Northwest Fire Science Consortium
A JFSP FIRE SCIENCE EXCHANGE NETWORK

UNDERSTANDING CLIMATE AND HUMAN IMPACTS ON HISTORICAL FIRE REGIMES IN THE PNW

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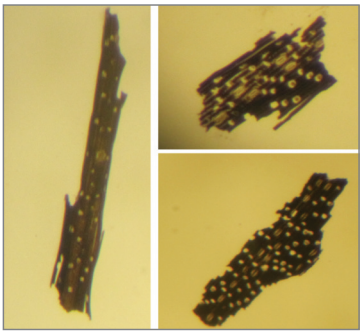
As fire is increasingly used as a restoration and management tool throughout the Pacific Northwest (PNW), it is important to understand the factors influencing historical fire regimes. For ecosystems with long histories of human activity, this requires looking beyond the past 200 years, when Euro-American disease and settlements reduced the majority of the Native American influence on the landscape. Paleoecological records provide reliable information on vegetation change and fire history, but these records should be balanced with archaeological, ethnographic and historical information for areas where fire regimes are influenced by both ecological and anthropogenic drivers.

Photographs of Fish lake taken ca. 1906 (top: F. Matsura) and 2006 (bottom; D. Swedberg), looking east. Note the dramatic increase in tree cover that has occurred on the south shore of the lake over the last 100 years.

In this study, researchers used an interdisciplinary approach to investigate the historical fire-climate-human relationships that have shaped two regions in the PNW: Lake Oswego, at the north end of the Willamette Valley in Oregon, and Fish Lake, at the southern end of the Sinlahekin Valley in Washington. They addressed three specific objectives with their work: 1) Use macroscopic charcoal and pollen analysis of lake sediment cores to reconstruct the late Holocene fire and vegetation histories at sites with rich archeological records; 2) Evaluate the fire histories within the context of known climatic and human influences, using paleoclimatic, archaeological, ethnographic, and historic records; 3) Identify charcoal morphotypes to better interpret the charcoal-based fire history.

Researchers collected sediment cores from each lake and pulled macrofossils and twigs from the cores for radiocarbon dating. They determined organic and carbonate content; conducted pollen analysis for aquatic taxa, tree, shrub and herbaceous species; and conducted macroscopic charcoal analyses to determine concentration of woody vs. herbaceous material and charcoal accumulation, or influx, rates (which reflect relative fire frequencies).



Photos of herbaceous charcoal taken from sediment cores. Note the presence of stomatal openings. Photo: Megan Walsh.

KEY FINDINGS

- Macroscopic charcoal and pollen analysis of sediment cores allowed for reconstruction of the vegetation and fire histories of two distinct PNW sites over the last 3300+ years.
- Identifying charcoal morphotypes allowed researchers to determine that historical fires around Lake Oswego burned primarily woody material, but that the majority of the Fish Lake area fires were low severity, consuming primarily herbaceous material.
- An interdisciplinary approach to evaluating fire histories provided a more robust and accurate understanding of the human-vegetation-climate relationship.

The Northwest Fire Science Consortium is a regional fire science delivery system for disseminating knowledge and tools, and a venue for increasing researcher understanding of the needs of practitioners.

RESULTS

Lake Oswego. The Lake Oswego core was dated to 3340 calendar years before present (cal yr BP). The historic vegetation could be summarized into five general timeframes: 1) 3340 to 1200 cal yr BP: Douglas fir (*Pseudotsuga menziesii)* and western red cedar (*Thuja plicata*) dominate. The proportion of trees and shrubs is around 80%; 2) 1200 to 1050 cal yr BP: Red alder (*Alnus rubra*) and bracken fern (*Pteridium aquilinium*) increase in abundance and trees decline to 65%; 3) 1050 to 850 cal yr BP: Trees and shrubs increase again to 86%, with *P. menziesii* at its highest level (~37%); 4) 850 to 100 cal yr BP: All conifers decline, and many understory species increase; 5) 100 cal yr BP to present: Tree and shrub species increase to 88% and many herbaceous taxa drop out.

