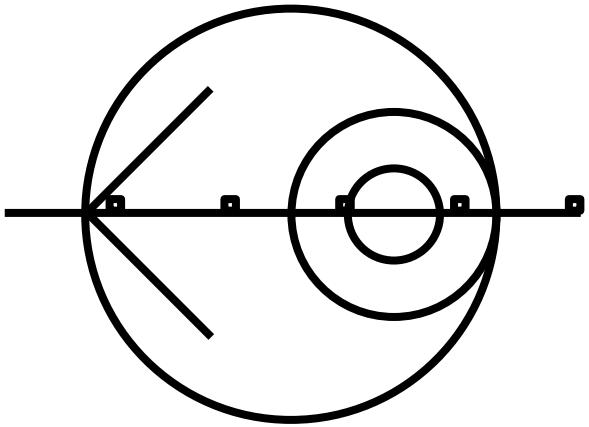
- Random plot location within treatment
- Up to 6 plots installed
- 2 types of plots – detailed & fuels
  - Detailed includes tree sampling (Pre n=77)
  - Fuels do not (Pre n=11)
- Actual fuel loading
  - Live & dead
- FVS for canopy calcs.

Methods

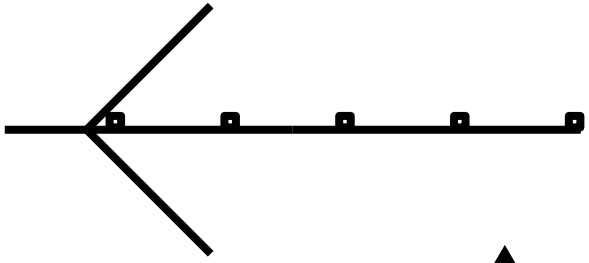
“Detailed” 2001-2002



“Detailed” 2003-2006



“Fuels” 2003-2006



Upslope

Research Questions

Objective 1 – Determine length of time fuel treatments are effective at reducing undesirable fire behavior.

1) Measuring effects of treatments on stand structure and fuel loads over time

2) Modeling potential fire behavior with custom fuel models

Objective 2 - Quantify the uncertainty associated with the use of standard and custom fuel models

Objective 3 - Assess prescribe fire effects on carbon stocks and validate modeled outputs

