

“What Can the Trees of Crater Lake Tell Us?”

Summary

The results of the original project titled “Recent Climate Change at Crater Lake National Park Using Tree-Ring Analysis” funded by the Crater Lake Natural History Association are presented in this document. Though the results of this project are currently not scientifically rigorous to entertain ideas of publication in a scientific journal, the findings are nonetheless of interest to Crater Lake National Park interpreters, the Crater Lake community, and the visiting public. The following document is presented to be the basis of an interpretive program called “What Can the Trees of Crater Lake Tell Us?” The following information about climate change can be coupled with a discussion of whitebark pine issues resulting from blister rust, and issues pertaining to fire exclusion in the forests of Crater Lake. It is important to note that all analysis from this project was based on data collected from mountain hemlock (TSME).

Findings of interest to Crater Lake interpreters and visiting public.

- No obvious increase in annual temperature could be detected from mountain hemlock at Crater Lake.
- Tree growth of mountain hemlock at Crater Lake is most strongly correlated with April 1st snow depth. The more snow on the ground on April 1st the less a tree will grow in the following growing season.
- Tree growth at Crater Lake appears to be surprisingly independent of temperature. Summer temperatures explain only 15% of growth patterns.
- Tree growth at Crater Lake was not correlated with the Oregon state region 3 Palmer Drought Severity Index, a measure of dryness that commonly correlates with tree growth in other regions.
- The dynamic nature of Crater Lake’s weather makes using dendrochronological techniques to be less robust than expected when using univariate (one climatic variable) at a time.
- The findings of this study are similar to responses detected at Mount Rainier National Park with regard to mountain hemlock (Graumlich and Brubaker 1986).
- Highest reconstructed prehistoric snow depth on April 1st 198 inches (16.5 feet) in 1810.
- Lowest reconstructed prehistoric snow depth on April 1st 54 inches (4.5 feet) in 1839.

Introduction

Climate change and “global warming” are currently being discussed in the popular media. They are hot button issues. Telling the climatic story of tree-rings enables the past come to come to life. Tree-rings are a window into the past. They call tell us many stories of what happened before accurate human records were kept. Stored in their rings are records of past events such as floods, droughts, insect attacks, lightning strikes, avalanches, and climate.

The purpose of study was to answer basic questions about the interaction of tree-rings (tree growth) and locally generated climate data from Crater Lake National Park. It was hypothesized that a localized warming trend could be detected from trees cored at Crater Lake.

Methods

Tree-ring data was obtained from the International Tree Ring Database, a public repository for tree ring data archived by the National Oceanic and Atmospheric Administration (NOAA). Data can be downloaded free of charge by visiting the URL – <http://www.ncdc.noaa.gov/paleo/ftp-treering.html>. The data used for this project was contributed by Briffa et al (1992). The data submitted by Briffa et al (1992) was based on standard dendroecological techniques (Stokes and Smiley 1968; Fritts 1976).

Snow depth, precipitation, and temperature climate data were compiled from the Crater Lake headquarters weather dataset. The Crater Lake headquarters dataset is complete from 1947 to present. It is one of the most complete and thorough climatic datasets especially with regard to snow depth data available in Oregon and Washington (Peterson and Peterson 2001). Palmer Drought Severity Index data for Oregon Region 3 was obtained from NOAA, from their climate data website (<http://lwf.ncdc.noaa.gov/oa/climate/onlineprod/drought/xmgrg3.html>). Palmer Drought Severity Index, is a measure of relative dryness, and is often used in tree-ring reconstructions as a proxy for precipitation data (Cook and Meko 1999).

The tree-rings widths are responding to a climate variable. Bivariate scatter plots were constructed for tree growth versus local climate data to determine which climatic variables most strongly are associated with tree growth. 57 scatter plots were constructed to analyze the relationships between climate variables and tree growth. The scatter plots demonstrated a spectrum of strength of correlation between the climatic variables and tree growth. Only those variables with the highest degree of correlation were considered for future analysis.

Once the climatic variables are isolated then they can be “backcast” into a climatic reconstruction for the most sensitive climate variables. A statistical model was created based on the relationship from the meteorological data and tree-ring widths (Fritts 1976).

