Conifer Responses to Changing Fire Histories in the Illilouette Creek Basin of Yosemite National Park

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Background

- Fire suppression policies in the western United States have altered the forest structures and fire regimes of California's Sierra Nevada forests.
- In the Illilouette Creek Basin (ICB) of Yosemite National Park, fire suppression policies ended in 1972, and the park entered a management era known as Wildland Fire Use (WFU).
- Wildland fire is now used as a management tool to increase landscape heterogeneity and forest resilience in the ICB.
- Studies have shown that the reintroduction of fire in the ICB has raised the water table in the Basin, as well as available soil moisture, streamflow, and snowpack.
- Few studies have tracked the physiological responses of individual trees following changes in local fire regimes.

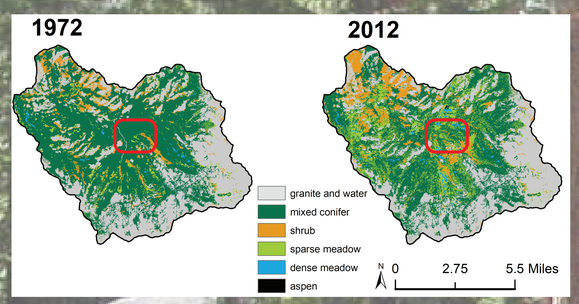

Figure 1 (above):
Outline of the ICB. Changes in vegetation cover have occurred on landscape levels in the ICB as a result of the reintroduction of wildfire. Approximate location of the study area is circled in red.

Objective

This study aimed to expand on the work already accomplished in the ICB by:

- quantifying the physiological responses of trees to two different management eras in the ICB: fire suppression and WFU eras.
- comparing the physiological responses of two species with uniquely different growth strategies (*Abies concolor* & *Pinus jeffreyi*) to fire suppression and WFU eras.

Methods

Study area and sampling:

- The study region included all plots that had both *Abies concolor* and *Pinus jeffreyi* present within the perimeter of two fires: Unknown Fire (burned 1980) and Illilouette Creek Fire (burned 1996).
- All tree core samples of each species taken in 2004 were prepped for analysis with additional sanding.

Basal Area Increment (BAI)

- Annual ring width measurements for every core were recorded using the dendrochronology program Measure J2X.
- Errors in ring width measurements were adjusted using the dendrochronology program COFECHA.
- Ring width measurements were converted to Basal Area Increment (BAI). BAI was used to estimate annual growth rates for each individual tree.

Creating a Linear Model

- A linear model was ran for both species using the programming language R.
- The linear model used (BAI / tree diameter) as the response variable, and incorporated management era and annual climate variables as predictor variables.
- Analysis was restricted to the last 15 years of each era.

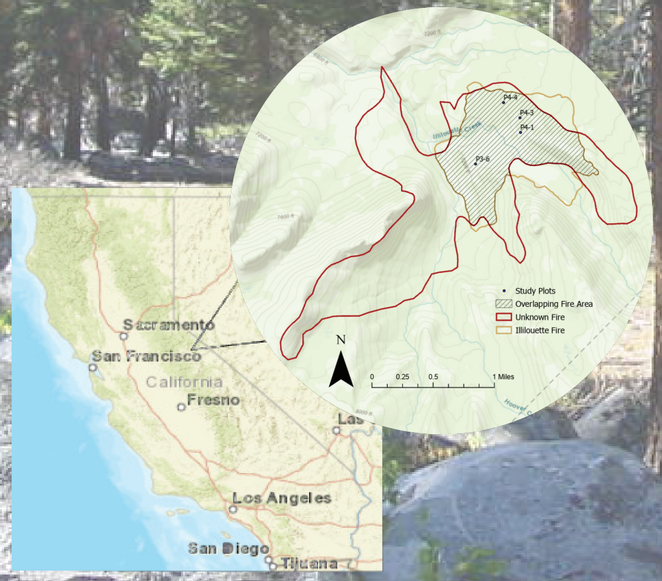

Figure 2 (above):
Study area in the ICB, including plot locations and fire perimeters.

