Fuel management in plantations

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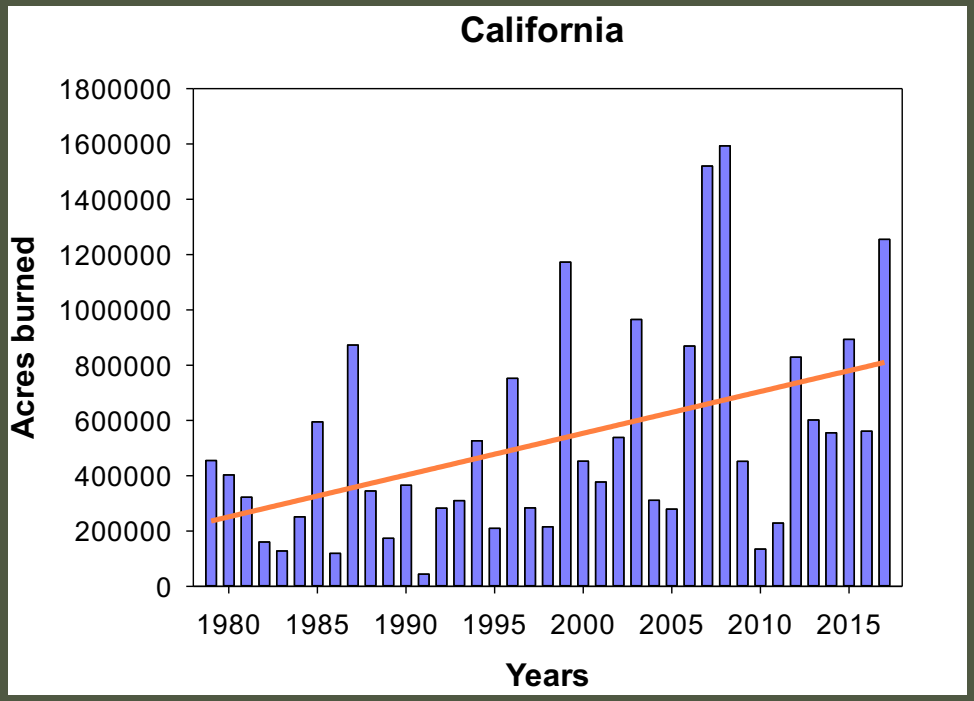
Why manage fuels in plantations?

Trends in fire activity



Planted after 1987 Stanislaus Complex re-burned in 2013 Rim Fire

Photo: CSERC

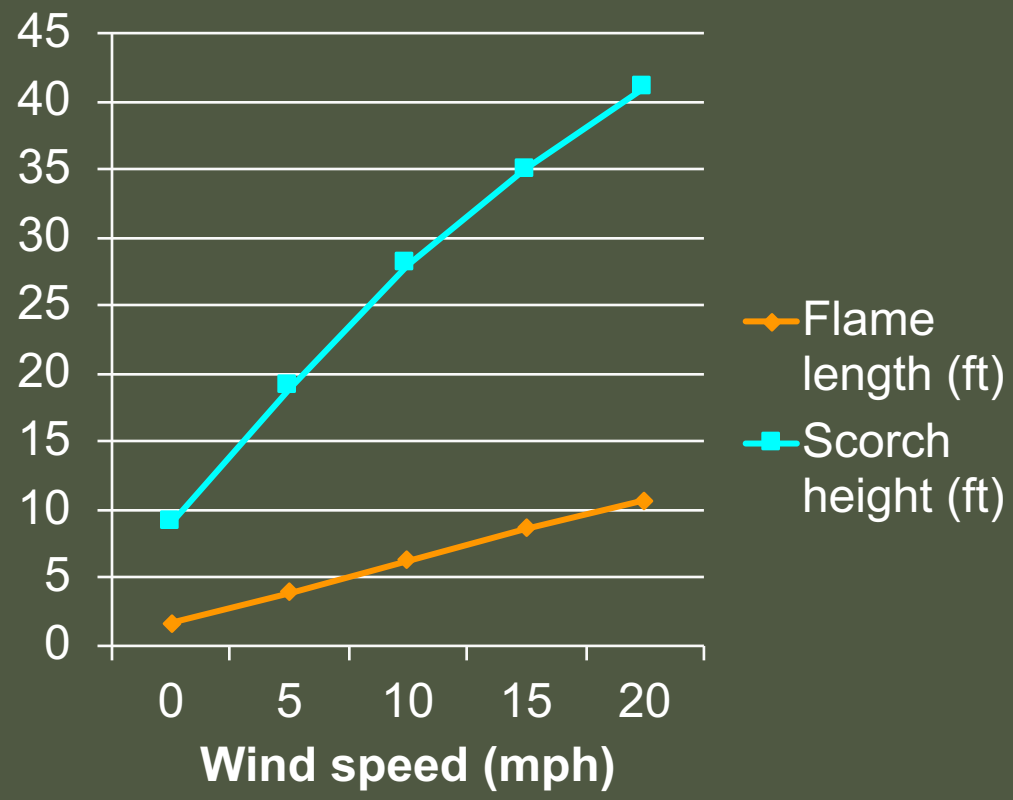
Structure of plantations can pose some challenges for surviving a wildfire