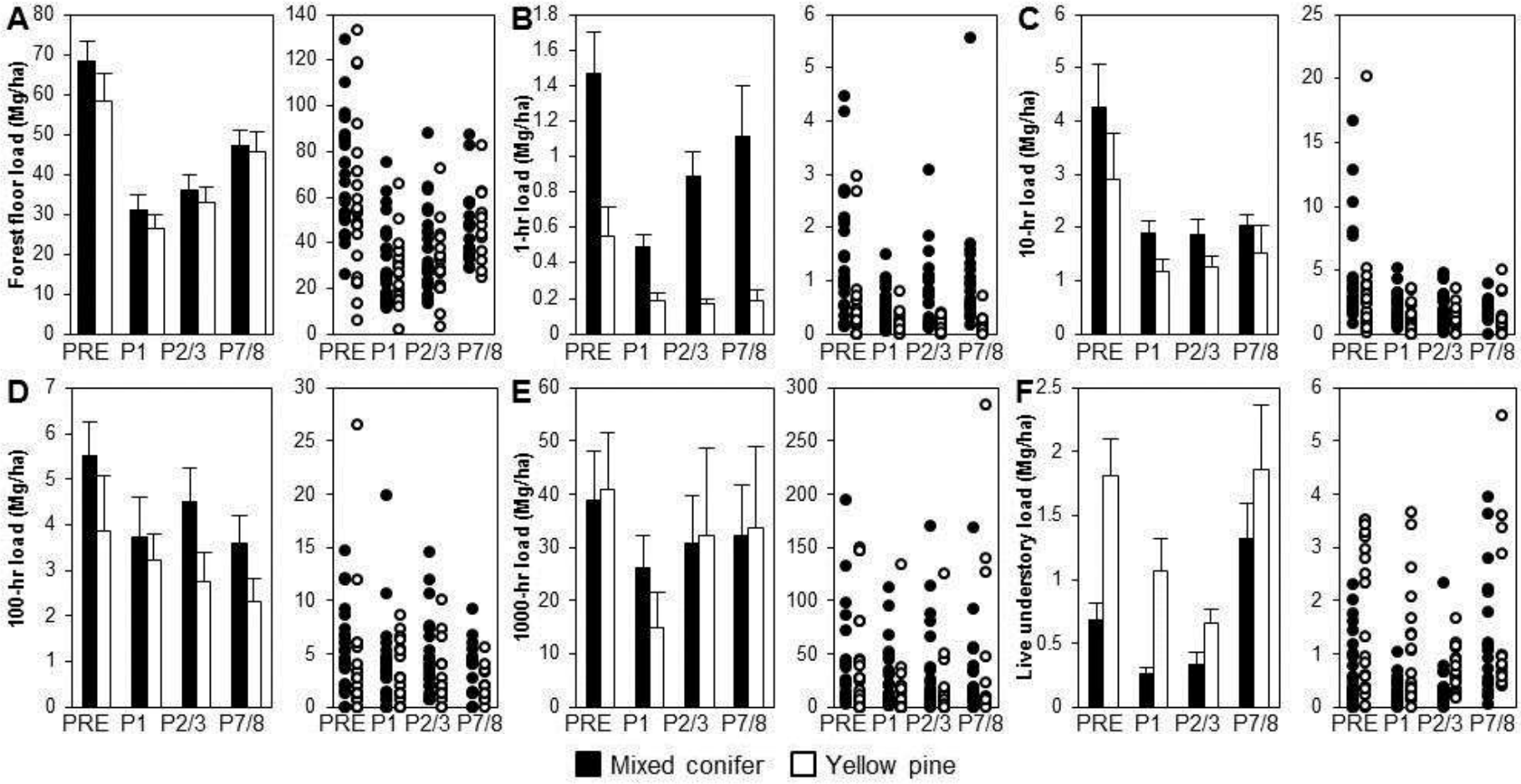
Methods

The plots have been stratified by treatment and dominant forest type:

