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Dendrochronological Reconstruction of Fire, Bogus Basin Area Boise National Forest

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Abstract:

Since people have settled along the Boise Front, there have been very few documented fire disturbances. This is likely an outcome of fire suppression policies. There is evidence, visible as scars on living trees, that the old growth ponderosa pines located on the East Side Trail in the Boise National Forest have withstood multiple fires. Samples were collected by using a chainsaw to remove small, partial cross-sections from several trees. The Boise Front master chronology was used to accurately cross-date the fire-scarred samples using COFECHA. Analysis of the samples revealed ten fire events ranging from 1709 to 1889. The fire frequency during this time appeared to be between 15 and 50 years. Understanding past events may help us better understand future fires caused by increasing temperatures and drought. This climate change is projected to impact sagebrush-forest ecotone for the region.

Introduction:

At this time, we do not have a record of past fire disturbance for the region. Dendrochronological methods can use tree ring records to document past forest fires enabling us to fill these gaps in the fire record. Ponderosa pine (*Pinus ponderosa*) forests depend on frequent low-severity surface fires to stimulate new growth and provide access to mineral rich soils while removing competitive growth from other trees and species (Speers 2010). Modern fire suppression policies have increased low-lying brush and highly packed areas of forest duff and pine needles. This accumulation of fuel increases the chance of stand replacing fires. These high-severity fires, also known as crown fires, are where full trees burn; tree mortality resulting from this type of fire is becoming more prevalent (Nijhuis 2012).

It is anticipated that Idaho's mountain forests will be directly affected by global climate change, causing an increase in the frequency and intensity of drought due to increased temperatures. This is known as a global-change-type-drought (Breshears et al. 2005) and is believed to correlate with increased severity of forest fires. In 2012, we witnessed an increase in the number of stand-replacing fires within the Pacific Northwest, including fire complexes covering large areas in Idaho (e.g. Trinity Ridge, Halstead). The Idaho 2013 fire season activity appears to be consistent with previous year's fire severity.

Study Area:

All the samples were collected from two sites two miles apart near the Bogus Basin resort (Figure 1) in the Boise National Forest. The first site is located on the East Side Trail (EST) within the Ridge to Rivers trail system and is a south southwestern-facing aspect. The second site is located on the upper part of the Dry Creek Experimental (DCEW) and is a south southwestern-facing aspect. Both sites are approximately the same elevation and have moderate to steep slopes. The two sites are dry forests sites, ie., dominated or co-dominated by ponderosa pine (Heyerdahl et al. 2008).

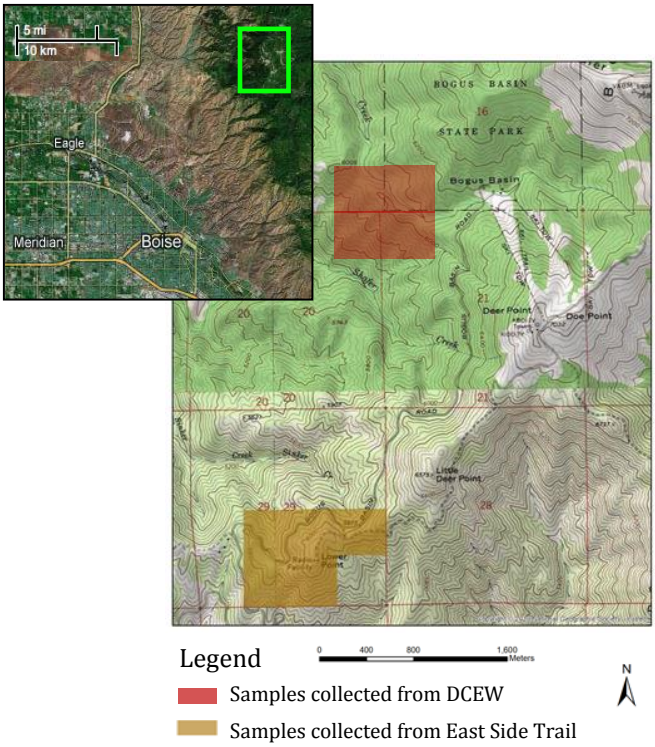

Figure 1. Map showing location of East Side Trail site and Upper Dry Creek Experimental Watershed (DCEW). Sampled trees were on SSW and SSE facing aspect of ridge.

