The missing human factor: examining the devaluation of Indigenous fire use in Anishinaabe homeland

Lucy Lipscomb, Laima Liulevicius, Kjersten Peterson, Annie Warren

Background

Traditional fire knowledge

Ecology in Western science has historically viewed ecosystems as pure, 'natural' systems. Nature, here, refers to a mythologized and objectified Nature that is separate from and unaffected by humans (Kristoff, 2019). The removal of humans from being considered a part of nature is a colonial ideology- not a scientific fact (see Vinyeta, 2022)- that perpetuates the erasure of Indigenous people whose ecological knowledge and practices have shaped the American continent since time-immemorial. The environmentalist's and conservationist's idea of 'wilderness'- so revered it could nearly be considered a religion- is a fundamentally flawed way of characterizing the natural world (Cronon, 1996). This view is starting to be challenged in Western literature (e.g. Christianson et al., 2022), but it is still pervasive in modern land management policies which continue to ostracize Indigenous communities on colonized lands.

Contrary to Western science, traditional ecological knowledge (TEK) has a holistic view of natural processes that emphasizes the role of humans as a part of nature and the human role as caretaker. Rooted in generational knowledge which has been honed for centuries, it is just as rigorous and valid a way of knowing as Western science methods (Berkes, 2012; Cajete, 2000). TEK is the collective product of many generations living in the same land, and thus produces an intimate, interrelated understanding of the natural world that is missed in the specialization and narrow focus of Western ecological studies. It is traditionally passed down orally, through ceremony, stories, and language, and relies on a deep connection to the land.

There is perhaps no more poignant example of the damage done to ecosystems when Indigenous voices and practices are eliminated than in fire ecology. Within TEK is a rich repository of traditional fire knowledge (TFK). Indigenous people all around the world burn and have a complex understanding of the timing, intensity, impact, and necessity of fire in ecosystems and landscapes (Huffman, 2013). Landscapes like California, where historically large wildfires have been devastating in the last decade, had been managed through TFK for centuries. These record-setting fires are partially attributable to fuel build up, a direct result of the century-long rule of fire suppression policy (Steel & Safford, 2015), which is in direct conflict with traditional fire knowledge.

People burn for myriad reasons, including making openings in the forest to camp and hunt, increasing the abundance of plants used for medicine, food, and basketry, and spiritual ceremony. Indigenous burning creates a mosaic effect, where past fire boundaries overlap and create a patchwork of forest stands of varying ages and compositions that increase the diversity and character of forest plant communities. This important effect not only impacts the availability of plants that are significant and sacred to these people (Lewis & Ferguson, 1988), it creates a more diverse and therefore more resilient forest, making it resilient to future disturbances. Fire has practical, cultural, and spiritual importance in the Indigenous way of life. TFK is a strong argument for putting people back into the fire regime of forests; allowing tribes to burn in their ancestral homelands, as their ancestors did, is a significant step towards decolonization.

The Anishinaabe people, which include the Ojibwe bands of Minnesota, have their own heritage of TFK. However, loss of culture perpetrated by genocide, forced relocation, and boarding schools, as well as the specific erasure of cultural fire practices through the strict US government policy of fire suppression and criminalization of burning, has resulted in the loss of invaluable TFK in Ojibwe communities. The removal of Indigenous people from the land and their inability to continue their fire stewardship, has on its own resulted in a large negative impact on the ecosystem, only compounded by habitat-destroying practices of European colonizers. Regeneration of red pine (*Pinus resinosa*) stands, a fire dependent species, has ceased in northern Minnesota due to exclusion of low-intensity surface fires. Surface fires are traditionally set by Ojibwe people in this region, and were set in red pine forests especially to promote the growth of plant medicines, accessibility for hunting deer, and blueberry production (Anderton, 1999). In Anishinaabemowin, the spirit of fire, *Oshkigin,* means 'the thing or mechanism that makes things new' (Murphy, 2022). In just this one word is a deep understanding of fire ecology: the knowledge that fire is an important and restorative force in an ecosystem. For Ojibwe today, the restoration of prescribed fire in their homelands is a reclamation of their culture (Holding Eagle & Marohn, 2022).

