# Three Centuries of Fire at Vaseux Lake

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## Restoration and Fuels Management in a Changing World

Global climate change has the potential to bring the world's forests into uncharted territory. In western Canada, where wildfire is a prominent disturbance, altered global circulation patterns could bring about novel and unpredictable changes to the frequency, intensity, and extent of future fires, with corresponding implications for vegetation dynamics, resource values, and community safety. In the face of challenges to come, focusing on ecological resilience, rather than a rigid set of "reference conditions," has emerged as a framework for managing forests proactively into an uncertain future.

The cornerstone of resilience in fire-maintained ecosystems will be understanding fire as a disturbance process, and how forest structure and composition are shaped by fire patterns. One of the most valuable tools for illuminating these relationships is fire history research. By examining past fire frequency, severity, and variability, and how these relate to forest dynamics, researchers can learn about fire as a disturbance process at local, regional, and continental scales. Although conditions in the future may have no analogue, historical fire regimes may be the most relevant platform for anticipating how fire-forest relationships will evolve as climate changes.




## Indigenous Land Stewardship and Fire Dynamics

One important, but often ignored, driver of past fire regimes is indigenous traditional land stewardship. Indigenous peoples have inhabited western Canada for thousands of years, and many utilized fire to care for and cultivate the landscape. In the southern Okanagan, the *Syilx* peoples have shared that fire was an integral component of their traditional land stewardship, and that they burned frequently in both the spring and fall, to promote the growth of important plant species, enhance wildlife habitat, and to cleanse the landscape. If forests in the Okanagan have developed in the presence of traditional burning, then modern lightning intervals will not be a sufficient baseline for restoration programs designed to emulate historical fire regimes. The forest that would have existed without humans becomes irrelevant if we wish to manage for wildlife, plant communities, and ecosystem services that are present on the landscape today because of human land stewardship over millennia.

# Fire History at Vaseux

The Westside Unit of the Vaseux-Bighorn National Wildlife Area is a biodiverse landscape with many values at stake. The property lies within the traditional territory of the *Syilx* peoples, known collectively as the Okanagan Nation Alliance. Archeological data and oral histories indicate that a *Syilx* village was located within the study area, and the area is of immense cultural value. Starting in the early 19th century, trade traffic passed through the property on the "Old Brigade Trail," and later a spur of the Kettle Valley railway was constructed along the same route.

Using fire-scars and forest demography data, our research reconstructed the historical fire regime of the west unit of this dry forest and grassland protected area, to answer the following questions:

- *How frequent, severe, and variable were past fires?*
- *How did past fires influence forest structure and composition?*
- *What was the relative influence of human history, local topography, and climate in driving the historical fire regime?*

We sampled and crossdated 148 fire-scar discs and 430 increment cores from 43 plots, reconstructing fire history from 1714 – 2013.


**Top: collecting a fire scar sample.**

**Bottom: fire-scarred trees provide evidence of surface fires. The location of the fire scar within the annual growth ring reveals not only the year but also the season of the past fire event.**

