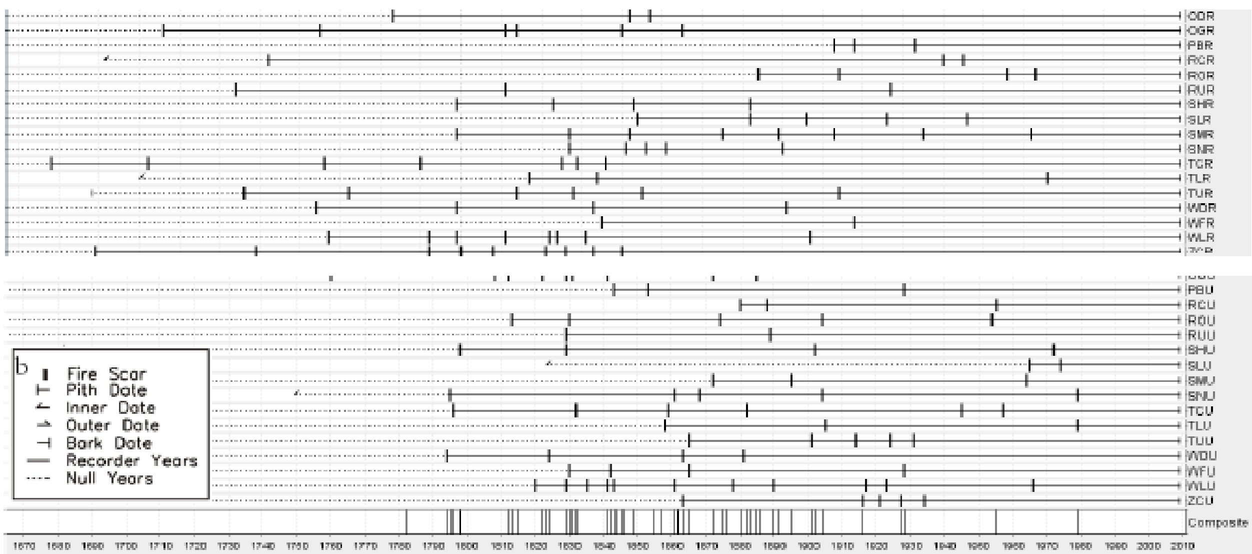
Alternatives for Fuel Treatments in Riparian Zones in Mixed Conifer Forests

Blodgett Forest Field Tour

Introduction and context

Blodgett Forest Research Station objectives are to facilitate research, extension/outreach, and university education. Most research is done within a "working forest" context, where forest management principles used to meet diverse objectives can be tested and demonstrated.

There is a large body of literature that supports the understanding that fires **frequently occurred in riparian zones** during the intact fire regime of the past (Agee 1998; Dwier and Kaufmann 2003; Everett et al. 2003; Pettit and Naiman 2007; Van de Water 2011).



