Pollinator Richness and Abundance in Forest Restoration Treatments of a Warm/Dry Mixed Conifer Forest, Southwestern Colorado

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Introduction

- There is a general consensus that climate change in the southwestern United States will result in the region becoming warmer and drier throughout the 21st century (Darmenova, 2013).
- Studies suggest more aggressive thinning treatments may increase fire resistance and provide greater resilience to future climate-related stress (Kerhoulas, 2013).
- For this study, we focused on a warm, dry mixed conifer forest stand in southwestern Colorado.
- Forest restoration treatments may be beneficial for pollinator-plant relationships by altering understory vegetation and habitat (Nyoka, 2010).
- Pollinators of most forest systems are dominated by a mixture of bee species (order Hymenoptera). Flies (order Diptera) are the second largest pollinating group (Larson, 2001).
- Overstory thinning and prescribed burning have the potential to substantially increase habitat suitability for pollinating insect taxa in ponderosa pine forests of the American Southwest (Nyoka, 2010).

Hypotheses:

- Pollinator richness/abundance will be significantly higher in the thin/burn treatment areas with higher richness in bees.
- Control and burn only treatments will have relatively similar pollinator richness/abundance with higher numbers of pollinator generalists (order Diptera).

Objectives

1. Compare richness/abundance of pollinators in three forest restoration treatments (control, thin/burn, and burn only) in warm, dry mixed conifer in southwestern Colorado.
2. Quantify if there are differences in pollinator communities among the three restoration treatments and if there were indicator species that were uniquely associated with restoration treatments.
3. Observe temporal changes in pollinators across the growing season.

Study Site

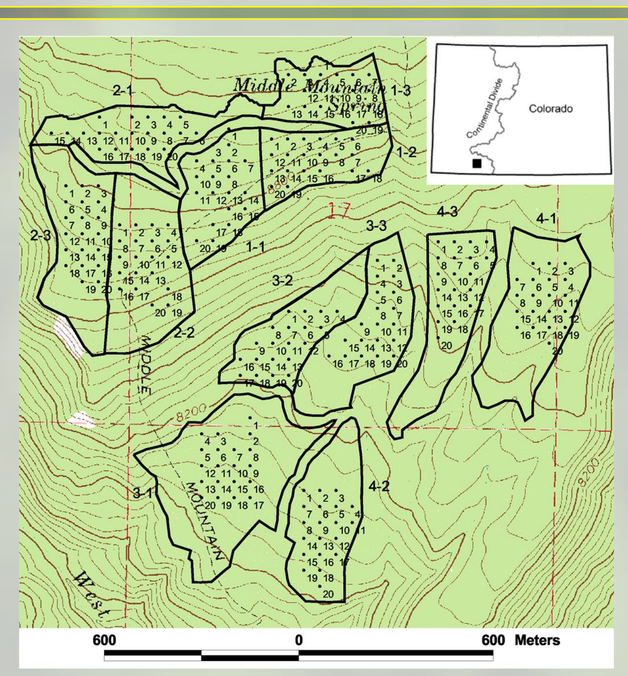

Figure 1. Topographical map of the study site, located in the San Juan Mountains of southwest Colorado, (N 37.296, W 107.228) in the San Juan National Forest, NW of Pagosa Springs, CO.

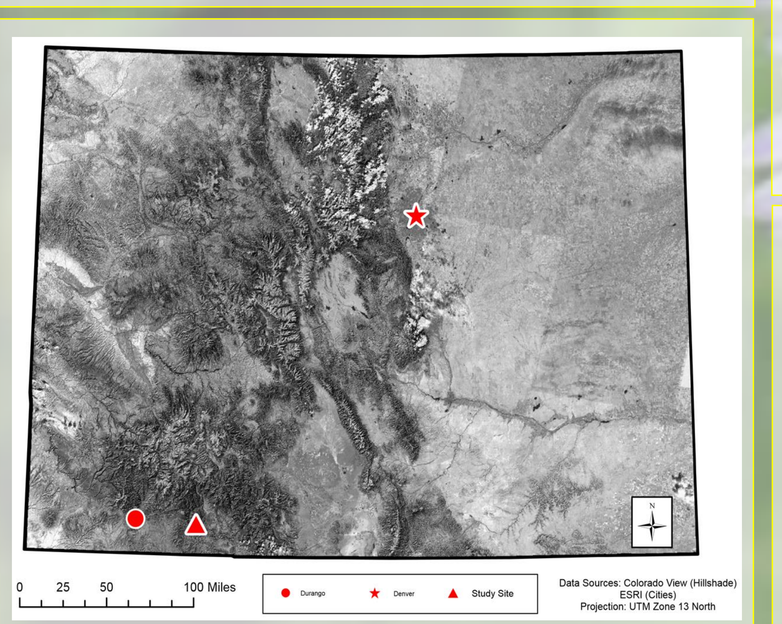

Figure 2. Satellite view of study site location within southwestern Colorado.