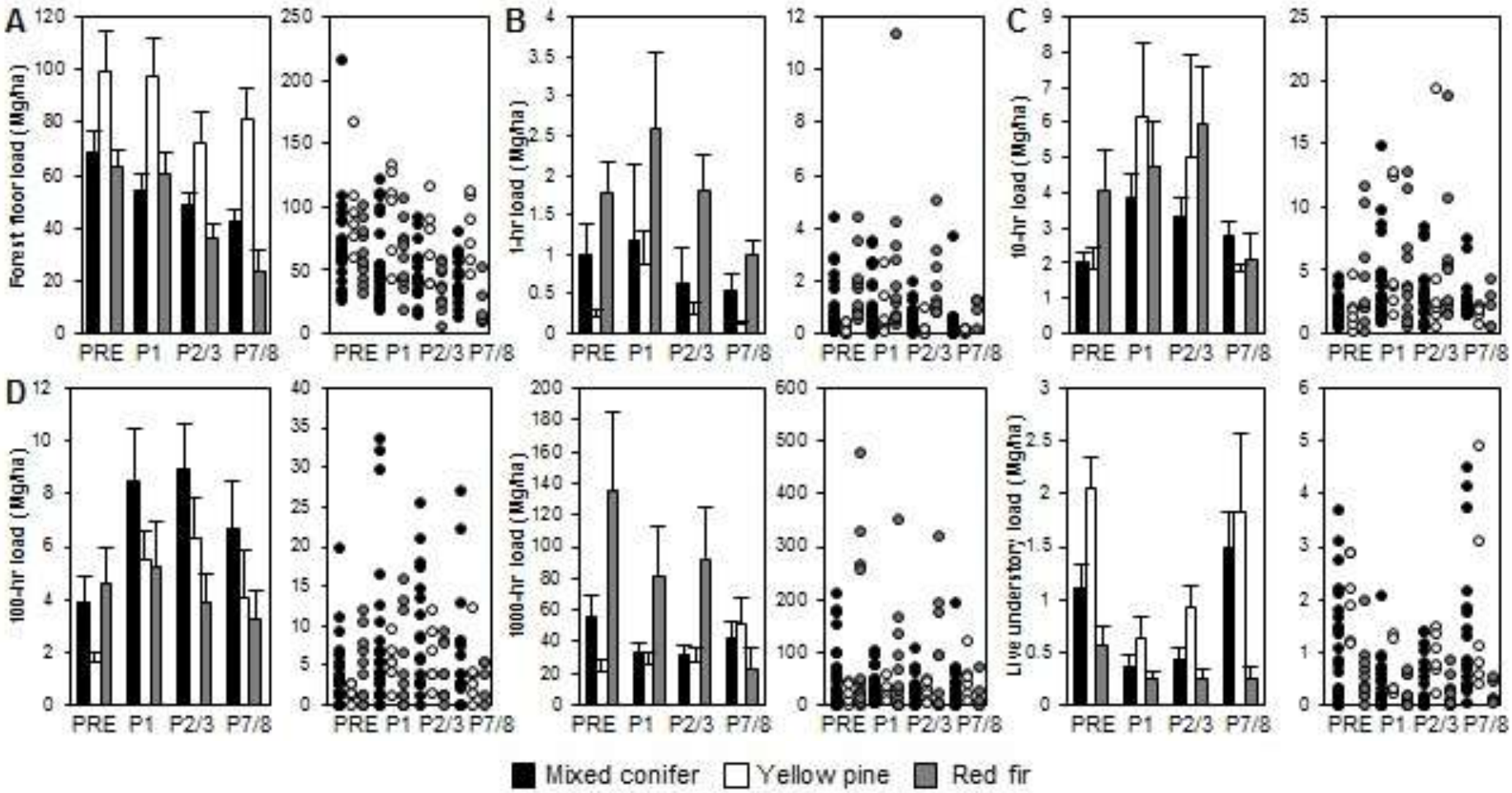
- FIRE-MC
- FIRE-YP
- MECH-MC
- MECH-YP
- MECH-RF

Used generalized linear mixed models (SAS Proc GLIMMIX) to test significance ($P<0.05$)