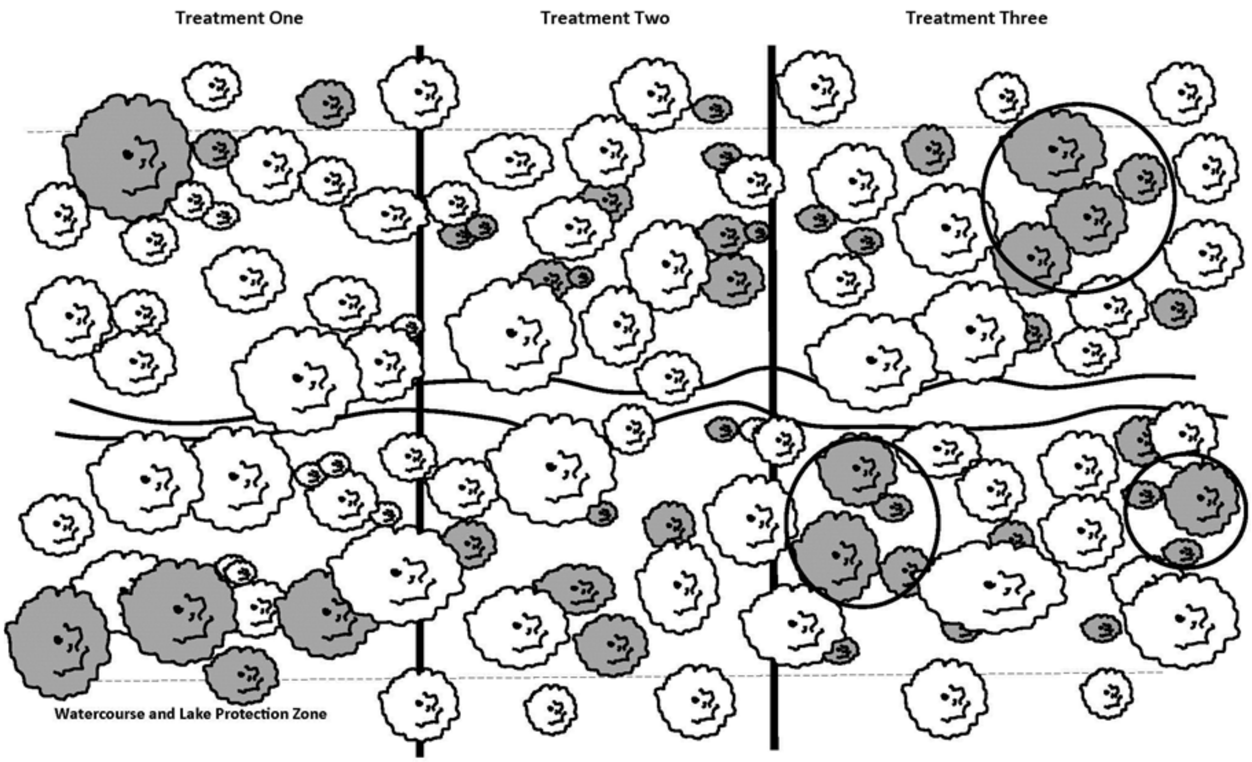
Above. From Van de Water 2011; the top panel shows fire scar years from trees sampled in riparian areas sampled at several mixed conifer sites. The bottom panel is from sample sites that were upslope pairings with riparian areas. Riparian Fire Return Interval = 16.6 yrs; Upslope Fire Return Interval = 16.9 yrs. Variability in FRI was higher in riparian compared to upslope zones.

Frequent fires, such as what occurred historically in riparian zones, maintained densities far below carrying capacities. Much of the density, in terms of basal area, was dominated by large trees (North et al. 2023).

Riparian zones, similar to upslope areas, were characterized by low fuel loads, heterogeneity, and large trees. Through the treatment of these areas as **Equipment Exclusion Zones** at Blodgett Forest, riparian zones have become characterized by high fuel loads (average 45 tons/acre), homogeneity (average 70% canopy cover), and a high probability of torching during extreme fire weather (average P-torch = 76%).

Figure 1 (York, In Press). A conceptual model of natural development in MCF following a canopy gap created by localized high-severity fire (A), initiation of a dense patch of seedlings (B), thinning of the young cohort, via periodic low intensity fire (C), canopy recruitment with low density, low surface fuels, and few ladder fuels, maintained by fire (D), and mature forest with high complexity at 1 ha scale maintained with low and moderate severity fire (E).

Above. Frequent but variable fires in mixed conifer forests created a mosaic of patches, most less than 2.5 acres (1 ha) in size. This patch-mosaic of dense regeneration, developing mid-sized trees, and large trees occurred within a matrix of low surface fuel loads. This pattern occurred in both upslope and riparian areas.



Above. Study design: Stretches of riparian zones were randomly applied to either control, status quo, fuel treatment, or fuel treatment plus canopy gap creation. Zones are adjacent to stands where silvicultural treatments periodically occur.

Treatments

Control- Do nothing

Status quo- When harvesting in the adjacent upslope stand, directionally fell trees that are accessible and operationally feasible to yard. Follow Forest Practice standards, while “recovering value.”

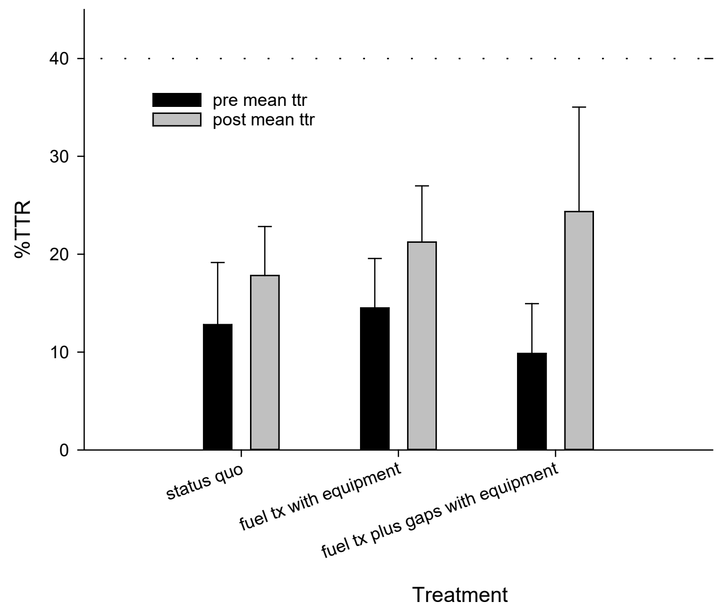
Fuel treatment- Everywhere accessible with heavy equipment, thin from below to a target of 140 ft2/acre. Following timber operations, cut non-merchantable trees and pile with either hand-crews or equipment. Burn piles, allowing for broadcasting in between piles when feasible.