- Small tree size
- Low height to crown base
- Even age and spacing = vertical and horizontal fuel continuity

Mechanisms of fire-caused tree mortality: crown scorch

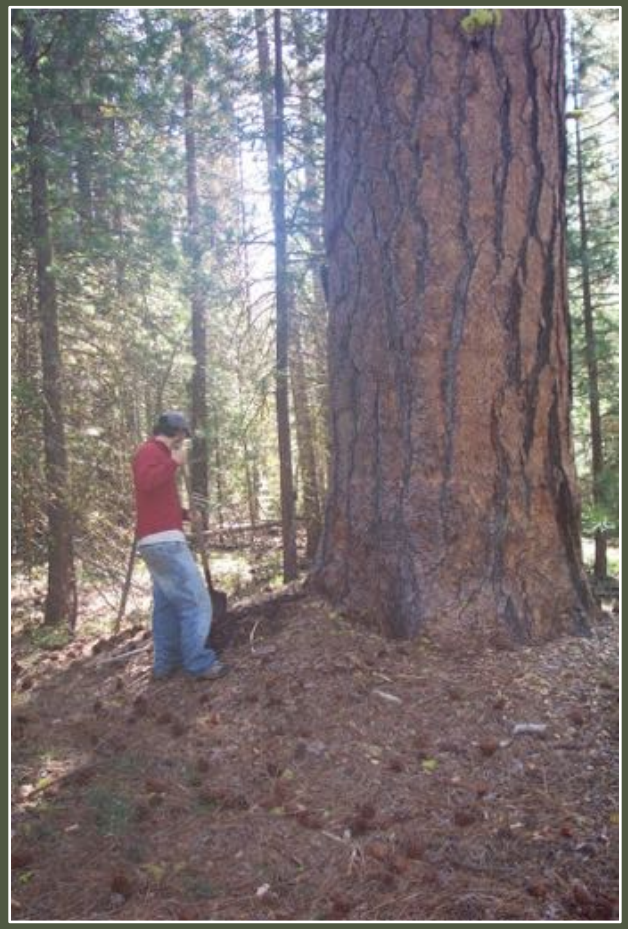
Scorch height:
>140°F for
> 1 minute

Flame length
Flame tip
~ 600° F



Fuel model 9 (long needle litter)
Late summer fuel moisture
25% slope, Temp. = 90° F

Mechanisms of fire-caused tree mortality: bole charring



Small trees: Thinner bark, lighter fuels at base
Large trees: Thick bark, heavier fuels at base

Bole charring and tree mortality in plantations

- Fuels raked 1.5 ft from base of randomly selected trees
- Prescribed burn

18/65 (28%) raked trees died
23/66 (35%) unraked trees died

Difference not statistically significant

Knapp EE, JM Varner, M Busse, CN Skinner, and CJ Shestak. 2011. Behaviour and effects of prescribed fire in masticated fuelbeds. International J Wildland Fire 20:932-945.

