Understory Growth Dynamics Following High Severity Burn in a Mixed-Conifer Ecosystem

Daniel Wilcox (danielwilcox@email.arizona.edu)[1,2], Shirley A. Papuga[2], Bhaskar Mitra[2]

[1]*Department of Chemical and Environmental Engineering, University of Arizona,* [2]*School of Natural Resources and the Environment, University of Arizona*

1. Introduction

Climate change is transforming the landscape of the southwestern United States, where record breaking temperatures and rampant wildfire are becoming more of the norm. In particular, the sky island ecosystems of this region are highly vulnerable. Importantly, these ecosystems provide many of the resources that sustain the communities developed below them. Therefore, understanding the recovery of these ecosystems from wildfire is important in the context of watershed management.

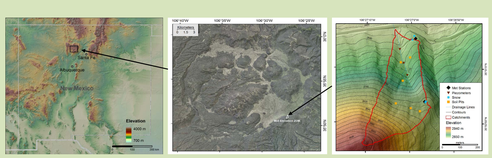
2. Objective

Our objective was to relate the growth dynamics of the understory following high severity burn in a mixed-conifer ecosystem to aspect and other environmental parameters. We expect that this information will be important for understanding both what influences the recovery of understory following high severity burn and also the implications of the dynamics of that recovery on the hydrology of the watershed.

3. Study Site

Our study site included two watersheds impacted by the 2011 Las Conchas Fire, in the Jemez Mountains of New Mexico.

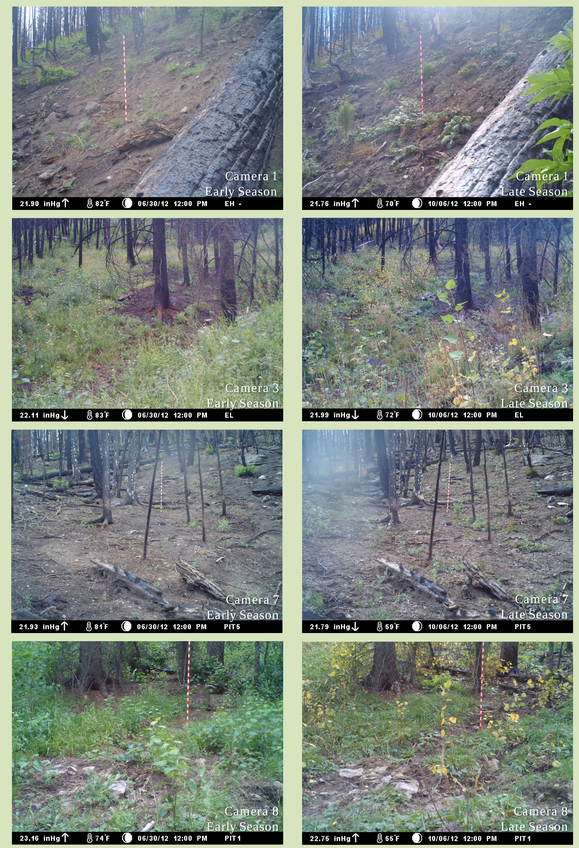
Elevation: 2,664-2,934 m
Annual Rainfall: 670mm



4. Methods

- Ten Moultrie Game Spy I60 digital cameras were installed with cameras 1-6 in one watershed, and 7-10 in soil pits in another watershed.
- These took hourly images for one year post-fire.
- Soil pits also had soil temperature and soil moisture sensors at three different depths taking measurements every ten minutes.
- Two meteorological stations, one lower in the watershed and one higher in the watershed, captured half-hourly measurements of ecohydrological variables such as precipitation.