Fuel treatment + canopy gap creation- Same as fuel treatment, except also create canopy gaps between 0.1 and 0.5 acres. Gaps will cover ~15% of the WLPZ area. Plant gaps with shade-intolerant species.

Measurements

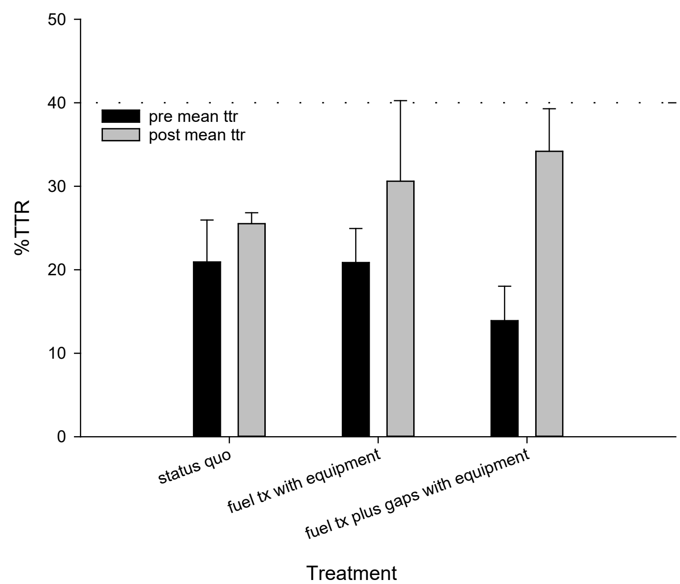
- Change in radiation input at WLPZ edges and at stream
- Timber yield and revenue
- Sediment delivery corridors
- Forest structure and species composition
- Surface fuel change
- Soil strength
- Alder tree growth and survival
- Water temperature

Current Results



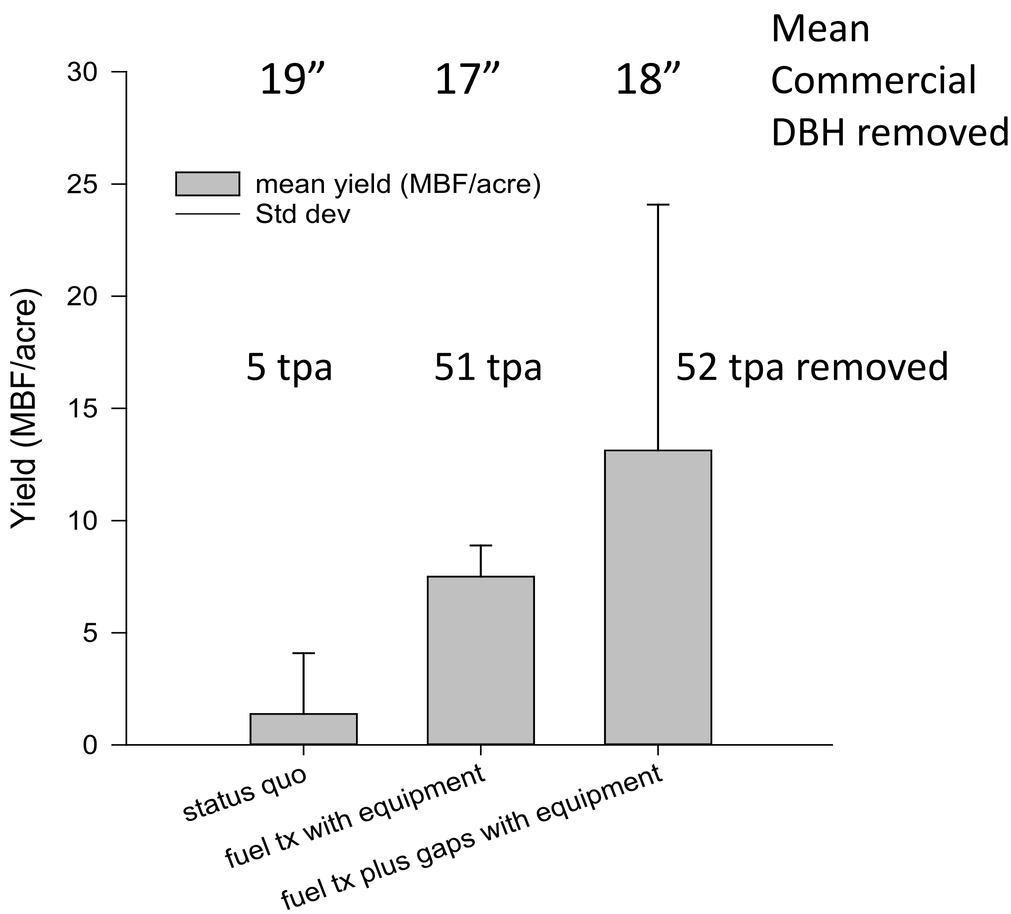
Left. All treatments resulted in an increase in radiation at stream channels. ANOVA suggests a significant difference *among* treatments. Post-hoc: Status quo ~ Fuel tx < Fuel Tx + gaps. Overall, light input is still low, considering that P. pine requires at least 40% light availability for recruitment.

