Effects of Restoration Fire Treatments on Avian Communities in Warm/Dry Mixed Conifer Forests, Southwest Colorado

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Introduction

- Warm/dry mixed conifer forests are dominated by fire-tolerant ponderosa pine (*P. ponderosa*), Douglas-fir (*Pseudotsuga menziesii*) and mesic species such as white fir (*Abies concolor*), and aspen (*Populus tremuloides*).
- Fire suppression over the last century has caused an increase in tree density a shift towards more mesic species composition that has moved the forest away from its historical make-up (Korb et al., 2012).
- Change in forest structure away from historical conditions increases the potential for future wildfires to be on a larger scale (compared to pre-1880 fires) that may result in novel ecosystems (Grissino-Mayer et al., 2004; Korb et al., 2012).
- Warm/dry mixed conifer forests host a large community of avian species that depend on variety of forest structure for survival.
- We used birds as indicator species because they are conspicuous, mobile, and easily identifiable, and therefore have been widely recognized as valuable indicators of environmental condition (Brock & Webb, 1984).

Hypothesis:

- The control stands will contain indicator species that are seed specialists and foliage insectivores (Garcia, 2011; Russel et al., 2009).
- Burn only and thin/burn stands will see an increase in cavity dwellers such as woodpeckers (Hutto, 2008; Horton & Mannan, 1988).
- Aerial foragers and ground foragers will increase in burn only stands (Horton & Mannan, 1988).

Objectives

- To quantify differences in avian richness and abundance among three forest restoration treatments (control, burn only, and thin/burn) seven years post-treatment in warm/dry mixed conifer across summer months.
- To quantify differences in avian communities and identify indicator avian species associated with each forest restoration treatment.

Study Site

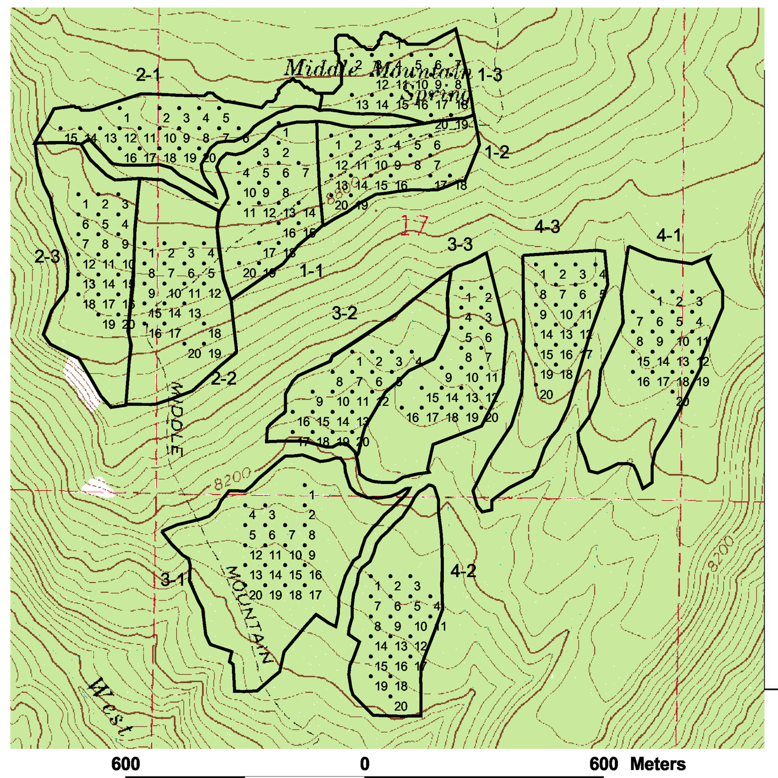

Figure 1: Topographical map of study site with treatment blocks (4), units (12) and plots (240).

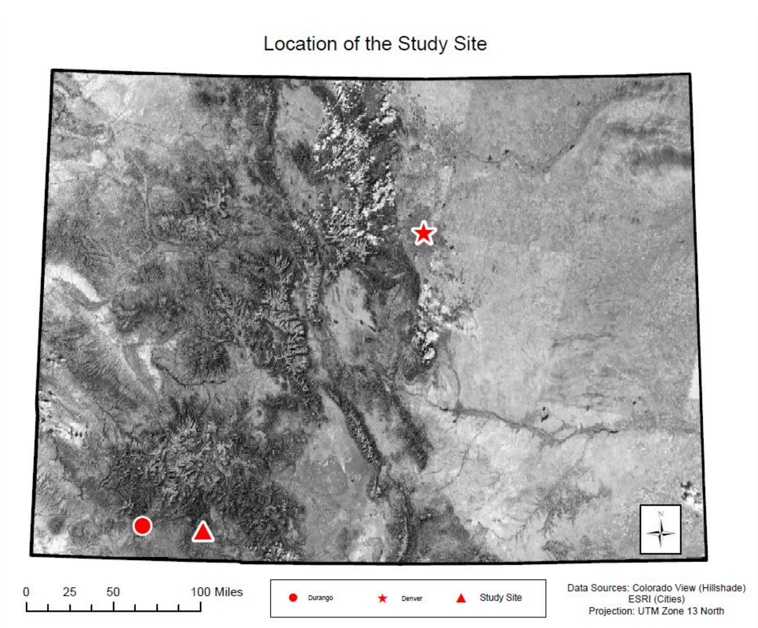

Figure 2: Hillshade view of study site location in Colorado.