Methods:

After a fire, the pitch in Ponderosa pine trees fills in the thinned portion of the damaged bark that is caused by the burn. Overtime, new growth will begin to form a scar that can be used to analyze past fire events. If there are repeated fires that occur over time, a triangle-shaped scar ("catface") will form on the tree's bark. Catfaces are typically visible at the base of a tree on the uphill facing side. These catfaces can contain multiple scars that can be used to reconstruct the history of fires that affected that tree. The trees that were selected for this study had little indication of rot to minimize the chance of compromised samples.

Partial cross sections of these catface-fire-scarred trees were collected with a chainsaw (Figure 2(A)), cutting a cross-section through one side of the scar to remove it while leaving the tree still standing (Speers 2010; Heyerdahl and Mckay 2012). This technique was developed by researchers with the US Forest Service, and has been used for several decades in fire studies across the western US (Arno and Sneck, 1973). Heyerdahl and McKay (2012) showed that this method does not adversely impact trees over long periods.

Samples were then brought back to the lab, where they were mounted onto plywood. The partial cross-sections were then planed and sanded with an orbital sander using progressively finer sandpaper from 80 – 320 grit. To accurately date the samples, micro-finishing film was used to maximize visibility of individual cell walls.

Figure 2: (A) Collecting a sample from a ponderosa pine with image of tree after removal of wedge. (B) Partial-cross section from East side trail. The Fire-scars are marked by red arrows and the year that the tree was scarred

All samples were visually crossdated and measured using a Velmex system in conjunction with J2X software. We analyzed our data using COFECHA software, using a 32-yr cubic smoothing spline, this compared the information we obtained from our samples to the established tree-ring chronology for the Boise Front (Wilkins and Cutter 2012). This was done to verify the accuracy of our visual dating of the tree rings. The fire-scars were then able to be accurately dated once the confidence in the dated tree-rings was completed (Figure 2(B)).

Results:

COFECHA determined that all of the partial cross-sections from both sites had an interseries correlation ranging from 0.29 to 0.61. Of the seven series (i.e., dated cross-sections) processed, confidence in six of these series is strong; however there was one outlying series whose correlation was 0.29. This series included a problematic section that did not crossdate with established chronology within the time frame between approximately 1650-1700. However, the sample did not have any fire events recorded prior to 1700, and all fire disturbances recorded on the sample after this time correlated with the established chronology. In the non-problematic area, of that sample, the interseries correlation was higher in the dates necessary.

There were three samples collected from EST and all had six recorded fire events. All samples at EST have a fire event at 1878. Since the sample EST.03 only has one recorded fire event this was the only event that correlated with all the samples. The two other samples, EST.01 and EST.02 both also have fire scars in 1829. The oldest sample is EST.01; this sample documents all six events and contains scars representing fires during 1709, 1721, 1739, 1771, 1829, and 1878. The correlation with the establish tree ring chronology was not strong for the 1709 scar as the rings were distorted and difficult to accurately assess.

The upper part of the DCEW, which for this project has been labeled UDC, also had six recorded fire events. There were four samples collected and all have fire-scars in 1846 and 1829. UDC.01 was the only

sample to have the most recent fire in 1889, and was the only sample from this site that didn't include 1883. Record of the fire during 1793 was documented in UDC.01 and in UDC.03. Only UDC.04 records a fire event in 1771.

Ten fire events were documented in both sites analyzed (Figure 3); however the sites appear to have only shared two fire events; during 1771 and 1829. All the fires-scars were damaged on the latewood of these years and are to be considered in the dormant season of growth (late summer, early fall).