Table 1: Mean (± SEM) forest stand characteristics by treatment. N=4. Different letters indicate significance at ≤ 0.05 using one-way ANOVA. Data from Stoddard et al. 2015.

	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/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 (13774.2) 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	26400.2 (5486.0) a

Methods

- Plots were established in 2002, thinned in 2004, and prescribed burned in 2007 and 2008.
- 4 replicate blocks with 3 randomly assigned treatments (1=control, 2=thin/burn, 3=burn only) N=12 units.
- In each unit, 20 plots were established with a plot center on a 60 m grid. Five of the 20 plots were randomly chosen (12 units x 5 plots = 60 plots).
- In each study plot, 1 glycol trap was placed 5, 10, & 25m away from plot center on both sides of the transect for a total of 6 traps per plot (6 traps/plot x 5 plots/unit) = 30 traps/unit.
- Traps included blue, yellow, green, and purple 473ml plastic cups, filled 1/4 of the way with a 50% water/glycol solution and set ~0.3 m above the ground using 2.5 cm PVC tubing. Cup colors were randomly placed.
- Traps were placed and allowed to collect pollinators for 5 days.
- Traps were established 3 times during the growing season (early July, late July and late August).
- Collected specimens were taken back to the lab for identification and counting, keeping all collection groups separated and labeled (i.e. collection date, location, etc.).

Figure 3: Images of treatment units: A) plot 2-1-4 (control), B) plot 2-2-4 (thin/burn), C) plot 2-3-5 (burn).

Figure 4: Example of glycol trap transect.

Figure 5: Images of plot 4-2-5. A) glycol trap transect with blue cup, B) black bear cub assisting with pollinator collection.