Our study area is within the San Juan National forest in southwest Colorado about 18 km northwest of Pagosa Springs, Colorado at N 37.296, W 107.228 (Figure 2). The elevation ranges from 2438 to 2743 m at about a 15-30% slope on south-facing aspects (Korb et al., 2012). The site has temperatures ranging at a maximum of 25.7° C in July to a minimum of -17°C in January (Korb et al., 2012). Vegetation at the site includes ponderosa pine, Douglas-fir, white fir, aspen, gambel oak, snowberry, chokecherry, wild rose and serviceberry (Korb et al., 2012).

Results

Table 1: Mean (± SEM) forest stand characteristics by treatment. N=4. Different letters indicate significance at ≤ 0.05 using one-way ANOVA. Data summary from Stoddard et al. in press.

	2009 Tree Canopy (% Cover)	2013 Tree Basal Area (m^2 ha^{-1})	2013 Tree Density (trees ha^{-1})	2013 Seedling ha^{-1} (<40 cm height)	2013 Sapling ha^{-1} (>40.1 cm height and >2.5 cm DBH)	2015 Shrub Density (stem ha^{-1})
Control	49.06 (1.8) **a**	26.8 (1.3) **a**	540.6 (49.8) **a**	276.3 (51.2) **a**	911.3 (246.5) **a**	17807.9 (1659.2) **a**
Thin and Burn	30.78 (1.8) **b**	11.3 (1.2) **b**	117.2 (34.5) **b**	87.5 (36.0) **b**	2982.5 (817.6) **a**	42721.6 (13744.2) **b**
Burn Only	40.31 (0.6) **c**	20.5 (0.7) **c**	316.6 (20.9) **c**	253.8 (53.9) **ab**	983.8 (520.5) **a**	26400.0 (5486.0) **a**

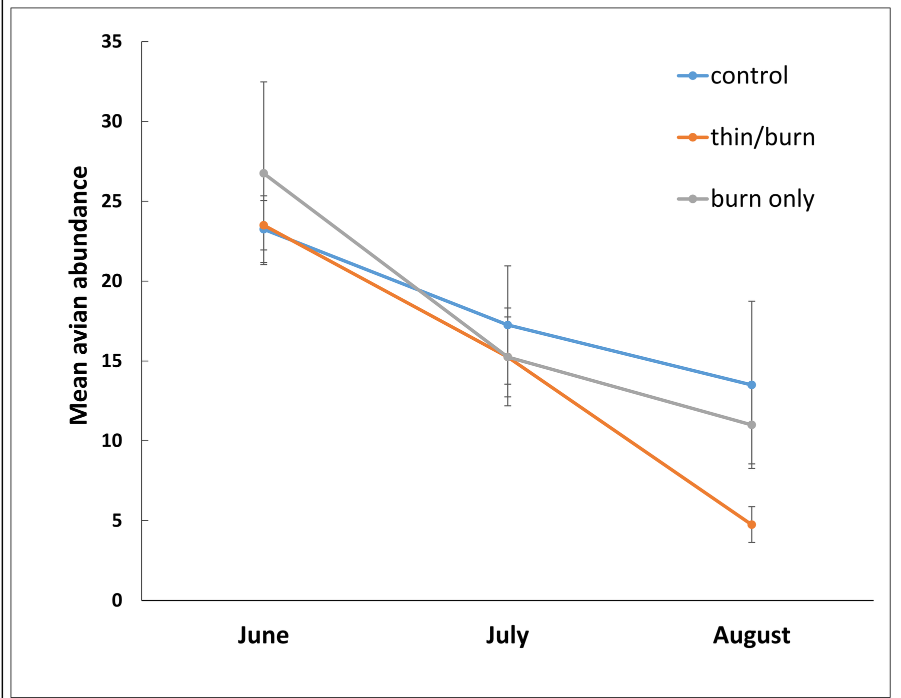

Figure 3: Avian mean ± SEM abundance determined from 10 minute point counts. Avian communities were not significantly different within a sampling period among different treatments. Avian communities decreased significantly in the control treatments (F=20.6, p=0.000) from June to August and in the thin/burn treatments (F=8.8, p=0.008).