Fire suppression in the 20th century

To understand the importance of returning fire to the landscape through reintegration of TFK, it is key to recognize the decisions made by the federal government that removed fire from the landscape initially. The region that is currently designated as the Boundary Waters Canoe Area Wilderness (BWCAW) is the homeland of the Ojibwe people. Archaeological evidence indicates that humans have lived in the Western Great Lakes region for at least 14,650 years (Goebel et al., 2008). Historical accounts of Ojibwe traditions emphasize the importance of waterways and fire for maintaining traditional ways of life. The unique location and physical geography of the Western Great Lakes region made seasonal rounds, a pattern of living following the resources available season-to-season, central to the lives of Ojibwe people (Spangler, 2022). During the winter, groups gather in the interior of the Boundary Waters for hunting; following winter Ojibwe people would gather at maple groves closer to the shores of Lake Superior for sugar tapping. Mid to late summer brought the blueberry season, which was made possible through deliberate burning of patches of pine forests (Larson, Kipfmueller, & Johnson, 2020). High frequency and low intensity fires are most conducive to berry production as this disturbance clears underbrush and allows blueberries to increase plant cover, stem density, and fruit abundance (Anderton, 1999).

Though Indigenous fire history is in no way encompassed within the history of European settlement, the fur trade marks an important landmark in the fire narrative of the Great Lakes region. The earliest known contact between the Ojibwe and Europeans occurred in 1609, a year before French settlers and Indigenous people fostered a commercial relationship. French and British settlers entered the Boundary Waters through Hudson Bay and traveled down waterways to access the Anishinaabe trade. Diminishing fur trade resources and identification of fertile lands in northern Minnesota, led to encroachment of Western settlers in areas surrounding the Great Lakes; the 1847 and 1854 treaties established the Bois Forte, Grand Portage, and Fond du Lac reservations in Minnesota, pushing Ojibwe people further south and forcibly removing them from their homeland.

Following the Hinckley fire in Wisconsin in 1894, the legislature of Minnesota enacted a bill in 1895 "for the preservation of forests of this State and for the prevention and suppression of forest and prairie fires" (White, n.d.). The higher density of forests without fire was conducive to the logging industry, and incentivized the continuation of fire suppression policies. By 1905, expansion of railroads led to the climax of lumber production. This harvesting boom resulted in the exhaustion of pine stands, and a sharp decline in the lumber industry followed (Minnesota Historical Society, n.d.).

The ramifications of the lumber industry catalyzed conservation efforts in Minnesota. In 1895, General Christopher C. Andrew, who would become Minnesota's Forestry Commissioner, began to advocate for the preservation of Minnesota forests for recreation. He began a public education program which resulted in the protection of 200,000 acres of what would become the Chippewa National Forest (US Forest Service, n.d.). A growing movement towards recreation and preservation of natural systems led to the establishment of the National Park Service in 1916, and eventually to the 1964 Wilderness Act. Under the 1964 Wilderness Act, the Boundary Waters were protected in order to "leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character" (Wilderness Act, 1964). The establishment of the Boundary Waters as a wilderness area reinforced the fire suppression policy codified by the 1909 establishment of the Superior National Forest. The policy of fire suppression has persisted since this enactment, and commitment to this policy is exemplified through the Ham Lake fire of 2006 and Pagami Creek fire of 2011, for which the Forest Service's fire suppression efforts cost $11 million and $21.6 million, respectively. The establishment of the Boundary Waters as an area for recreation has greatly influenced the decision to exclude fire from an area with extensive historical oral evidence of high frequency and low severity fires set by Ojibwe people. Currently, the BWCAW serves as a critical extension of local economies. As seen in 2021, fires lead to closure of a major recreation area, and an economic loss: garnering support for the fire suppression policy among local communities.