Results

The bivariate scatter plots indicate the strongest relationship between climate variables and associated tree growth is April 1st snow depth. It was determined that April 1st snow depth explains nearly 30% of the tree growth for the following growing season for Mountain Hemlock (TSME). Palmer Drought Severity Index, precipitation, and temperature yielded weaker correlations. February precipitation (liquid form) explains 23% of tree growth. Tree growth at Crater Lake appears to be surprisingly independent

of temperature. Summer temperatures (average of June, July, and August) explain 15 % of growth patterns. Palmer Drought Severity Index explains 5%-15% of tree growth.

Since April 1st snow depth exhibits the strongest relationship this variable was used to “backcast” past snow depths (Figure 1). The highest reconstructed prehistoric snow depth on April 1st was 198 inches (16.5 feet) in 1810 while the lowest reconstructed prehistoric snow depth on April 1st was 54 inches (4.5 feet) in 1839.

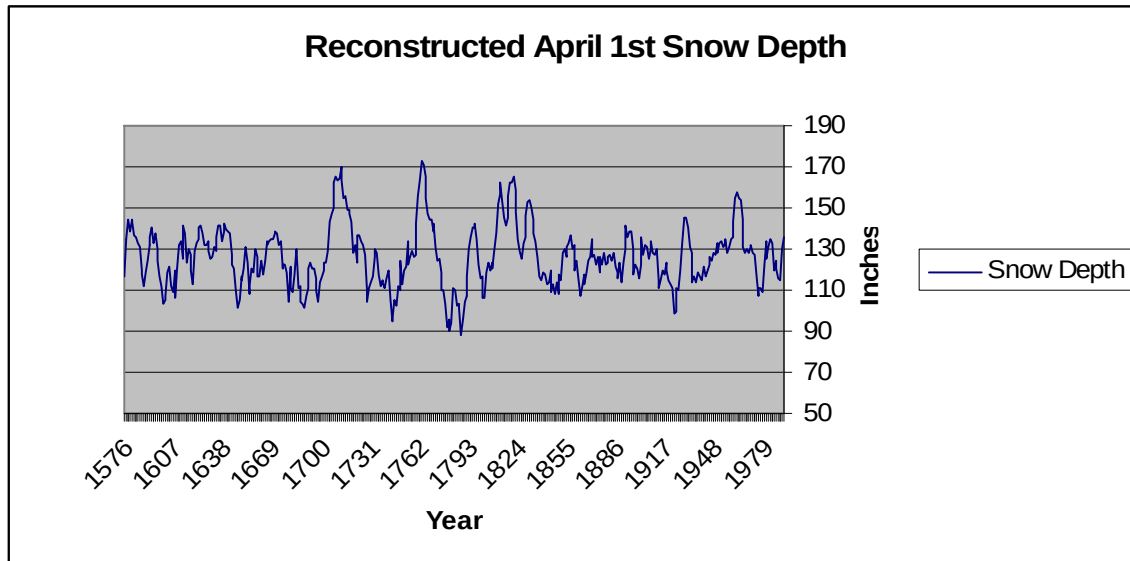


Figure 1. Reconstructed April 1st snow depth for Crater Lake National Park based on dendrochronological analysis for the time period of 1564-1979. The data has been smoothed via a 5 year moving average.

Conclusions

Frequently, dendroclimatic investigations find that temperature and precipitation are the controlling variable and hence these variables are reconstructed (Briffa et. al 1992; Graumlich 1993; Peterson et al 2002; Szeicz and MacDonald 1995). The trees at Crater Lake exhibit a much more complex response to climate. Temperature at Crater Lake does not exert a strong enough of a relationship with tree growth to assert any conclusions regarding “global warming.”

April 1st snow depth and February precipitation (liquid form) explain much of tree growth. These metrics may be closely allied with each other considering the vast majority of February precipitation falls primarily as snow and would then contribute to April 1st snow depth. April 1st snow depth is negatively correlated with tree growth, in other words the more April 1st snow depth the less a tree is likely to grow in the following growing season.

References

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