Charcoal influx values were low from 3420 to 2000 cal yr BP, then generally increased until 750 cal yr BP. The influx values were quite variable for the following 500 years, eventually dropping to near zero by 200 cal yr BP and remaining low until present day. The proportion of charcoal identified as herbaceous in the Lake Oswego sample was generally low (avg = 8.2%), with the lowest proportion occurring in the last 200 yrs.

The largest increase in fire frequency from 1200 – 700 cal yr BP does not coincide with any large changes in climate but it does coincide with the largest historical indigenous human population in this region. Archeological evidence suggests that the Lake Oswego region was utilized as far back as 9,000 cal yr BP, with upwards of 15,000 Chinook Indians living along the lower Columbia River Valley. The Chinookan and Kalapuyan people used fire to increase yields of Garry oak (*Quercus garryana*) acorns, camas (*Camassia* spp.) bulbs, bracken fern (*Pteridium aquilinum*), and to open prairies to support game animals. The dramatic shift in vegetation 200 years ago was driven by the devastating effects of introduced European diseases, which killed over 80% of the indigenous population in the Columbia River Valley by the early 1800s, and, consequently, eliminated all human-set fires in the region.

Fish Lake. The Fish Lake core was dated to 3780 cal yr BP. The pollen percentages were fairly consistent throughout the entire record, with the exception of the past 100 yrs. *Pinus* spp. pollen made up 45%-65% of the total pollen throughout the record, with evidence pointing to *Pinus ponderosa*, which still dominates the site today. Pollen from several other tree, shrub and herbaceous species were found throughout the record, with high percent trees and shrubs the entire time (85-95%).

Charcoal influx values were low and variable until about 1200 cal yr BP, when they generally increased until 180 cal yr BP, after which they sharply declined to near zero today. The proportion of charcoal identified as herbaceous in the Fish Lake sample was high (avg 59.3%) throughout the entire record.

There were no clear climate-vegetation patterns at the Fish Lake site and prior to 1200 cal yr BP the fire activity was fairly low and stable. Since 1200 cal yr BP, fire frequency increased, regardless of large-scale climate variability. The disappearance of fire from the sediment records occurred about 75 years before organized wildfire suppression efforts began in the early 1900s. Regional archeological data show that the indigenous people from the Okanagan region were complex hunter-gatherers, moving seasonally across elevations to access different resources. Archaeological and demographic research shows that human populations increased after 4000 yr BP, peaking between 1800 and 800 yr BP, which coincides with the increase in fire activity around 1200 cal yr BP. Fire was used to encourage food plants, open trails for trade routes, and increase browse for game animals. Similar to Lake Oswego, fire activity declined precipitously with the arrival of Euro-American diseases (around 1770), and reached near zero by the mid 1800s, when Euro-Americans began settling in the Sinlahekin Valley.

MANAGEMENT IMPLICATIONS

The charcoal content and influx rates from the two lakes suggest that fire was a frequent disturbance in both landscapes over the last 3500 years, up until Euro-American contact. Climate fluctuations alone throughout the late Holocene do not explain the dramatic shift in vegetation from closed forest to open woodland/savannah, especially at the Lake Oswego site. Pairing archeological, ethnographic, and historical data with paleobotanical data provided additional context for interpretation of the human influence on fire frequency of this region. This interdisciplinary approach generated valuable insight into the role of humans in land management and prompts opportunities to re-engage and incorporate traditional ecological knowledge in current-day management. Additionally, evaluation of different charcoal sources (herbaceous, trees, shrubs) provided information on the relative severity of past fire regimes that maintained these ecosystems. Fire managers can use this information to guide prescribed fire application to achieve restoration and conservation outcomes.

MORE INFORMATION

This brief is based on the following article:

Walsh, M. K., H. J. Duke, and K. C. Haydon. 2018. Toward a better understanding of climate and human impacts on late Holocene fire regimes in the Pacific Northwest, USA. *Progress in Physical Geography 42*(4): 478-512. doi: https://doi.org/10.1177/0309133318783144.

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