Fuel treatment effects on carbon stocks in Californian coniferous forests over time

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INTRODUCTION

Forest management, land use change, and natural disturbances all significantly affect forest carbon balance. In dry forests of the western US, wildfire is one of the largest threats to forest carbon. While fuel treatments result in initial reductions of stand carbon, they have a potential to reduce the severity of wildfires and therefore losses of carbon due to emissions from combustion and decomposition of fire-killed biomass. To better understand the impact of fuel treatments on carbon stocks, we quantified aboveground carbon stocks (forest floor, surface fuels, understory herbs and shrubs, and live and dead trees) before and up to eight years after fuel treatments and compared field-derived to FFE-FVS modeled values.

Study Questions

1. **Do different fuel treatment types affect carbon stocks differently?**
2. **How do carbon stocks change over time with respect to treatment type?**
3. **Do carbon stocks differ between field-derived and simulated values?**

METHODS

Study Area & Field Sampling

•85 permanent plots in 3 fuel treatment types across California (fig. 1).

•Forest & fuels data gathered pre-treatment through 8 years post-treatment (fig. 2).

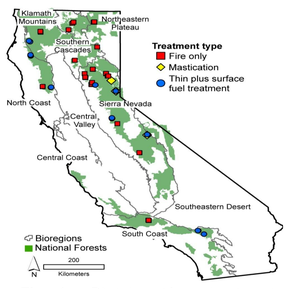

Fig. 1 – Plot locations by treatment type

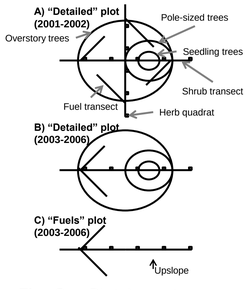

Fig. 2 – Plot layout

Treatment	# sites	Pre	1-yr post	2-yr post	5-yr post	8-yr post
Fire-only (FIRE)	17	44	44	40	9	24
Mastication (MAST)	3	9	9	9	5	0
Thinning plus surface fuel treatment (THSF)	10	32	32	31	22	8
Total	30	85	85	80	36	32

Table 1 – Sample size by time interval

METHODS CONT'D

Carbon Calculations

- The Fire and Fuels Extension to the Forest Vegetation Simulator (FFE-FVS) was used to calculate live and dead tree carbon stocks.
- Live herbs & shrubs biomass was calculated using the FIREMON methodology then divided in half to get C stocks.
- Surface fuel & forest floor fuel loads were calculated using coefficients specific to the Sierra Nevada then multiplied by appropriate conversion values to get C stocks.

Carbon Simulations

- The FFE-FVS was used project C stocks into the future using post 1-yr treatment data for comparison to field-derived values.

Statistical Analysis

•We fitted one-factor linear models from the family of the general linear mixed models (GLMM) because of unbalanced sample sizes (Table 1).

•Multiple pairwise comparisons were tested using the Tukey-Kramer to see treatment effect.

•Student paired t-test to compare differences by treatment type for each pre- and post-treatment pair (i.e. pre vs. 1-yr post, pre vs. 2-yr post, etc.) and for field-derived vs. simulated values.

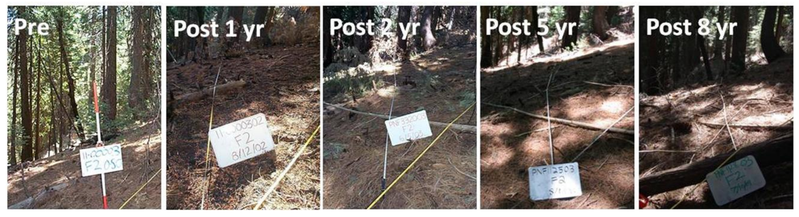

Fig. 3 - Photo series from a prescribed fire site

CONCLUSIONS

- Similar to other research we found more rapid tree carbon recovery in less intense treatments.
- Persistent elevated fine fuel (THSF) and fine fuel & forest floor (MAST) have the potential to increase fire behavior relative to pre-treat.
- Aboveground carbon stocks simulated into the future were on average 7% different than the field-derived values.

RESULTS

Treatment Type

•No sig. diff. between tree, and herb & shrub C stocks between treatment types for any time step.

•No sig. diff. .between treatment types for 5-yr post or 8-yr post-treatment for any C stocks.

•Fine fuel C was sig. less in FIRE than MAST & THSF and coarse fuel was sig. higher in MAST thank FIRE & THSF 1 and 2-yr post-treat.

Changes Over Time

•C steadily increased for FIRE & reached ~98% of the pre-treat. level by 8-yr post-treat.

•C stocks in trees and snags generally decreased post-treat. relative to pre-treat. for THSF and MAST.

•Herb & shrub C was reduced for all treat. types and THSF & FIRE both bypassed pre-treat. by 8-yr post.

•Fine fuel C was sig. diff. 1-year after treatment for all treat. types and the first two years for FIRE.

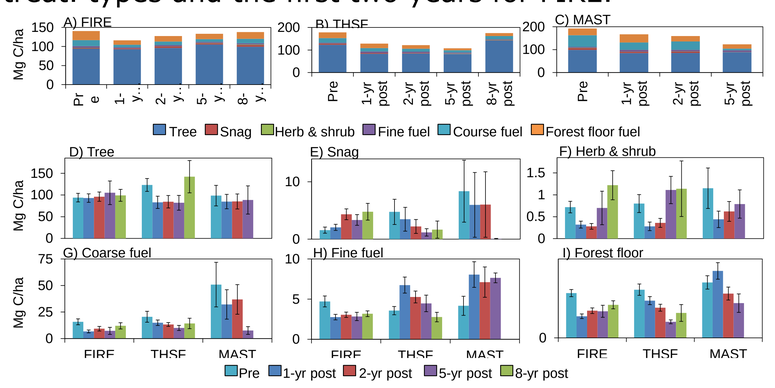

Fig. 4 - Mean total aboveground stand carbon stocks by carbon pool and time step

Field-derived vs. Simulated

•No set pattern was observed among differences between modeled and field-derived values with the exception of snags where simulated>field-derived.

- Differences were significant ~40% of the time.

•The snag and herb & shrub carbon stocks were the most variable and tree carbon stocks the least.

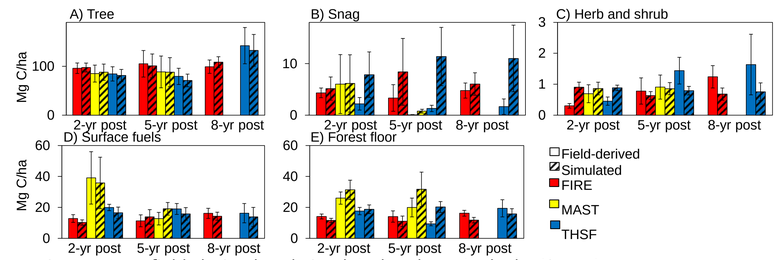

Fig. 5- Mean field-derived and simulated carbon stocks by time step