The impact of fire suppression on Ojibwe communities cannot be understated. The establishment of the BWCA as a designated wilderness area in 1964 has contributed greatly to the policing and control of Indigenous communities and denial of treaty rights through fire suppression. Wilderness, defined in the 1964 Wilderness Act as "an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain," is greatly responsible for the erasure of Indigenous history and TFK in the Boundary Waters. In this study, we compare two fire history datasets: Bud Heinselman's record of stand origin fires, and the University of Minnesota's tree-ring fire history reconstruction. We aim to demonstrate the importance of frequent, low intensity fires in the pine forests of the Boundary Waters. We hope to bring attention to the importance of this type of restorative fire and more broadly of the traditional fire knowledge held by the Ojibwe.

Methods of fire history mapping

Fire history reconstruction relies on what data can be gathered from the living landscape, so a challenge lies in finding methods of extracting that data which illuminate the myriad of factors relevant to characterizing a fire regime. Historical fire frequency, intensity, and size, especially before the fire suppression era of the 20th century, are crucial to informing modern land management. There are two general types of fire which together can illuminate much of a historical fire regime. Fierce, high intensity, destructive fires that kill entire stands of trees, aptly named stand-replacing fires, and low intensity, less destructive fires named surface fires, after their tendency to stay low to the surface of the forest floor.

One method of fire history reconstruction, stand origin mapping, tells the story of a forest's catastrophic disturbances. It works by dating forest stands made up of trees of the same age class. This gives a good look at minimum time-since-last catastrophic disturbance that would have killed the entire previous stand. Stand replacing fires are cataloged in this way, but this very destructive type of disturbance does not typically paint the whole picture. While the frequency and size of stand replacing fires are an important facet of a fire regime, lower intensity surface fires are completely missed by stand origin mapping by virtue of their non-lethal impact on forest stands. These two fire types are not a strict binary, but do help illuminate important factors of a historical fire regime. Modern practitioners of TFK like the Fond du Lac band of Lake Superior Chippewa demonstrate that the primary fire type used by Indigenous land caretakers are low intensity surface fires. These fires maintain the balance of critical fire-dependent food sources like blueberries, and promote forest resilience. When this type of fire is missed or underrepresented in fire history reconstruction, the human contribution to fire regimes is diminished or outright discredited.

Dendrochronology, the use of tree rings to analyze events throughout the life of the tree, presents a useful alternative to stand-origin mapping for the purposes of fire history reconstruction. Tree ring data gives researchers a peek into the entire life history of the tree, including non-fatal surface fires. The record of surface fires is a crucial facet of the fire regime of a landscape.

In his landmark 1973 paper on fire in the BWCAW, Miron 'Bud' Heinselman set out to show the importance of fire in the forested landscape of the area. Fire suppression policy was, and still is, extremely influential to Western forest management decisions, so this was a critical step in the direction of reintroducing fire to the landscape. To construct a fire history, Heinselman used a stand-origin mapping method, cross referencing year-of-origin data for forest stands with older trees bearing fire scars to determine the corresponding fire year. Although he achieved what he set out to, which is an impressive undertaking in itself, Heinselman's choice of stand origin mapping method led him to miss the human element of the historical fire regime. To correct this absence, the fire history of the Boundary Waters was re-examined using tree-ring data in the 2020 study by Larson, Kipfmueller, and Johnson.

Methods

The two datasets from Heinselman and Larson, Kipfmueller, and Johnson, representing stand-origin mapping and tree-ring data respectively, were analyzed to quantitatively compare the methods. The Heinselman dataset contained over 4,000 polygons with geometry that represented each stand. The first stand origin dates in the Heinselman dataset ranged from 1595 to 1988. The Kipfmueller dataset contained 101 points where fire history data was collected. The earliest fire dates in this dataset ranged from 1489 to 2016. On average, the Kipfmueller dataset recorded fires 115.8 years earlier at each site before the Heinselman dataset recorded fires.