Results

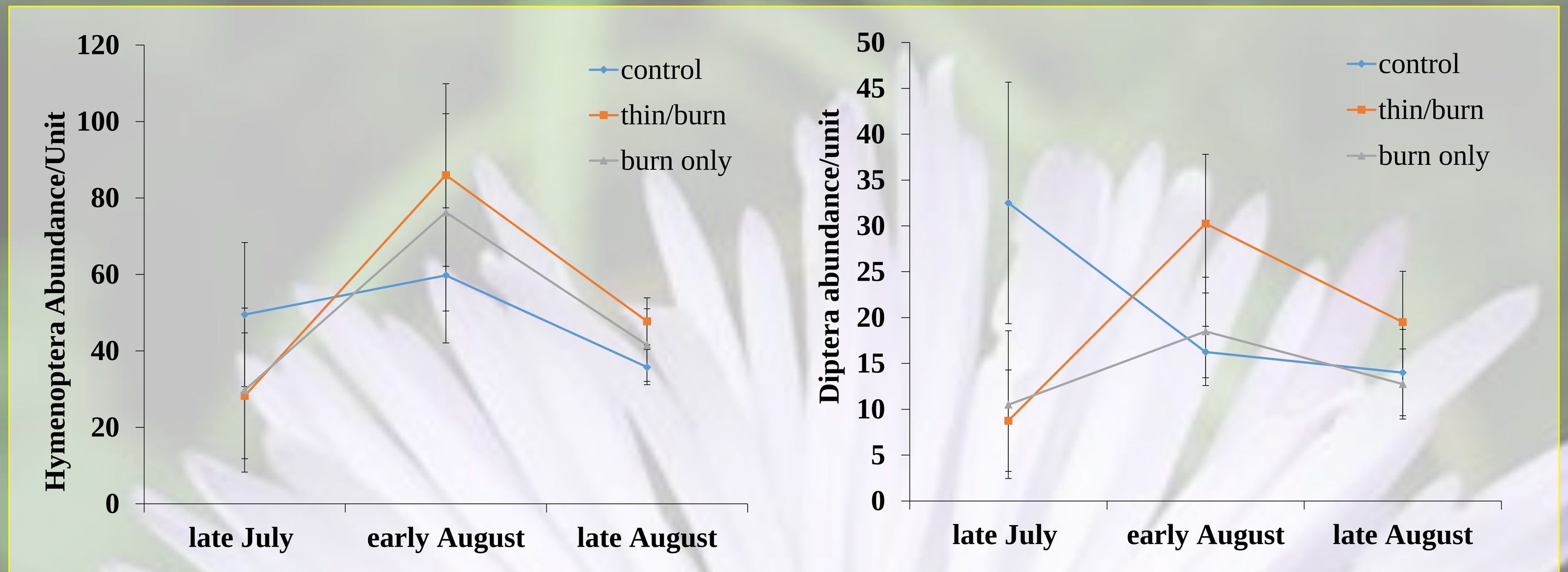

Figure 6: Pollinator order average abundance throughout the growing season. Error bars present as ± SEM. Hymenoptera control sign. dif. (F=4.8, p=0.038) between late July and early Aug (0.031). No significant difference for treatment across time for Diptera.

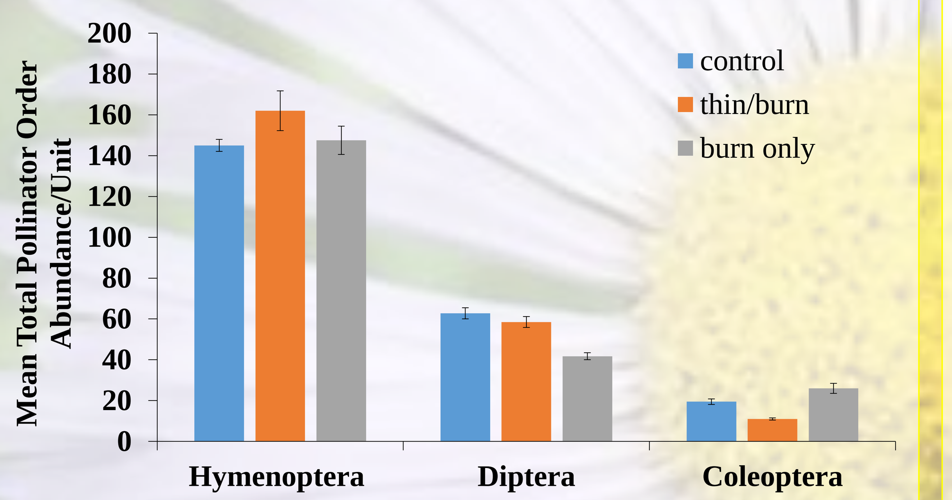

Figure 7: Average total of pollinators by order per treatment. Error bars present as ± SEM. There were no significant differences among treatments within a specific order using a one way ANOVA .

Table 2: Indicator families associated with different sampling periods (indicator family=family abundance x frequency) calculated with PC-Ord.

	Time	Indicator Value	P
Syrphidae	late July	47.2	0.0002
Erotylidae	late July	44.6	0.0002
Noctuidae	late July	26.1	0.0002
Scarabaeiade	late July	24.3	0.001
Asilidae	late July	12.6	0.0148
Apidae	early August	41.2	0.0354
Halictidae	early August	35.9	0.0956
Tachinidae	early August	35.6	0.0044
Bombyliidae	early August	15.4	0.068
Erebidae	early August	5.3	0.0602
Colletidae	late August	7.6	0.0746

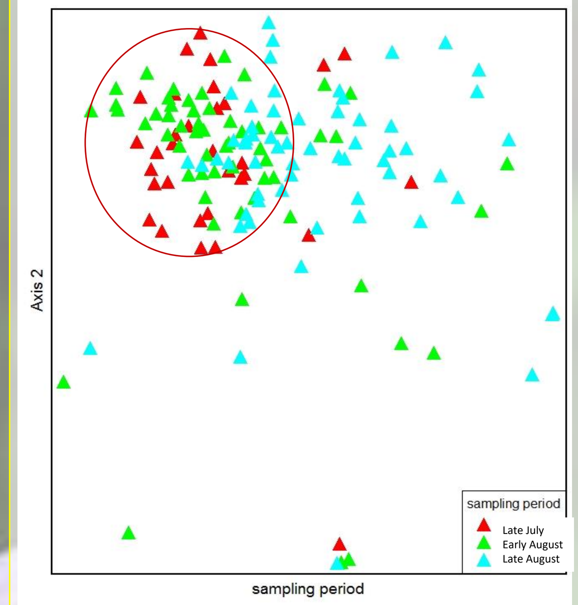

Figure 10: Non-metric multidimensional scaling ordination showing significance (permanova-F=5.925 p=0.0006) for community differences at order level across time. Pairwise comparisons 1 vs 2 p=0.03, 1 vs 3 p=0.0002, 2 vs 3 p=0.03.