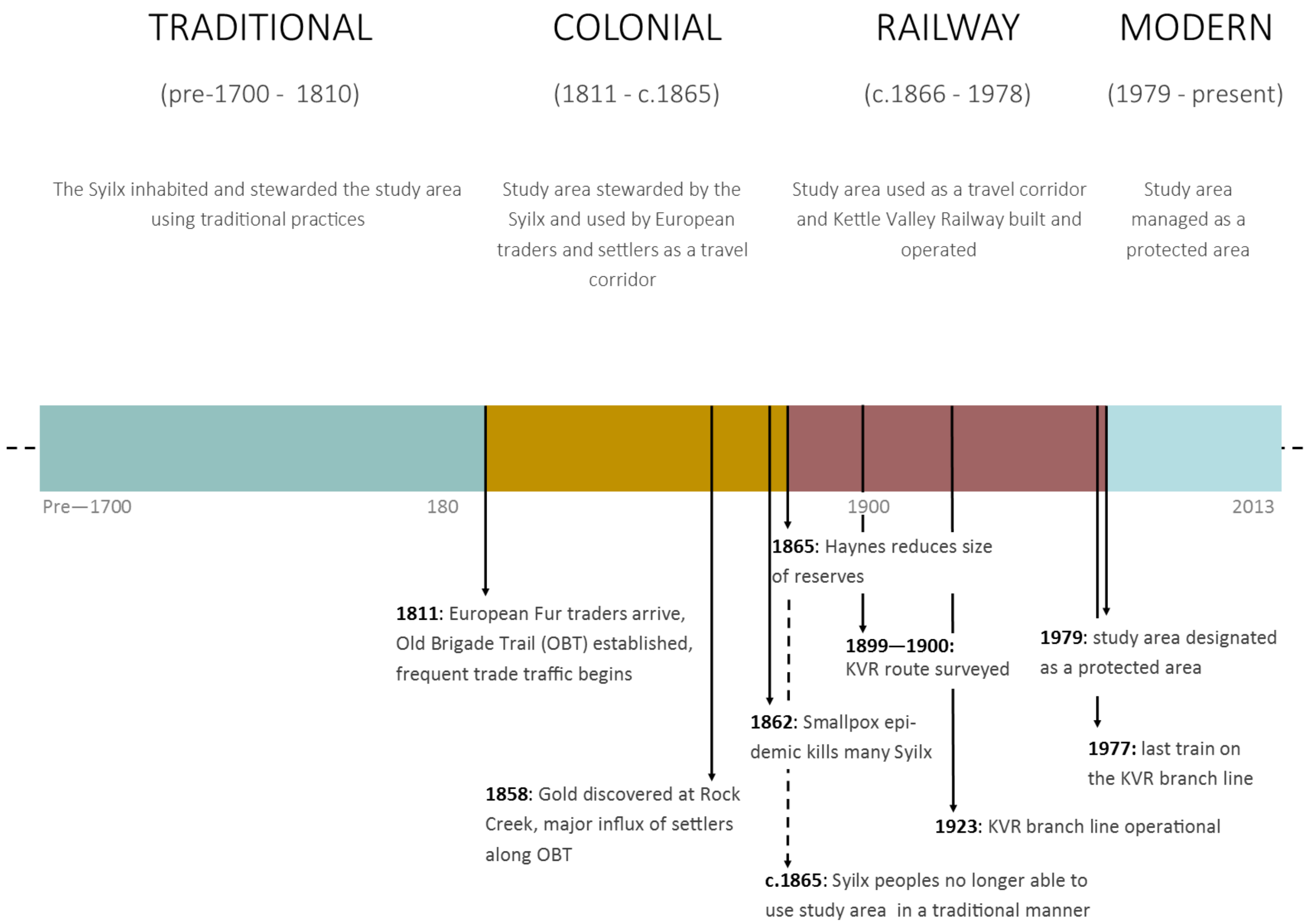
# Frequent Mixed-Severity Fires

Fire scars and post-fire cohorts revealed that historical fires were frequent and were of mixed-severity in time and space. From 1714 – 2013, 34 fires burned in the study area at an average interval of 8 years. Thirty percent of fire events were recorded as both fire scars and cohorts (mixed severity in space), and 70% of plots recorded a cohort for at least one fire event and only fire scars for other events (mixed severity in time).

The historical fire regime varied not only in severity but also in the interval between fires. At the plot level, fire intervals ranged from 3 – 145 years, while at the study area level, intervals ranged from 3 – 31 years. The last recorded wildfire in the study area occurred in 1970, and the time since this event exceeds any prior interval recorded.

# Indigenous Burning Drove the Fire Regime

Multiple lines of evidence suggest that indigenous traditional burning was the primary driver of the historical fire regime. Fires were more frequent, more synchronous, and burned earlier in the season when the *Syilx* were stewarding the study area traditionally. In the mid-19$^{th}$ century, European colonialism brought disease and forced