Fire-only Fuel Loads



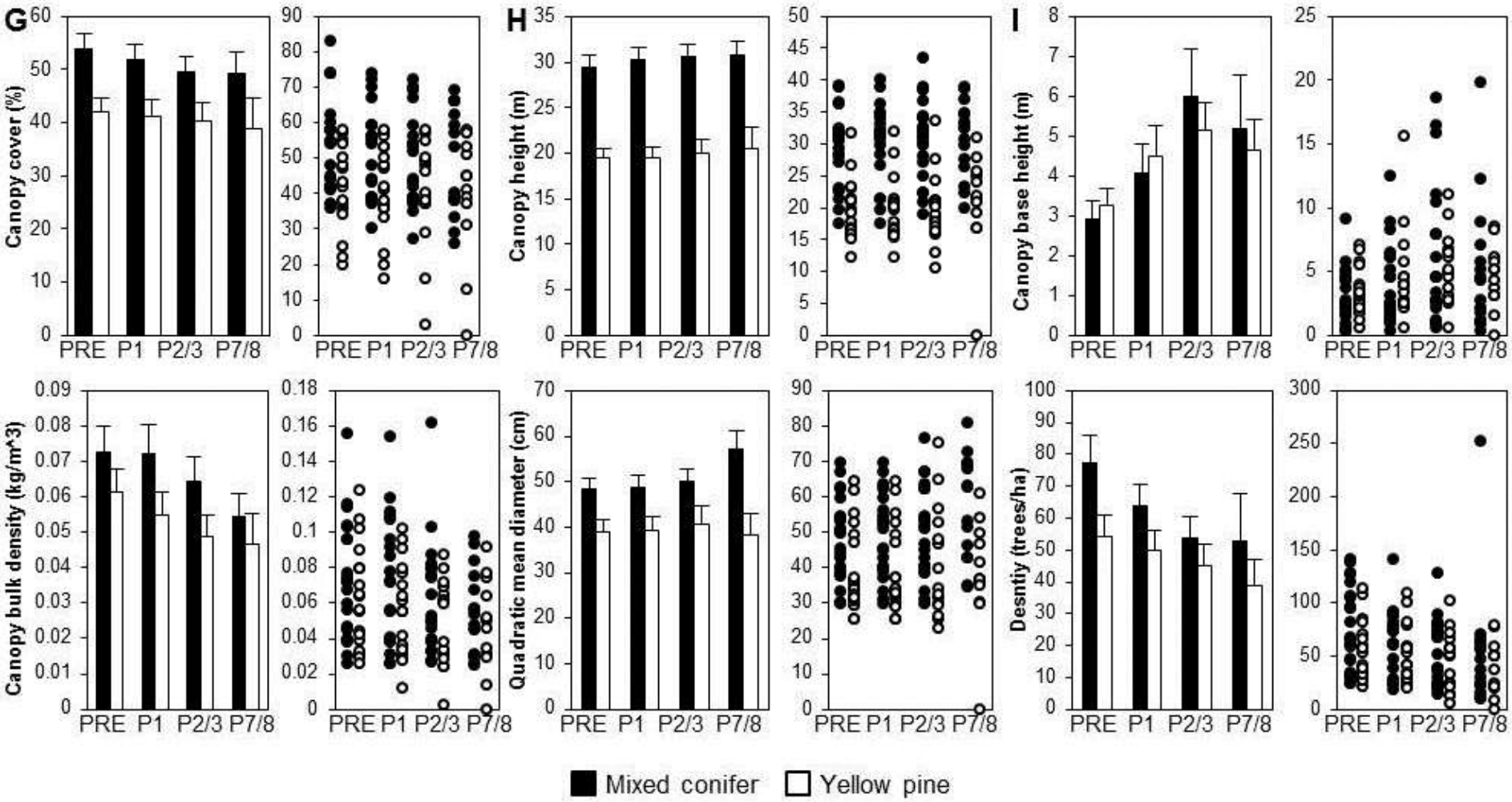
Mechanical Fuel Loads



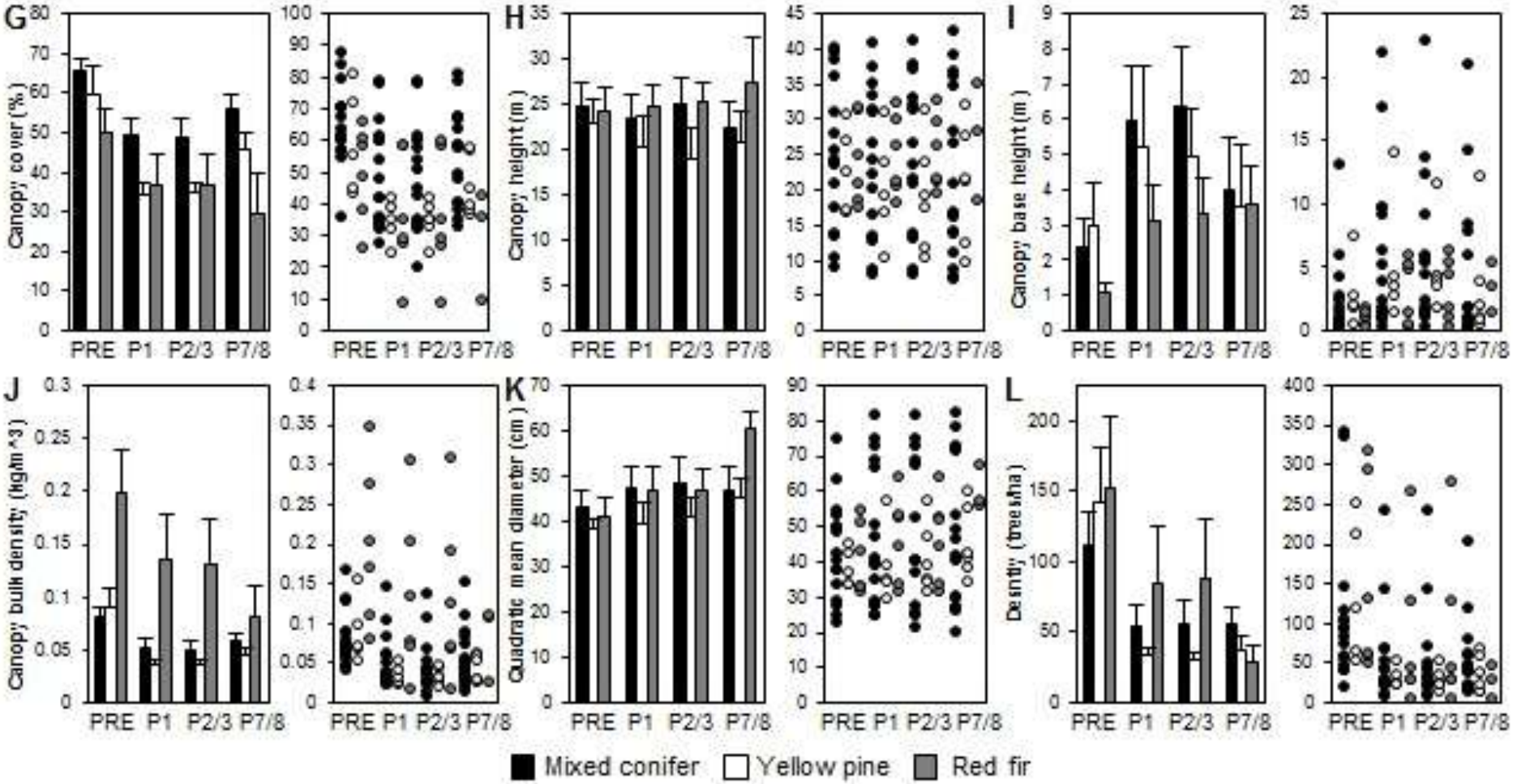
Fuel Loads

- Fire only-treatments initially ↓ loads followed by ↑
  - Except for 100-hr fuels = no trend
  - Total fuel load back to 73-79 % by P7/8
- Mechanical treatments initially ↑ fine fuel loads (1-100 hr) and decrease others but no trend over time
  - Partially because of sample sizes, partially because of lumping of mechanical treatments
- With exception of RF live understory exceeded PRE by P7/8
- Fuel loads are quite variable!
  - ….but the trends for fire-only are “cleaner”

Fire-only Stand Structure



Mechanical Stand Structure

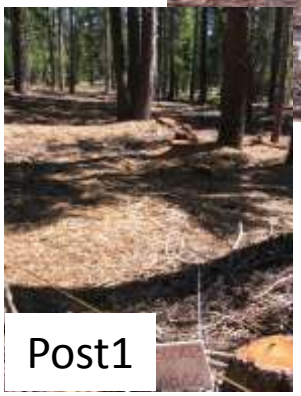


Stand Structure

- Fire-only treatments did not greatly affect stand structure (~10-15%)
  - Most change ↑ CBH, ↓ density (continued overtime in YP)