- Young tree mortality in many cases caused by crown loss
- Crown loss a function of fireline intensity
- Fireline intensity a product of the amount of ***fuel consumed***
- Survival: smaller trees require lighter fuels


King Fire - 2014


Chips Fire - 2012

Starting with light fuels increases the odds

Clean site prep vs. planting in slash

Fuel reduction in older plantations

- Trees still small relative to potential fire line intensity

Whitmore fuel reduction study

- Control
- Masticate
- Masticate + herbicide
- Masticate + burn
- Masticate + incorporate
- Manual removal

X 4 replications

Timeline

- **Plantation established 1982**
- **Mastication 2002/2003**
- **Herbicide 2004**
- **Burn 2006**
- **Data collection 2014**

Whitmore fuel reduction study

Herbicide:
hexazinone (spring)
glyphosate + imazapyr (early summer)

Burning:
Early June

Treatments – 2014

Whitmore results - 2014

Variable	Treatment			
	Control	Masticate	Masticate/ Burn	Masticate/ Herbicide
Manzanita ground basal area (% of control)	64.3[a]	3.3[b]	0.9[bc]	0.1[c]
Poison oak ground basal area (% of control)	6.9[a]	10.0[a]	4.2[a]	0.3[b]
Trees per acre	292[a]	136[b]	157[b]	131[b]
Tree basal area (ft^2 ac^{-1})	89.7	82.8	89.7	91.0
Canopy base height (ft)	14.1	14.8	15.4	12.8

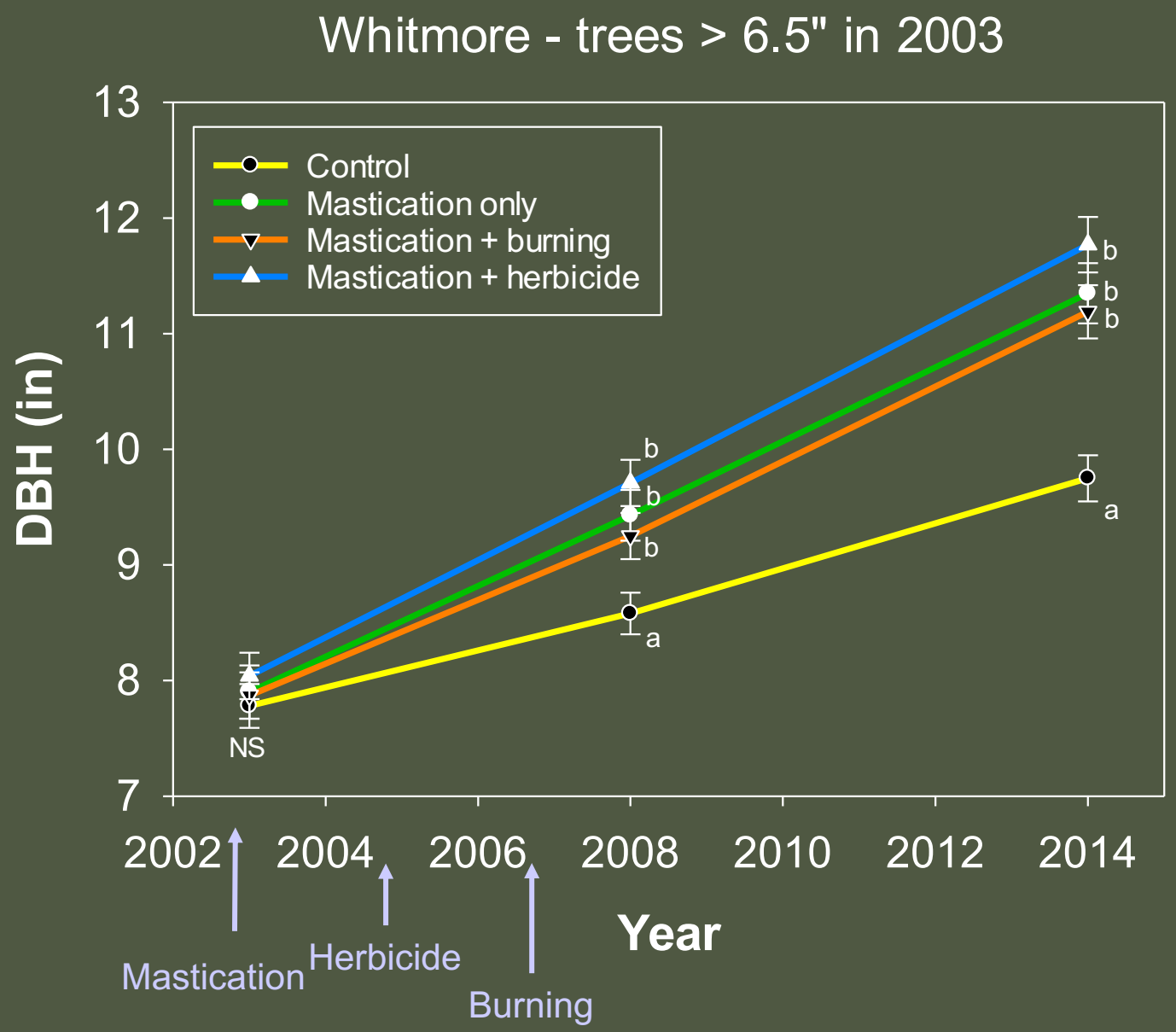
Tree mortality with prescribed burning – 6%