The two datasets were imported into ArcGIS Pro. Using the summarize within function, points from the Kipfmueller dataset which were located within polygons of the Heinselman dataset were identified and exported as a new, combined dataset. Only sites where the Heinselman dataset recorded a stand origin fire and where the Kipfmueller dataset recorded a fire were used in the analysis. There were a total of 69 sites where the datasets overlapped, ranging west to east from Lac La Croix to Saganaga Lake. Table 1 depicts certain attributes of the combined datasets - site name, the first stand origin fire as recorded by the Heinselman dataset, the first fire as recorded by the Kipfmueller dataset, the mean fire interval (MFI) from the Kipfmueller dataset, and the historic vegetation of the area from a presettlement vegetation map (Marschner, 1930).

Data and Results

Presettlement Vegetation and Fire Location

Fire locations were compared with historic presettlement vegetation. A shapefile containing the vegetation data from Francis J. Marschner's map of vegetation at the time of public land surveys was obtained from the Minnesota Geospatial Commons. An ArcGIS Online map depicting presettlement vegetation, the complete Kipfmueller data, and the complete Heinselman data was created (*Presettlement Vegetation and Fire History Data*, 2022). By comparing historic vegetation with fire history data, a pattern of where fire most often occurred emerges. Of the 69 points in the combined dataset, 41 were in locations that had historic vegetation data from the Marschner map. Of the 41 points that had both fire history data in both the Heinselman and the Kipfmueller datasets and Marschner's vegetation data, 11 were in Aspen-Birch (trending to conifers), 4 were in Jack Pine Barrens and Openings, and the remaining 26 were in mixed White Pine and Red Pine (see Fig. 1).