- Mechanical treatments had a larger impact (>25%)
  - Fairly stable over time
  - Sig ↑ CBH (MC), ↓ CC, CBD, density (all) – all years
  - MECH-RF P7/8 different trends, low n

- CBH starting to ↓ again by P7/8 for all trt-forest combinations except RF



Between Forest Types

Treatment	Forest	Time	FF	1-hr	10-hr	100-hr	1000-hr	Live	CC	CHT	CBH	CBD	QMD	Density
FIRE	MC vs. YP	PRE	**15**	**67**	33	29	-5	**-157**	**22**	**34**	-14	16	**19**	**31**
	MC vs. YP	P1	15	60	37	14	43	**-267**	**21**	**36**	-10	24	**19**	**22**
	MC vs. YP	P2/3	8	78	32	40	-4	-133	**20**	**35**	13	23	**18**	**17**
	MC vs. YP	P7/8	3	**82**	29	36	-5	-46	**20**	**34**	12	13	**33**	**26**
MECH	MC vs. YP	PRE	-44	80	10	**59**	62	-82	**8**	8	**-30**	-11	11	-27
	MC vs. YP	P1	**-79**	25	-59	**35**	22	-50	29	14	12	31	17	38
	MC vs. YP	P2/3	-48	50	-52	**29**	13	-125	29	24	23	27	15	46
	MC vs. YP	P7/8	-94	83	39	**39**	-25	-20	18	6	13	24	3	32
	MC vs. RF	PRE	10	-44	-51	-15	**-59**	83	**23**	2	52	**-146**	5	-38
	MC vs. RF	P1	-10	**-54**	-19	62	-59	100	24	-6	47	**-162**	1	-55
	MC vs. RF	P2/3	34	**-67**	-44	128	**-65**	33	24	-1	48	**-167**	4	-55
	MC vs. RF	P7/8	77	-40	33	109	89	**400**	**46**	-23	10	-41	-29	50
	RF vs. YP	PRE	-57	**89**	**56**	**65**	**85**	**-233**	-20	6	-173	**55**	7	8
	RF vs. YP	P1	-62	**65**	-29	-6	68	-200	5	18	-68	**74**	16	60
	RF vs. YP	P2/3	-98	**83**	15	-62	**70**	-200	5	25	-48	**73**	12	66
	RF vs. YP	P7/8	**-242**	90	19	-28	-136	**-500**	-53	24	3	46	25	-36

Bold *font indicates significant difference P<0.05*

Management Implications

- Fire behavior not assessed in this part of the work
- Increases in live understory loads indicate potentially need for retreatment
- Total fuel load in fire plots ~75% of pre- also indicate potential need for re-treatment
- Mechanical treatments would benefit from prescribed fire treatments to reduce still elevated fuel loads
  - Crown fire potential is likely low because of ↑ CBH and ↓ CBD
- CBH starting to ↓ again by P7/8 except RF

Monitoring

Need for monitoring

- To understand how fuels change from treatment over time – very few studies
- Monitoring needs to extend beyond the first year or two in fire treated areas to not miss delayed mortality
- Need to archive the data!
  - FFI is a great tool
- Moving in that direction
  - CFLRP 15 years after trt
  - Not standardized

2-yr post *8-yr post* *10-yr post*

Lessons Learned

Plot and transect relocation: 1) make a map noting rebar locations, 2) bring GPS coordinates, & 3) bring data and photos to help locate plots.

Trees: 1) always bring previous years data, 2) emphasize appropriate sampling techniques, & 3) each year input and QA all data.

Litter and Duff: we recommend measuring them together as ‘forest floor’ and assigning a percentage to each to minimize sample error.

Fuel bed depth: we found that it is imperative to refresh field crews annually on the true definition of fuel bed depth.

Grass/herb: we recommend trying to visit plots at the peak of flowering for the majority of species to aid in identification of plants.

Photos: print the previous years’ photos and take them into the field for direct comparison.

Acknowledgements

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