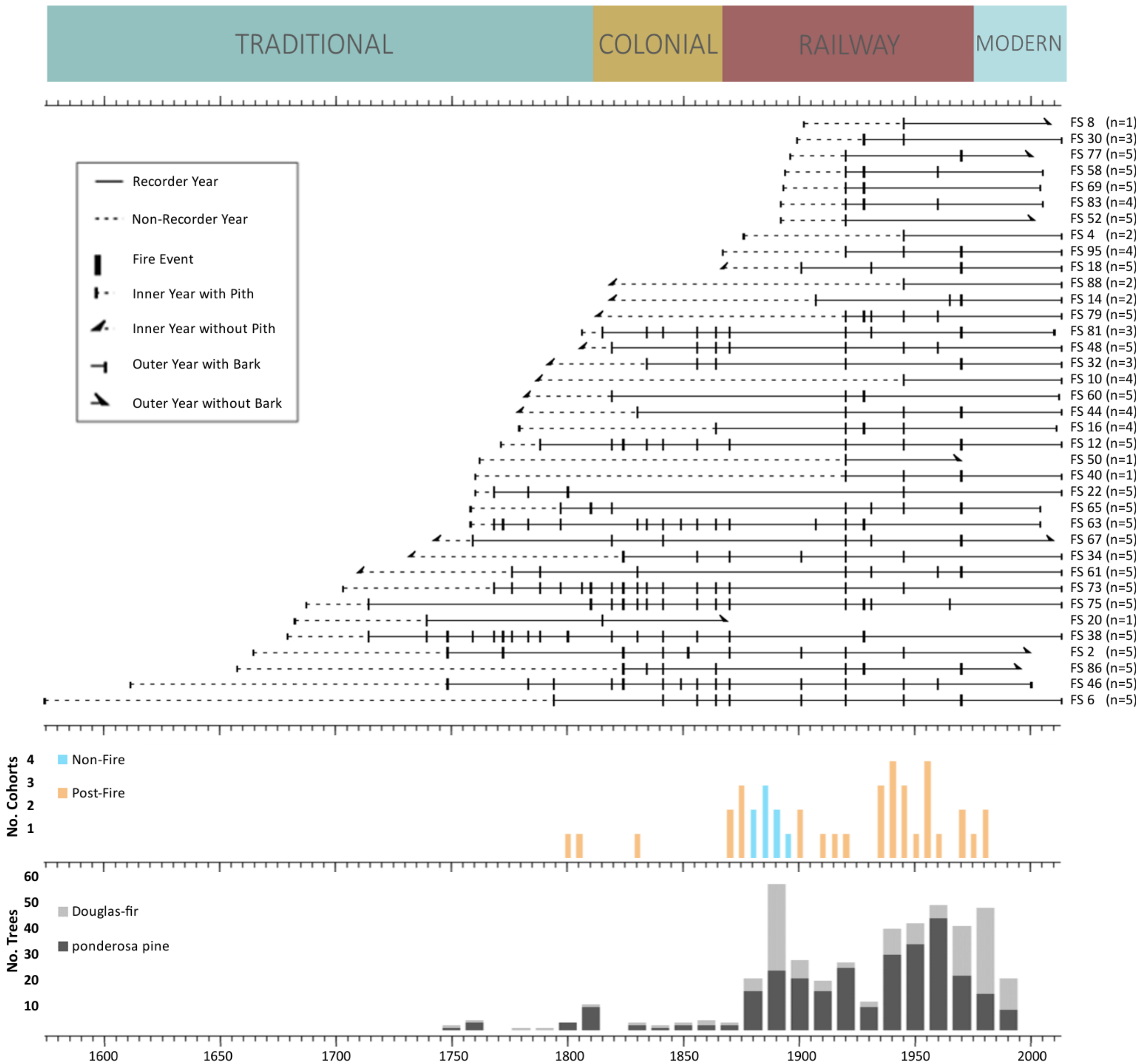



**We compared fire frequency, seasonality, and synchrony among the above eras, to assess whether changes in fire patterns coincided with shifts in land use. We used logistic regression to test whether fires were statistically more likely during any of the above eras, as well as two broader eras, corresponding to the period before and after the *Syilx* peoples were displaced from the study area. Fires were over twice as likely when the *Syilx* were stewarding the study area traditionally, and this result was statistically significant.**

the *Syilx* onto reserves, after which fire was absent across the study area for 48 years in all but 7 plots, in which the gap was 29 years. It wasn't until a spur of the Kettle Valley Railway was surveyed and installed in the study area in the early 20$^{th}$ century, bringing a novel potential ignition source, that fires resumed—though frequency never rebounded to pre-colonial levels. Topographic factors, such as elevation, slope steepness, and aspect were not significant controls of past fires, as would be expected if lightning were the primary ignition source, further supporting the conclusion that past fires were largely anthropogenic. Although lightning is common in the Okanagan region at large, the study area is located in the valley bottom, and at the base of a prominent cliff system, making lightning ignitions within the study area relatively infrequent.

## Fire-Climate Relationships Changed with Human History

We also found that fire-climate relationships differed among land-use eras, lending further evidence to the conclusion that many historical fires were anthropogenic. When the *Syilx* were stewarding the study area traditionally, fires occurred during a variety of climatic conditions, and were not more likely during inter-annual and decadal scale