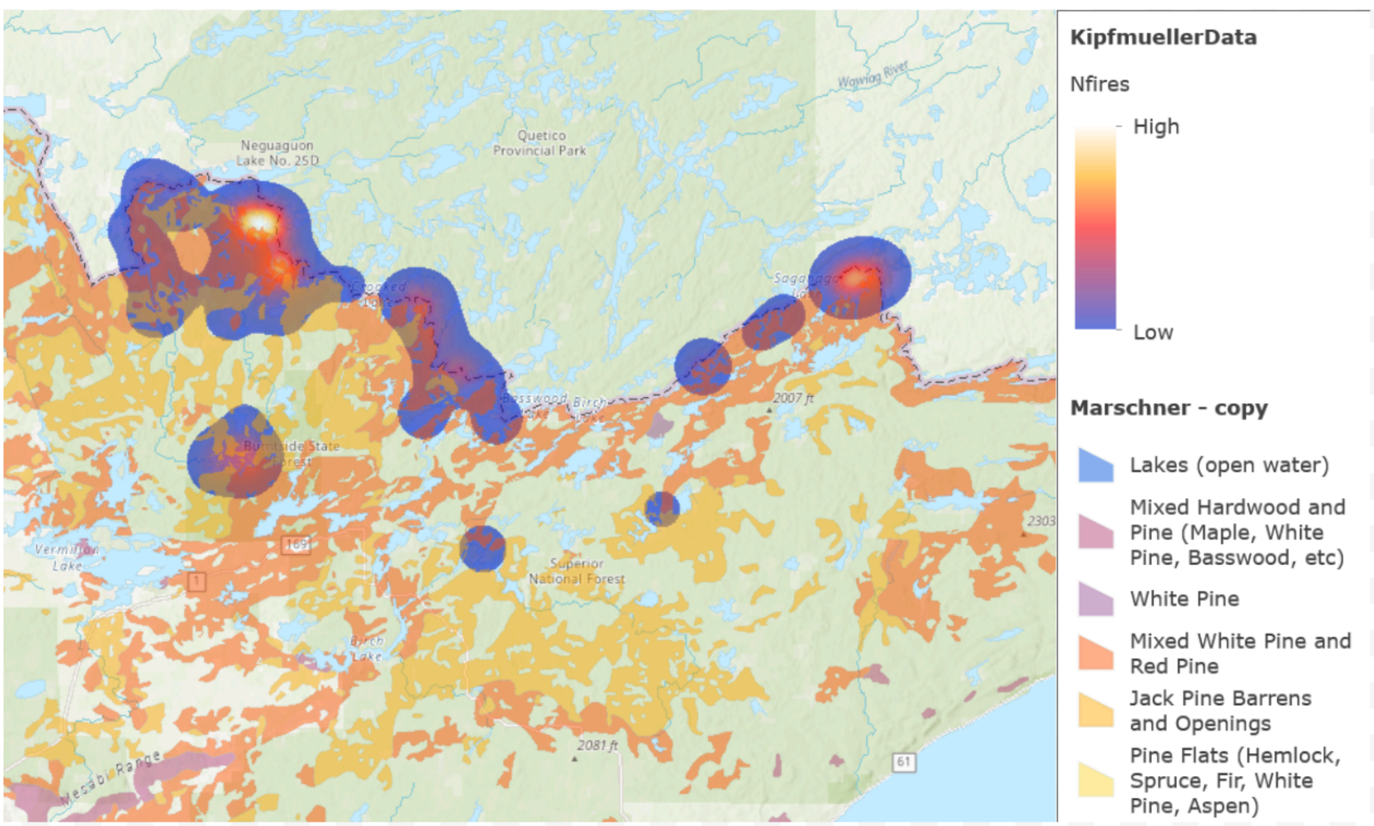


Fig. 1: Number of fires in pine-populated areas (*Presettlement Vegetation and Fire History Data*, 2022)

First Recorded Fire

Differences between first fire recorded in each dataset for each site ranged from 340 to 5 years. The Kipfmueller data tended to record earlier fires than the Heinselman data. There were 54 sites where the Kipfmueller data recorded fires between 340 and 5 years before the Heinselman data did; there were 15 sites where the Heinselman data recorded fires between 122 and 5 years before the Kipfmueller data did. A map was created which illustrates the comparison between earliest fire years (*First Recorded Fire*, 2022). The map shows the combined dataset where data overlapped at sites. The points with negative values are sites where the Kipfmueller data recorded earlier fires than the Heinselman data, and the points with positive values are sites where the Heinselman data recorded earlier fires than the Kipfmueller data (Fig. 2). Figures 3 and 4 show the distributions of first fire years for the respect.

