University of Utah

UNDERGRADUATE RESEARCH JOURNAL

RECONSTRUCTING A FIRE HISTORY RECORD AND DISTURBANCE PATTERNS FOR A HIGH ELEVATION SITE IN THE NORTHERN ROCKY MOUNTAINS

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Background and Introduction

The fire history of an area can be reconstructed using documented fire history records such as fire atlases, analysis of dendrochronological data such as fire scars and stand ages, or by charcoal records which are derived from lake sediment cores (Brunelle and Whitlock, 2003). A fire return interval can be best determined based on analyzing charcoal particles recovered from lake sediment coring. Whitebark pine (Pinus albicaulis) forests occupy the highest elevations of Rocky Mountain forest growth from Southern British Columbia to western Wyoming as well as along the Cascades into Northern California and have occupied this range for approximately 8000 years (Arno, 2000; Ellison et al., 2005). Extensive forests of whitebark pine developed after glacial retreat and as warming continued from 8000 to 4000 years ago, became strictly a high elevation pine type (Ellison et al., 2005).

In the Rockies, whitebark pine forests occupy over 1,000,000 hectares and fires are usually identified as mixed severity, occurring at 80-500 year intervals (Keane et al., 2002). Major fires in the whitebark pine type are mostly confined to late summer in dry years (Arno, 2000). Whitebark pine is a long-lived species that can survive to reach over 400 years of age but are still a seral species and without fire, whitebark pine forests are eventually replaced by subalpine fir and spruce (Keane et al., 2002). When subalpine fir encroaches on whitebark pine stands, risk for stand-replacing fires is greatly increased due to multilayered canopies, increased crown bulk, and low crown base heights. Fire exclusion in whitebark pine ecosystems will eventually cause conversion of a mixed-severity fire regime to a stand-replacing fire regime, causing for both higher intensity and higher severity fires (Keane et al., 2002). However, after a high elevation burn, whitebark pine is likely to be established first due to its hardiness and its advantage of having its seeds stored in caches by Clark's Nutcracker, a passerine bird in the family Corvidae. Still, little is currently known about human-induced changes regarding ecological succession patterns in this high elevation type (Arno, 2000).

Research suggests that intact fire regimes are vital to nutrient cycling and soil health in the Northern Rocky Mountains and fire exclusion and suppression, which causes a decline in whitebark pine, a fire adapted keystone species, can negatively impact fauna in ways such as reducing the carrying capacity for elk due to reduction in quality browse plant species. Whitebark pine dominance also impedes snow melt at high elevations and benefits the quality of undergrowth forage due to the typically open canopy of whitebark pine stands. This forest type is easily susceptible to other factors such as blister rust (Cronartium ribicola), which speeds succession to grand fir, western red cedar, and western hemlock, making this forest type difficult to restore (Keane et al., 2002). Fire may be even more critical for the overall survival of whitebark pine since the introduction of blister rust. Reconstructing a fire history for Phyllis Lake Idaho, USA will help contribute to a further understanding of past fire regimes, allowing for better stewardship of this high elevation pine type when considering future forest management practices.

This research is part of a larger project that uses proxy data to investigate Mountain Pine Beetle outbreaks and fire disturbance in the Northern Rocky Mountains. This research contributes to the larger project by adding a Whitebark pine dominated site to the existing data for the area. A measure of fire occurrence frequency is known as a fire return interval. A fire return interval can be best determined based on analyzing charcoal particles recovered from lake sediment coring. Research suggests that intact fire regimes are vital to nutrient cycling and soil health in the Northern Rocky Mountains. Fire exclusion and suppression, which cause a decline in Whitebark pine, a fire adapted keystone species, can negatively impact fauna in ways such as reducing the carrying capacity for elk due to reduction in quality browse plant species.

Research Methods

Field Work: Field methods included collecting both a short sediment core from the water sediment interface to 93 cm depth and a long sediment core (61 cm – 231 cm). Coring for these depths allowed for 32 cm of overlap in sediment samples. A Livingston coring device was used to collect the long sediment core, which in combination with the short coring device allowed for sediment to be recovered from the water sediment interface all of the way down to the bedrock in the lake bed.

Lab Work: The sediment cores were sub-sampled at one-cm intervals and sieved for plant and charcoal macrofossils. The charcoal particles ranged from >125µm to >250 µm in size were analyzed during the Fall of 2017 and Spring of 2018. All 231 sediment samples were tested for magnetic susceptibility using a Bartington magnetometer. Selected samples were sent to a lab for plutonium dating, which allowed the creation of an age model for the first 20 cm of sediment.

Preliminary Results

The preliminary charcoal data for the top 93 cm of sediment exhibit a charcoal peak at 46 cm depth, indicating one or more large fires. The rest of the record is punctuated by numerous smaller peaks in charcoal. There is a peak in magnetic susceptibility between 55 cm and 65 cm that may indicate an erosional event during that period. The preliminary age model derived from plutonium dating indicates a resolution of 3-5 years per cm in the upper sediments.

Next Steps:

- The remaining 138 cm of sediment will be analyzed for charcoal.
- Char Analysis software will be used to help draw conclusions regarding possible meanings of charcoal data.
- Selected samples will be submitted for radiocarbon dating, which will allow for creating a more detailed age model for the entire record.
- Pollen data will be used to reconstruct vegetation change over time.