Gregory W. Hamby, J. Morgan Varner, Eric E. Knapp, Scott D. Roberts, and Brent R. Frey (In preparation)

Whitmore – shrub response

- Seeding species
  - Manzanita seed is stimulated by fire
  - Expectation: large response in burn treatment
  - Many manzanita seedlings likely died due to shading

Tree growth


Whitmore - trees > 6.5" in 2003
DBH (in)
13
12
11
10
9
8
7
Control
Mastication only
Mastication + burning
Mastication + herbicide
NS
b
b
b
a
b
b
b
a
2002
2004
2006
2008
2010
2012
2014
Year
Mastication
Herbicide
Burning

Likelihood of surviving a wildfire

* Low
***** Very high

Treatment	2002 (pre-treatment	2004 (post mastication)	2007 (post burning)	Current
Control	*	*	*	*
Mastication	*	**	**	***
Mast/Burn	*	**	*****	****
Mast/Herbicide	*	**	**	***

So why isn't more burning done in plantations?

Prescribed burning in plantations on the Shasta-Trinity NF

- "Little Mule" - planted 1984
- ponderosa pine, Douglas fir, black oak (natural), sugar pine
- Masticated, then burned, spring 2017
  - Temperature – 61 to 73 degrees
  - RH – 35 to 56%
  - 1,10 hr fuel moisture – 12%,12%

- "Rush" - planted 1992
- ponderosa pine, Douglas fir, black oak (natural)
- pruned, then burned, fall 2017
  - Temperature – 59 to 67 degrees
  - RH – 38 to 48%
  - 1,10 hr fuel moisture – 13%, 21%

Prescribed burning in plantations on the Shasta-Trinity NF: early results

Site	Planted	Burned	Trees ac^{-1}	Basal area (ft^2 ac^{-1})	Ave DBH (in)	% mortality
Little Mule	1984	5/18/2017	109	60	9.9	4
Rush	1992	10/30/2017	309	86	6.2	26
Telephone	1995	10/23/2018	239	85	7.5	10
McCloud261	1989	10/30/2017	159	65	7.6	4