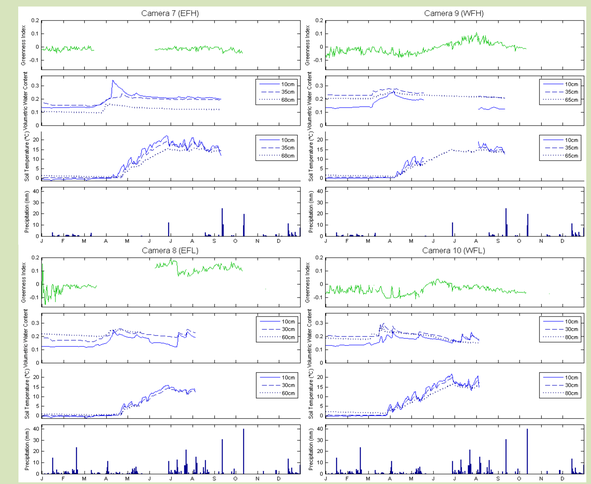
5. Observations - Raw Image Analysis



Aspens were seen in all sites except the two higher-elevation east-facing sites. Here the two sites and their corresponding lower-elevation sites are shown side-by-side for comparison with photos from both midsummer and autumn.

Camera	Aspect	Elevation	Grass?	Herbs?	Aspens?
1	East-Facing	High	Some	Yes	**No**
2	East-Facing	Middle	Yes	Yes	Very few
3	East-Facing	Low	Yes	Yes	Yes
4	West-Facing	High	Yes	Yes	Yes
5	West-Facing	Middle	Yes	Yes	Yes
6	West-Facing	Low	Yes	Yes	Yes
7	East-Facing	High	Some	Yes	**No**
8	East-Facing	Low	Yes	Some	Yes
9	West-Facing	High	Yes	Yes	Yes
10	West-Facing	Low	Some	Yes	Yes

6. Observations - Time Series

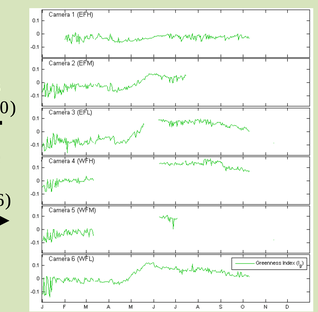


Greenness index: a measure of the greenness in a photo based on pixel RGB values. Greenness of a photo is taken as an average of the greenness values of every pixel in the photograph.

$$I_g = 2 \times green - red - blue$$

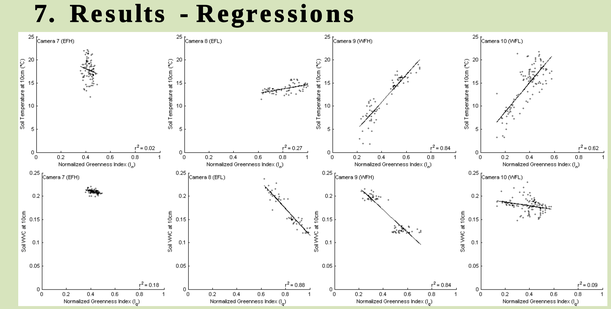
Soil Pits (Cams 7-10) ←

Hillside Aspect (Cams 1-6) →



- Greenness of photograph appears to be correlated with the soil temperature, but not with soil moisture or precipitation.
- Soil moisture appears to increase primarily following springtime snowmelt. These increases quickly subside.
- Greenness values of sites without aspen (cams 1 and 7) don't change much throughout the year.

7. Results - Regressions



- Plotted only for green season (April through October)
- For cameras 9 and 10, there is a strong correlation between soil temperature and greenness index. There is no correlation for cameras 7 and 8, which are missing spring-time greenness data.
- There is a negative correlation between greenness and soil moisture for cameras 8 and 9. However, both cameras are missing large amounts of data.

8. Take Home Points/Further Questions

- Aspen growth appears to be related to both aspect and elevation together. Is this always the case or does it say something about the recovery dynamics? How does greenness index reflect this?
- Soil temperature, in some instances, is strongly correlated with greenness. What are the specifics of this correlation (effects of depth, etc.)?
- Soil moisture, in some instances, is negatively correlated with greenness. Is this a valid correlation or is it due to problems with the data?

9. Acknowledgments

This project was funded by the NSF National Critical Zone Observatories Program (EAR-0724958). Thanks to Mark Losloben and Scott Compton for Jemez camera maintenance, and to Matej Durcik for providing maps. Thanks also to the Arizona NASA Space Grant Consortium for their support.