Right. Same as above, but at edges of WLPZ's. Results are the same, but edges are high light environments compared to stream channels, pre-harvest. Because of gap creation, light levels sometimes reach 40% TTR (whiskers are standard deviations in both graphs).



Conclusions:

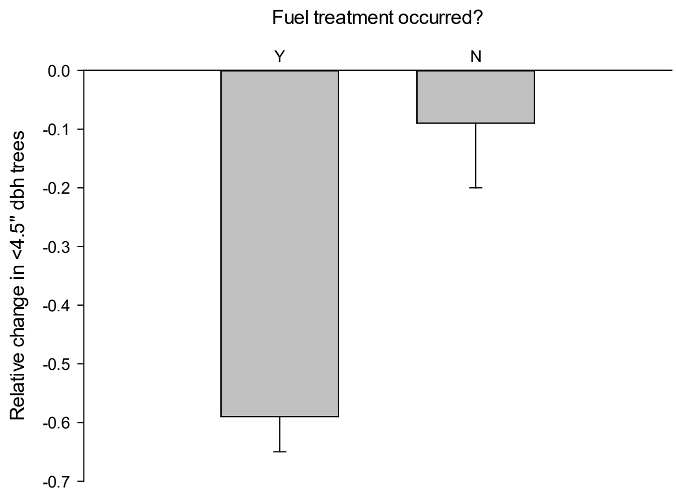
- Thinning operations tend to create a high to low light gradient going from WLPZ edge to center, with the amount of operations-related light increase controlled by stocking decisions.
- Status quo harvests do not change light availability, likely not increasing growing space enough to initiate new cohorts of trees
- Sufficient light for shade-intolerant tree species and shrubs can occur in distinct gaps, if large enough (>0.25 acres).



Treatment effects on yield

- Volume removed increased as heavy equipment was allowed into WLPZ stretches (p=0.04); the actual increase was substantial, from 1.4MBF/acre in status quo to 9.9MBF/acre when heavy equipment was allowed.
- Greater yield came from more small trees being removed, not from bigger trees being removed
- Overall stem removal was an order of magnitude greater where fuel treatments were done, because of non-merchantable cutting/pilling.
- Maximizing profit was not the objective of these treatments, but it was desirable to cover costs of fuel treatments with timber revenue.

	Revenue ($/acre)		
Assumed net $/mbf	Status quo	Thin with equipment	Thin+gaps with equipment
100	139	750	1312
200	277	1500	2624
300	416	2250	3936



Left. As expected, small tree density is reduced substantially compared to status quo treatments. This is because they are specifically targeted for removal. This mid-story density reduction makes broadcast burning much more feasible.

Conclusions

This study demonstrates some of the tradeoffs when conducting fuel treatments that involve heavy equipment in riparian zones. Of greatest value, in terms of riparian zone resilience, is the capacity to reduce surface fuels and create canopy heterogeneity at gap scales. A lack of disturbances in riparian zones causes an ecological departure from historic conditions and increases the likelihood of high-severity fires and associated species shifts, sediment delivery, and water temperature increases.

Study phases and future directions

- Phase 1 is completed. Further monitoring can assess changes in soil compaction, surface fuel dynamics, and alder tree responses.
- Phase 2 would involve the continuation of monitoring at Blodgett Forest, and also the expansion to other sites.
- Hydrology work, involving stream temperature monitoring and sedimentation, may be feasible in further phases.

Works Cited

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