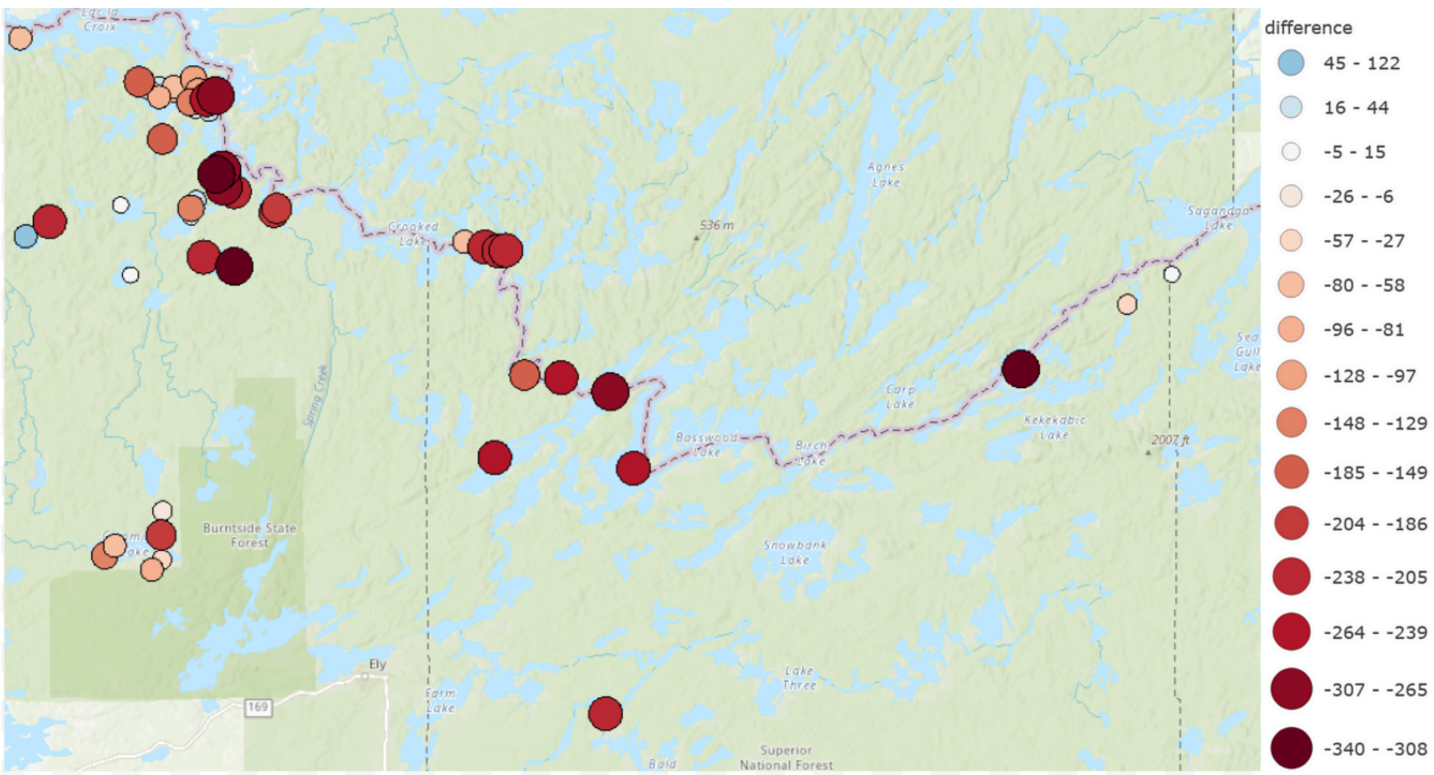


Figure 2: First recorded fire difference between Kipfmueller and Heinselman data sets

Figure 3

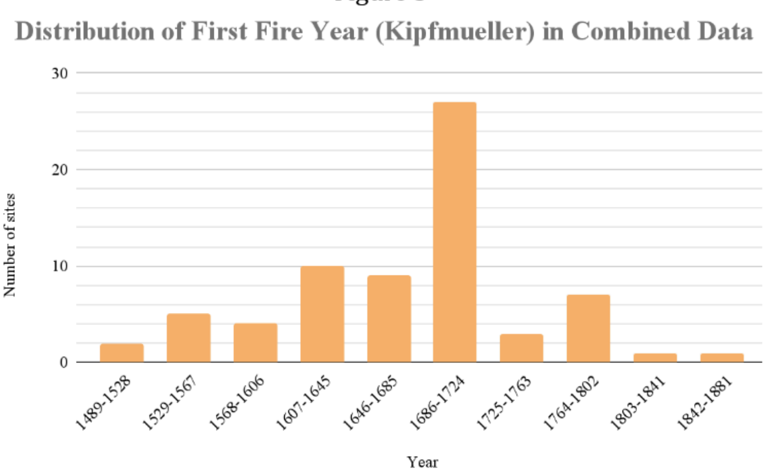
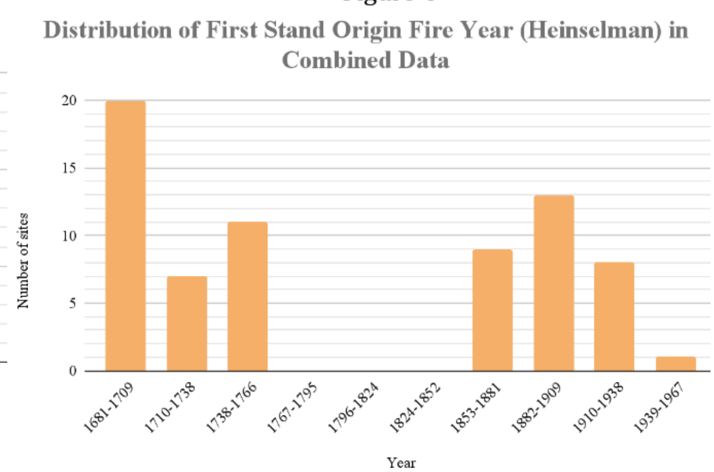