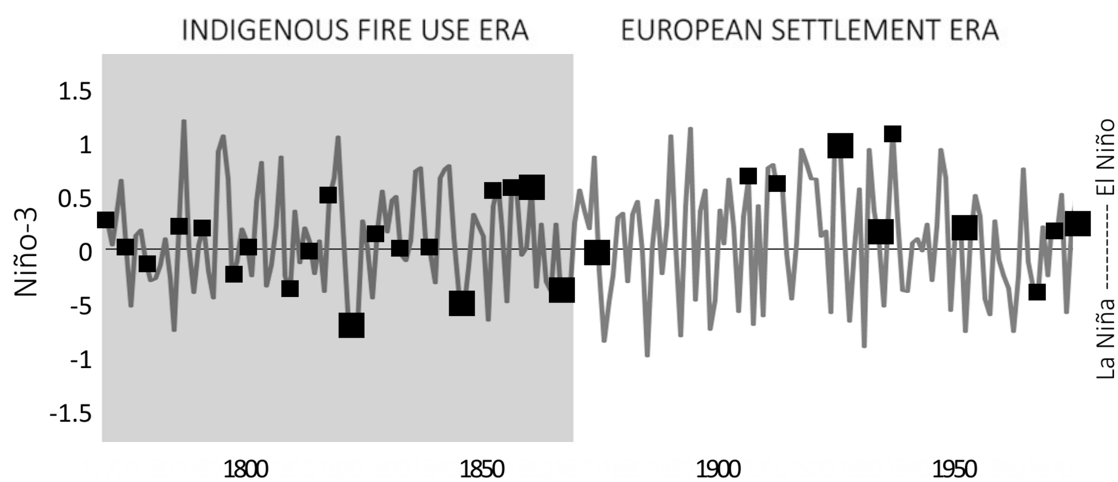

**Top: the upper panel in the diagram shows the distribution of fire scar evidence in relation to the human history of the study area. The colored blocks correspond to land-use eras identified on the previous page. Rows in the chart below the timeline represent plots of fire-scarred trees, while vertical bars indicate fire events. When bars are close together on the horizontal axis, this indicates frequent fires. When bars are close together on the vertical axis, this indicates synchronous fires.**

**Middle: this panel summarizes cohorts identified from forest demography data. Orange bars indicate post-fire cohorts, while blue bars indicate cohorts initiated by a combination of favorable climatic conditions and a gap in surface fires. Post-fire cohorts form when a higher-intensity fire kills canopy trees, and releases sufficient growing space to initiate an even-age group of seedlings. These can be used to infer higher-severity fire effects.**

**Bottom: This panel summarizes the age structure of the forest, reconstructed from increment cores. Few trees established and survived prior to 1870, likely as a result of frequent fires. As fire frequency declined in the late-19th and 20th centuries, a greater number of seedlings were able to grow to fire-resilient size classes and survive to the time of sampling.**

droughts. After the *Syilx* were displaced from the study area, in contrast, fires were associated with warm/dry El Niño conditions.

The El Niño-Southern Oscillation (ENSO) is a phenomenon where coupled changes in surface air pressure and sea-surface temperature in the tropical Pacific Ocean affect global circulation patterns. ENSO has been linked to fire occurrence in many parts of Western North America, including the Pacific Northwest, where El Niño years typically bring warm/dry winters and springs. Warm/dry winters are thought to cause a shallower snowpack that melts earlier in the spring, priming fuels for burning earlier in the fire season. That fires were associated with El Niño conditions after the *Syilx* were displaced, but not before, lends support to the conclusion that their traditional burning was the primary driver of the historical fire regime. Fire Keeper Annie Kruger has shared that the *Syilx* burned based on seasonal weather and fuels conditions on the ground, and that they lit fires when they knew they could control them to bring about desired effects on the landscape. Traditional burning would not necessarily be associated with inter-annual and decadal scale droughts, as these are precisely the times when fires would be hardest to control, and when burn severity would be maximized. After the *Syilx* were displaced, however, fires were probably started by lightning and accidental ignitions from travelers and the railway, which would be most likely to spread and scar trees during hot and dry conditions.