Results

Results of the linear model ran for *Abies concolor* show:

- BAI was most strongly correlated with maximum April temperatures and management era.
- As maximum April temperatures rose, BAI decreased.
- There was a statistically significant difference ($p < 0.001$) between growth rates during fire suppression and WFU eras.

Results of the linear model ran on *Pinus jeffreyi* show:

- BAI was most strongly correlated with management era
- There was a statistically significant difference ($p < 0.001$) between growth rates during fire suppression and WFU eras.

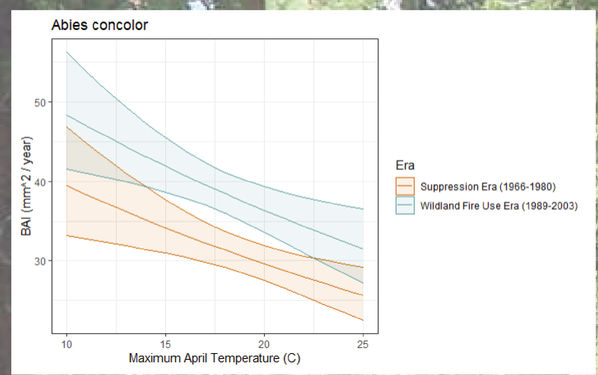

Figure 3 (above):
Results of the linear model ran for *Abies concolor*

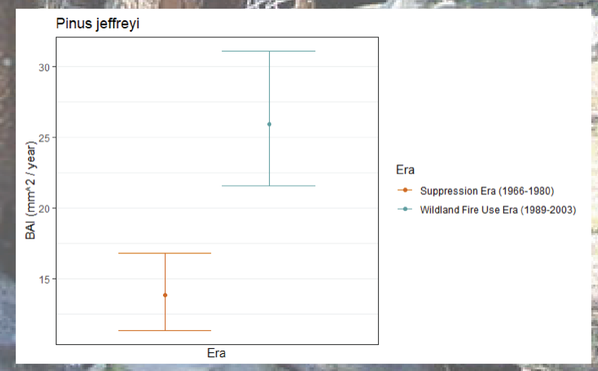

Figure 4 (above):
Results of the linear model ran for *Pinus jeffreyi*

Conclusions

The results of the *Abies concolor* model indicate that increases in spring temperatures can lead to a decrease in annual growth rates. As climate models predict an increase in overall annual temperatures due to climate change, this model suggests that lower growth rates among *Abies concolor* may also be expected. However, because growth rates were significantly larger during the WFU era than the fire suppression era in the ICB, it is speculated that the presence of an intact or restored fire regime may mitigate the effects increasing temperatures on annual growth rates.

Differences in sample size between *Abies concolor* and *Pinus jeffreyi* cores may account for the lack of significance among any climatic variables on the annual growth rates of *Pinus jeffreyi*.

Future Work

This study initially planned to use the annual intrinsic water-use efficiencies of individual trees as an additional method to quantify the physiological response of trees during different management periods. Intrinsic water-use efficiency gives insights to how a plant regulates loss of water from transpiration relative to the uptake of CO_2 for photosynthesis. Quantifying intrinstic water-use efficiency would give insights into how water stressed a tree would be during a given year or time period. However, due to COVID-19, this data was unable to be recorded. Finishing these observations and incorporating them into a linear model may strengthen the power of the existing models.

Finally, increasing the sample size of *Pinus jeffreyi* samples through field collection would give better insights into the responses of the species during these two periods.

Acknowledgements

Many thanks to John Sanders of the Battles Forest Ecology Laboratory for his expertise and assistance in using the J2X and COFECHA programs. Thank you to Ekaterina Rakhmatulina, Zachary Steel, Jean Wilkening, Brandon Collins, and Scott Stephens for their extended support in the development and analysis of this project. I would also like to thank Todd Dawson for use of laboratory space and equipment during the preliminary stages of isotope analysis. Finally, I would like to thank the CNR Sponsored Projects for Undergraduate Research organization for the support and funding for this project.