Table 3: Indicator families associated with different treatments (indicator family=family abundance x frequency) calculated with PC-Ord version 6.0. Significance (p=0.1)

	Treatment	Indicator Value	P
Syrphidae	control	30.4	0.0938
Halictidae	thin/burn	42.4	0.002
Tachinidae	thin/burn	30.6	0.0282
Bombyliidae	thin/burn	14.5	0.0836
Pompilidae	thin/burn	7.7	0.0562
Buprestidae	thin/burn	7.4	0.0752
Erotylidae	burn only	23.7	0.0284

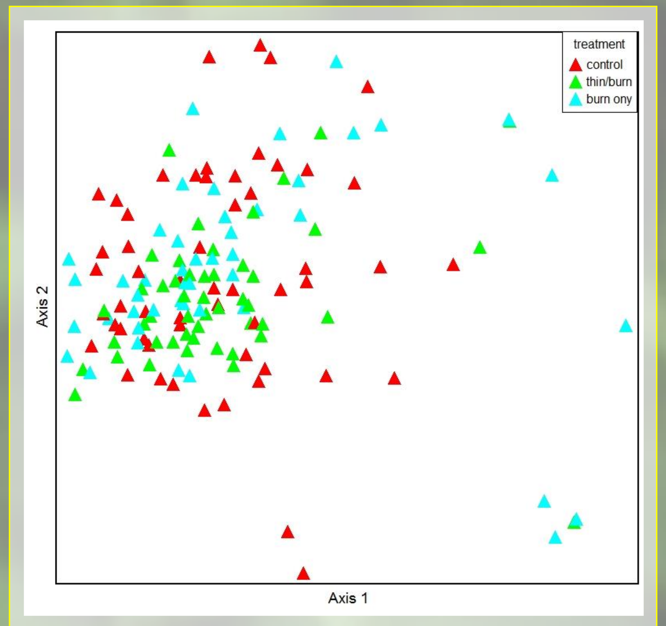

Figure 11: Non-metric multidimensional scaling ordination showing no significant difference in the community level of pollinator orders for the different treatments.

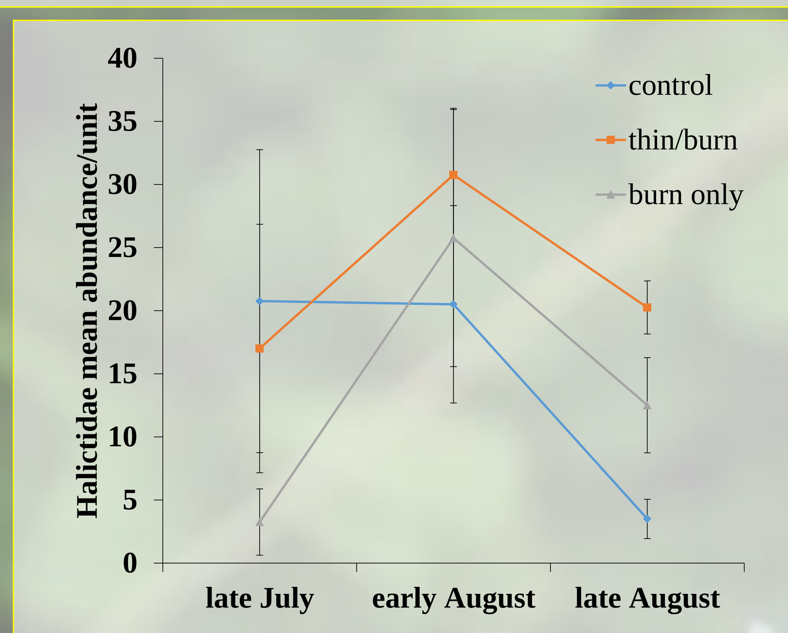

Figure 12: Halictidae average abundance in the growing season. Error bars present as ± SEM. Halictidae abundance was significantly higher (F=10, p=0.05) in the thin/burn stand in late August than the control or burn only treatments.