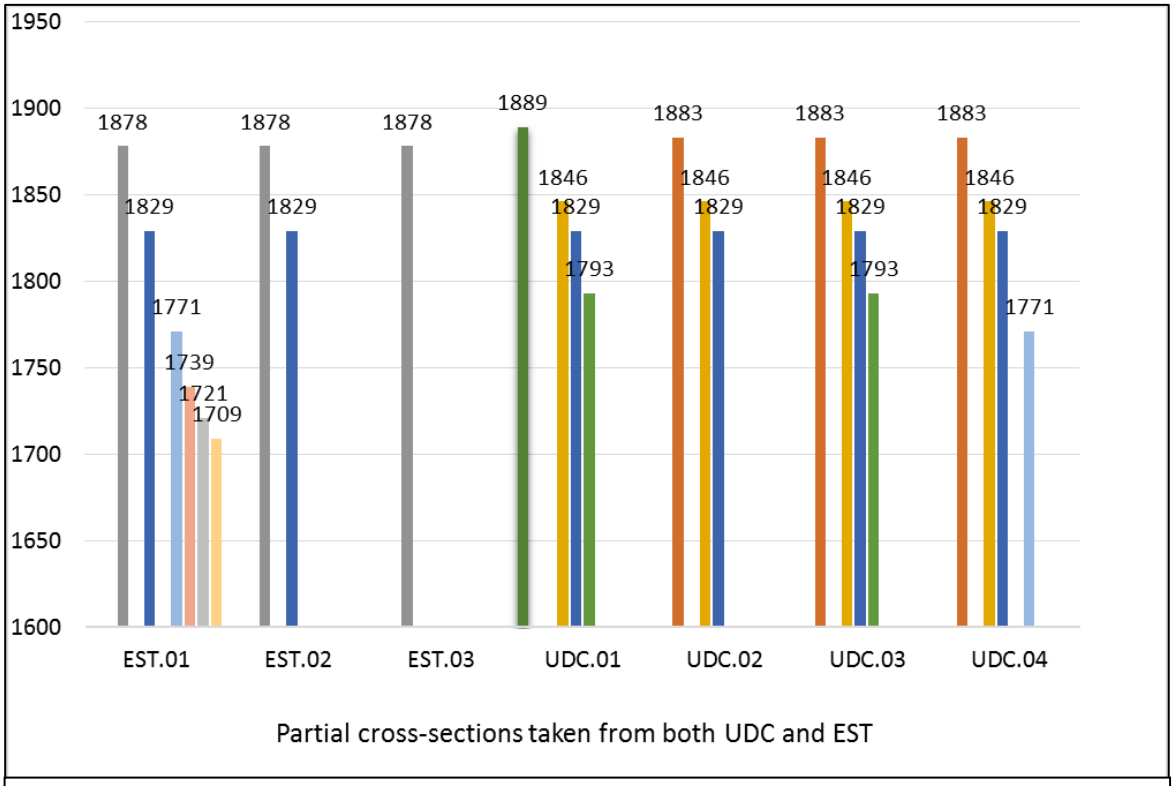

Figure 3: Fire dates for ponderosa pine partial cross-sections collected along the Boise Front.

Discussion:

Using dendrochronological techniques we can see that the most recent fire for the Boise Front was in 1889 and prior to that time there was a fire frequency ranging from 15 to 50 years. This is a much higher fire frequency than that observed since fire suppression policies were enacted. Given that the fires recorded at both sites do not generally correlate, this also suggests spatial patterns of fire on the Boise Front may be patchy rather than contiguous. Past frequent fires were also low lying fires where there was little brush or fuel for the fire. These fires are climate driven in nature and are a result of warmer springs which facilitate early melting of snowpack from previous winters, followed by warm, dry summers (Heyerdahl et al. 2008).

Regional fires related to the Boise Front would likely also occur in other dry forested areas, where regional weather patterns would be similar to that of this area. All fire events recorded of both sites were also previously documented in regional-fires histories from ponderosa-dominated forests (Heyerdahl et al. 2008a). 1889 was only recorded on one partial cross-section in this study, but this fire was the most

prevalent regional fire in Idaho and Western Montana documented in a study analyzing 23 sites (Heyerdahl et al. 2008b).

There was little correlation of fire events among the samples obtained at the East Side Trail site. Some of the ponderosa pine trees in this area did date back as far as 1488. By analyzing a larger sample set, there would likely be a stronger correlation of fire events dating much older than this study.

Conclusion:

Fire-adapted forests such as those dominated by ponderosa pines are experiencing changes in climate and fire frequencies (Keeling and Sala 2012). These forests rely on frequent low-severity surface fires to stimulate new growth. In 2012 and 2013 we have witnessed multiple high severity stand replacing fires. These are likely linked to changes in regional climate, as well as fire suppression policies that have greatly reduced natural fire occurrences. This study has laid the ground work for documenting previous fire frequencies in the Boise Front. Fire history reconstructions can help us understand these changes and can aid in developing more successful fire management policies.

Data compiled during this study has shown that prior to 1889, fires in the Boise Front area were frequent but most likely of low severity. The fire history constructed with these samples correlates with previously documented regional fire events. However, after analyzing these samples, we found there were several fire events that did not correlate with samples obtained from the other location. This leads us to believe that climatic conditions during these times created opportunities for many small, well contained and low severity fires to proliferate in the region.

This fire history reconstruction has improved our understanding of the fire frequencies that occurred before the 20th century fire suppression policies were enacted for the region. This study will also provide a context for understanding future vulnerability of the lower ecotone between semiarid sagebrush and ponderosa forest.

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