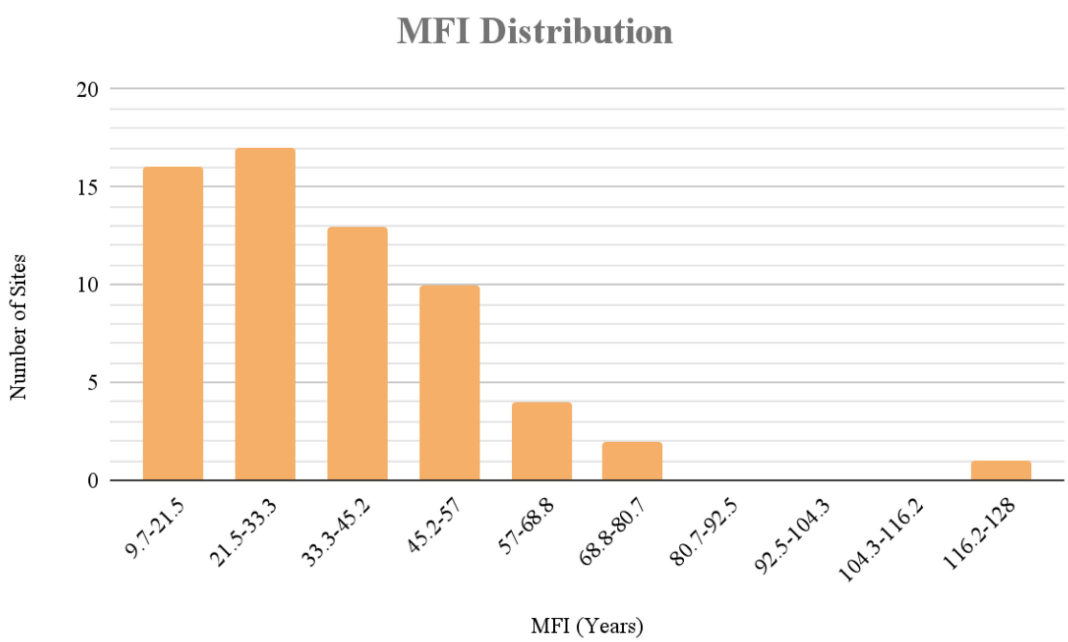
Figure 4



Mean Fire Interval (Kipfmueller)

Mean fire interval (MFI) refers to the average amount of time between fires under a historical fire regime. MFI is a method of identifying historical fire frequency on a landscape. The lower the MFI, the more frequent the landscape burned. Because the Heinselman data only recorded stand origin fires, no MFI comparisons can be made between the two datasets. However, the Kipfmueller dataset includes MFI. A map depicting this data was created (*Kipfmueller MFI*, 2022). The mean MFI was 35.7 years, the median was 31.4 years, the standard deviation was 19.9 years, the minimum was 9.7 years, and the maximum was 128 years. When the outlier MFI of 128 years was removed, the mean MFI was 33.7 years. MFI tended to be smaller in the area of Lac La Croix. See Figure 5 for the distribution of MFI.