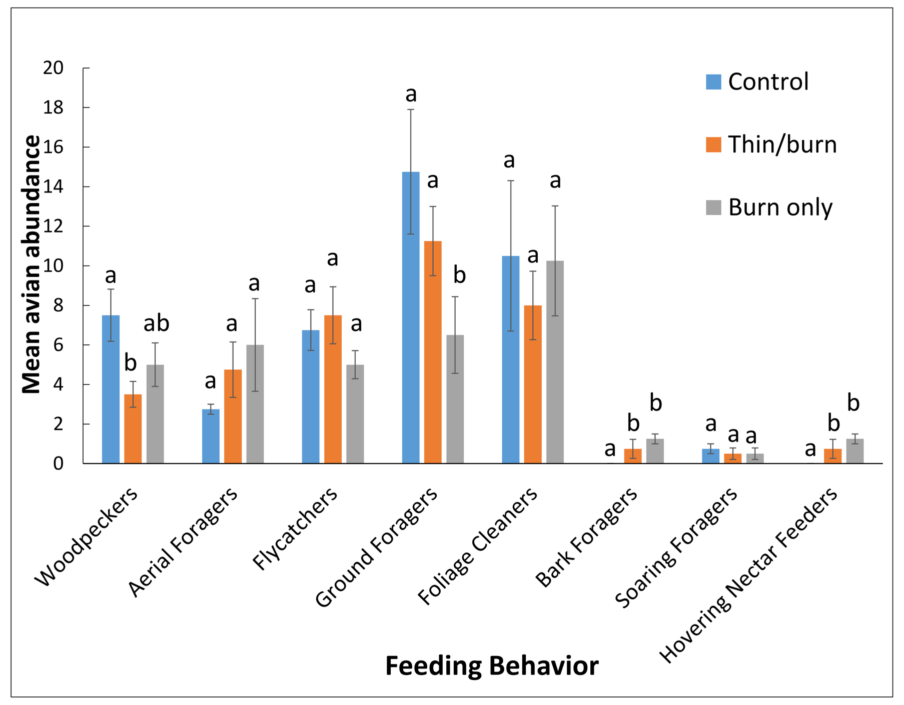

Figure 4: Mean ± SEM abundance of avian feeding groups in different treatments determined from 10 minute point counts. Bars with the same letters are not significant at P≤ 0.1 within a feeding group based on one way ANOVA tests followed by post-hoc Tukey's test.

Figure 5: Indicator species for different restoration treatments (Table 2). Starting from the left, common raven, pine siskin, and the hermit thrush.

Table 2: Indicator species associated with different treatments in Pagosa Springs, Colorado. Indicator species analyzed with a Monte Carlo test of significance of observed indicator values, which identifies species that are consistent indicators for different treatments (Indicator value = species abundance x species frequency). Indicator values were calculated using PC-Ord version 6.0.

	Species	Common Name	Indicator Value	P
Control	*Corvus corax*	Common Raven	70	0.05
Thin/burn	*Carduelis pinus*	Pine Siskin	57.9	0.06
Burn only	*Catharus guttatus*	Hermit Thrush	90	0.01

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Experimental Design and Methods

- The plots were established in 2002, thinned in 2004, and prescribed fire occurred in 2007 and 2008.
- Treatments included (1) control, (2) thin/burn, and (3) burn only.
- There were 4 replicates of each treatment (4 x 3 = 12 treatment units), within each unit 20 plots were established in a systematic grid.
- I surveyed each treatment 3 times (4 blocks x 3 treatments x 3 randomly chosen plots = 34 plots) once a month during June, July, and August.
- I used the point count method as well as bird calls to measure bird species richness and abundance within a 50 meter radius during a 10 minute period.

Table 3: Permanova based on Bray-Curtis dissimilarities of avian abundance for three sampling periods (June, July, and August) across three forest restoration.

Source	d.f.	SS	MS	F	p
Time	2	0.7	0.4	0.6	0.9
Treatment	6	3.4	0.6	2.4	0.0002
Residual	27	6.3	0.2		
Total	35	10.4			

Figure 6a-c: Example photos from the three forest restoration a: control plot 2-1-5; b: thin/burn plot 2-2-5; c: burn only plot 2-3-2.

Major Findings/Conclusion

- Stand structures of the thin/burn treatments showed the closest return to historical vegetative structures (Fule et al., 2009).
- There was a significant difference in avian abundance between treatments as well as a significant difference in avian abundance from June to August in control and thin/burn stands matching with other .
- There were three indicator species identified: *Corvus corax* in control stands, *Carduelis pinus* in thin/burn stands, and *Catharus gattatus* in burn only stands.
- Woodpecker abundance was significantly higher in control stands than thin/burn stands where they were least abundant. Control stands at our study site had similar mortality rates to thin/burn and burn only stands (Stoddard et. al., 2015) providing snag habitat in all treatment stands. They are also mostly significantly seen in fire treatment stands immediately after the burn, by 4 years post-fire populations usually even back out (Kristen et al., 2006).
- Ground forager abundance was significantly lower in burn only stands compared to control and thin/burn stands. This finding contradicts other research that shows ground foragers with high abundance in burned stands (Horton & Mannan, 1988; Bange & Purcell, 2011).
- Bark foragers and hovering nectar feeders were not present in control stands but showed no significant difference between thin/burn and burn only stands. Bark foragers have been shown to respond positively to prescribed fires (3-6 years post-treatment) while hummingbirds have been shown to respond negatively (Bange & Purcell, 2011).

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