Ignition techniques for minimizing scorch

Strip head firing

Tree-centered spot firing

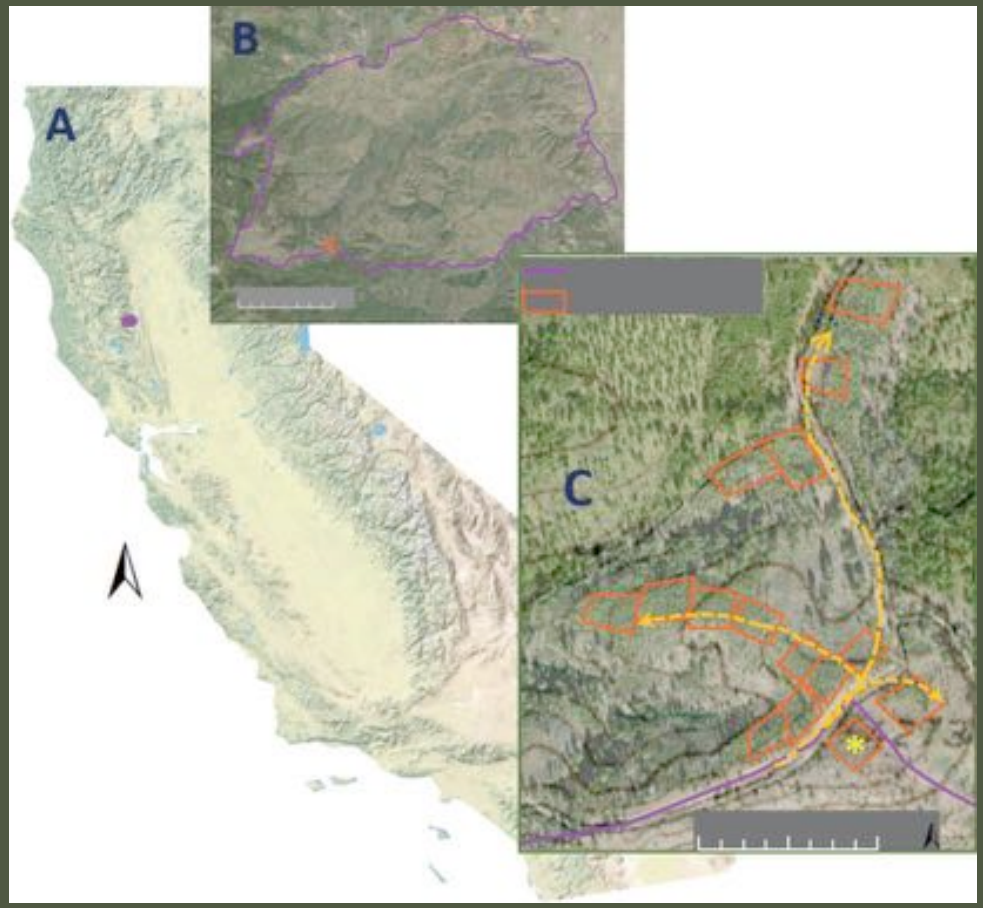
Flanking firing

- Fewer strips
- More time between strips
- Tree centered spot firing or flanking firing
- Burning when air temperature is cool and/or with a breeze

Prescribed burning in plantations: surface fuel reduction

Effect of backburns on plantation survival

- 2012 Mill Fire (Mendocino NF)
  - July 7-18
- Plantations with density and vegetation control treatments
- Control, ½ shrubs removed, all shrubs removed
- Tree densities: 890, 680, 437, 223 trees/ ac



Zhang J, Finley KA, Knapp EE. Resilience of a ponderosa pine plantation to a backfiring operation during a mid-summer wildfire. Int. J. Wildland Fire. In Press

Backburn and tree survival

Pre-fire – heavy shrub cover

Post-fire: No shrub removal 100% shrub removal

Mill fire backburn – outcome in plantations

- Fire killed 24% of trees, 14% of basal area
- No effect of plantation tree density or shrub control treatment on survival
- No effect of fire on subsequent tree growth
- Why?
  - Backburn done at night
    - Day conditions: 100^{o} F, relative humidity: 11%
    - Night conditions: 61^{o} F, relative humidity: 60%

2018 – Mendocino Complex Fire

Burned in 2012

Re-burned in 2018

Did not burn in 2012

Burned in 2018

Mill and Mendocino Complex study conclusions

- Shrubs can be a heat sink under some conditions
- Burning in young stands is possible under a broader range of conditions – including burning at night in mid summer
- Fire can help reduce shrub competition
- Subsequent wildfire demonstrates the vital role of light surface fuels to plantation survival

Other concluding thoughts

- Minimizing fuels at all phases of plantation development is key
  - Site preparation prior to planting
  - Pre-commercial thinning or pruning - pile burn instead of lop and scatter
- Managing understory shrubs
  - Mastication, burning, herbicides, shading, can all provide long duration control
  - Different strategies for seeding species vs. re-sprouters
- Prescribed burning provides the greatest resilience to wildfire
  - Reduces litter and down woody fuels
  - Scorch can be controlled by how fire is applied and under what conditions
  - Can be done without sacrificing tree growth