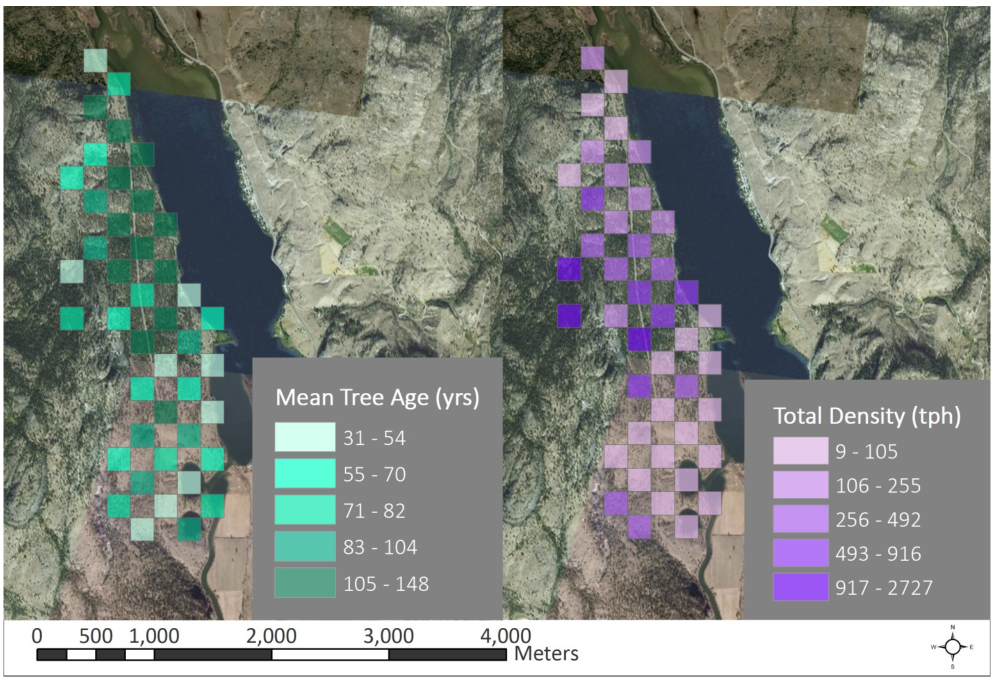



**Squares represent fire events, and large squares represent fire events that scarred trees in ≥ 20% of plots. The Niño-3 Index reconstructs ENSO conditions for historical time series. El Niño years typically bring warm/dry conditions to the Pacific Northwest region.**

## A Young, Complex Forest

The majority of trees in the study area established in the 20th century. Combined with the fire record and presence of a grassland plant community in the understory, these lines of evidence suggest that the study area was formerly a parkland with far less tree cover, and that reduced fire frequency in the 20th century has allowed infilling to occur.

The forest within the study area varied considerably in density and age, and this heterogeneity can be linked to the historical mixed-severity fire regime. Frequent surface fires promoted an open forest structure by killing seedlings and saplings not yet large enough to be resilient, and enhancing the competitive advantage of grassland species that are highly fire-adapted. Trees that survived multiple fires due to their thicker bark continued to grow to become canopy veterans, often with decadent crown shapes that are valuable to multiple wildlife species. At the same time, local stand-replacing effects within fire events, and occasional fire events of higher-severity, liberated varying amounts of growing space across the landscape, encouraging a heterogenous forest to develop over time. The ecosystem at Vaseux developed in the presence of fire, and preserving the ecological and cultural values present on this landscape is contingent upon maintaining fire as a process there. Many portions of the study area are already far denser than they were historically, and future fires could burn with higher intensity, and be more difficult to control as a result. Continued infilling could shift the fire regime outside the historical range of variability, towards a much greater component of high-severity fire effects.




**Douglas-fir and ponderosa pine trees ranged in age from 22 to c. 265 yrs, and average tree age was 87 yrs. Density at the plot level also varied considerably, ranging from 10 – 2727 trees per hectare (prior to thinning and burning treatments that took place in 2004 and 2013). The average post-thinning density, reflective of the current aerial fuel load, was 293 ± 539 tph. This heterogeneity in forest structure is reflective of the mixed-severity fire history of the study area, though many stands may be far more dense today than they were historically, due to less frequent fires in the 20th century.**

## Management Suggestions

The results of this study support the management direction that the Canadian Wildlife Service has already undertaken: to utilize prescribed burning and thinning to restore and maintain frequent fire at Vaseux. The reconstructed fire record can provide a locally-specific template for emulating the historical fire regime, and provide a guideline as to past fire severity and variability. Prior to the *Syilx* being displaced, fires burned at an average interval of 7 years and intervals varied between 3 – 25 years. We recommend that CWS utilize these metrics as a baseline, but caution that variability may be the cornerstone of maintaining ecological resilience at Vaseux. We recommend that CWS vary the interval between

treatments, as well as the severity within and among treatments. A program of this nature will not only emulate the historical fire regime, but is also most likely to maintain a complex forest structure that is resilient to future disturbances in a changing world.

The results of this research also underscore that the indigenous people of the Okanagan have a tremendous amount of knowledge to offer surrounding fire ecology and fire use. Ecological restoration at Vaseux should reflect indigenous traditional practices to be successful in emulating historical fire dynamics and restoring biodiversity and wildlife habitat to the landscape.

## Acknowledgements

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