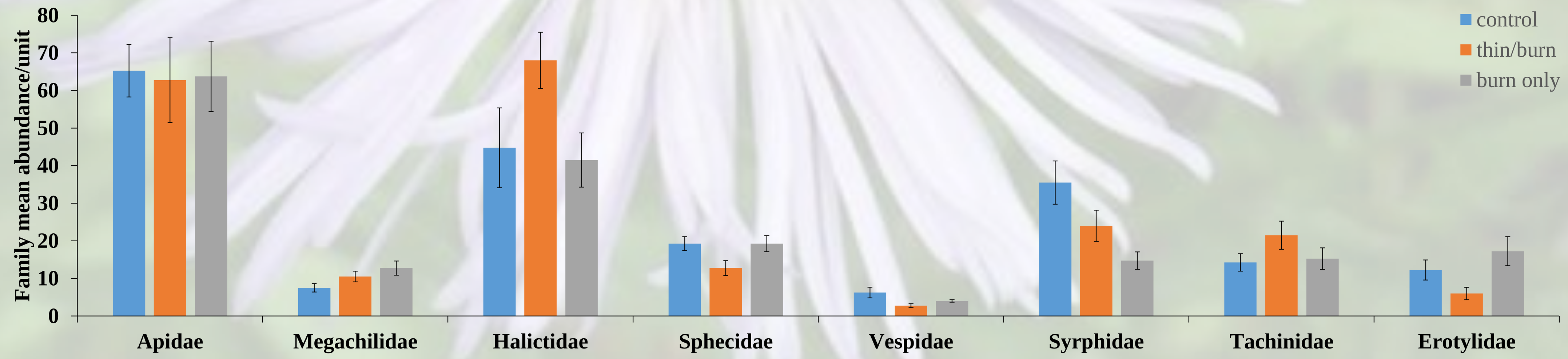

Figure 8: Total average of pollinators by family per treatment over the growing periods. Error bars present as ± SEM. There were no significant differences among treatments within a specific family using a one way ANOVA .

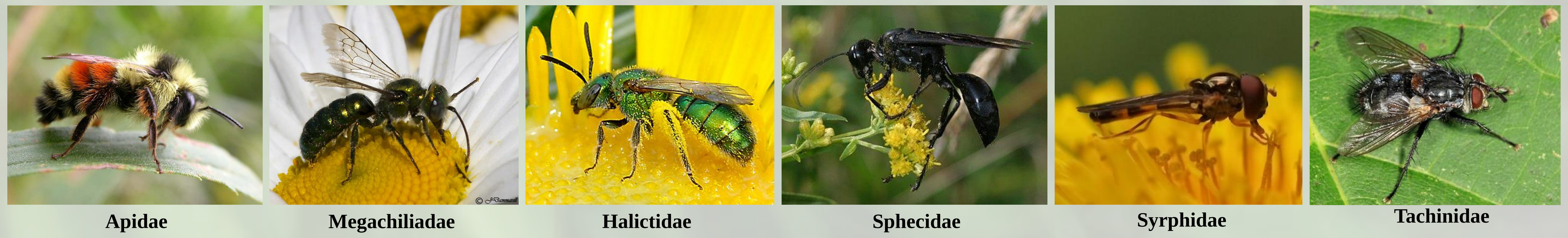

Figure 9: The four most abundant Hymenoptera families (left) and the two most abundant Diptera families (right) found at the study site.

Major Findings/Conclusions

- Hymenoptera was an indicator species for the early August growing period for all treatments (indicator value=35.6, p=0.008).
- No significant difference at the community level for pollinators by order among treatments, but the thin/burn pollinator community was more similar (points closer together) than the other treatments which had more pollinator community variability (Figure 11).
- 28 different families of insects were identified.
- Ichnuemunidae and Bombyliidae had significantly higher abundance in thin/burn treatment compared to control in early August.
- No differences among treatments for species richness/diversity values: control = 5.4/1.32; thin/burn = 5.7/1.35; burn only =6.1/1.49.
- Although data did not show significance to support my hypothesis, general trends show Hymenoptera more abundant in thin/burn treatments and Diptera more abundant in control treatments.
- Because there were more indicator families that are pollen/flower dependent (i.e. Bombyliidae or Halictidae) in the thin/burn treatments, thinning and burning forest restoration treatments may be a viable option to increase pollinator abundance/richness.

Acknowledgements

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