Figure 5



Discussion

The Kipfmueller dataset is more descriptive of overall fire history in the BWCAW than the Heinselman dataset; the inclusion of lower intensity fires points to a fire regime characterized by low intensity fires at relatively frequent intervals, rather than the high intensity, infrequent fire regime that Heinselman originally found. Fire is the only natural agent which can provide red pine (*Pinus resinosa*) with its favored conditions of mineral soil, limited competition, and a sparse canopy; fire is critical for the survival and regeneration of red pine in forests (van Wagner, 1970). In the Great Lakes region, fire has been used for millennia to maintain the composition and structure of forests in the region (Swain, 1973). Fire is used by Indigenous people for an incredible variety of purposes; the Ojibwe people alone have 700 different life-sustaining reasons to burn (Murphy, 2022). Fire as a land management practice was halted when fire suppression policies were enacted in the early 1900s. These suppression policies were bastions of settler colonialism, rooted in anti-Indigenous rhetoric (Vinyeta, 2022). Therefore, understanding the past frequency of the use of fire on the landscape is important for providing quantitative evidence to support bringing back fire as a way of encouraging the long-term health and regeneration of fire-dependent forested ecosystems (Ryan et al., 2013). At a recognition level, having a record of frequent surface fires in scientific literature is essential to emphasize Indigenous fire history in western science. Exclusion of surface fires in academic research contributes to a pattern of erasure that is all too common in ecological journals and publications.

The visualization of Kipfmueller's mean fire intervals demonstrates a consistent application of low intensity surface fires across the boundary waters (Kipfmueller MFI 2022). The spatial distribution of the MFIs recorded reinforces that low intensity fires were burned wherever there were people: illustrating the importance of cultural burns for Ojibwe peoples throughout the entire boundary waters region (Kipfmueller MFI 2022). The low intensity fires recorded by the Kipfmueller dataset capture how frequent surface burns were and the importance of these disturbances in managing and maintaining healthy pine ecosystems. Heinselman's data only captured the date of the stand origin fire, therefore a MFI could not be calculated. Without the inclusion of surface fires in the Heinselman data set, only one date could be compared between the two data sets; the great discrepancies between the stand origin date between the data sets may indicate difficulties in dating the stand origin fire without the ability to crossdate surface fires. Crossdating samples from within the sample site validated the dates assigned to surface fires, and thus perhaps gave more confidence in the stand origin date in the Kipfmueller study.

Recommendations for policy

Understanding how frequently Ojibwe people burned in the boundary waters and the MFIs established by the Kipfmueller data set should be used in making informed policy decisions in land management. The large tracts of pine-dominated areas recorded in the presettlement vegetation map fall within fire dependent regions, supported by both Heinselman and Kipfmueller (*Presettlement Vegetation and Fire History Data*, 2022); without fire, these species that depend on the disturbance may diminish until they can no longer exist, and this pattern is already apparent in the Great Lakes region. A comprehensive review of forest change in the Great Lakes region compared data from a mid-1800s public land survey to a survey conducted from 2008 to 2014, demonstrated widespread mesophication(Paulson et al., 2016): this process occurs when fire is removed from a forest of fire dependent species, and shade tolerant and fire sensitive species, hardwoods begin to dominate the landscape (Paulson et al., 2016). Forest composition in six out of the nine national parks included in the survey experienced an increase in aspen and maple, coupled with a decrease in fire dependent species such as red pine and jack pine (Paulson et al., 2016). In the initial 1800s survey, pines were the most dominant species in six of nine parks, illustrating the great importance of Indigenous land management of pine forests through cultural burnings. A convergence towards hardwood dominant forests coincides with the forced removal of Indigenous people from areas once dominated by pine forests.

The mesophication of the Boundary Waters holds great cultural significance. The shift towards hardwood forests, facilitated by land management policies that do not align with TFK, marches towards the elimination of the possibility for Ojibwe people to reinstate cultural land management practices in their homeland. Land management that does not reflect the historical, traditional fire regime, including surface fires, of culturally significant pine forests, actively perpetuates the erasure of Indigenous culture. Hardwood dominated forests in the Great Lakes region makes the traditional Ojibwe seasonal rounds impossible, and denies Indigenous people the right to maintain traditional practices that for so long have been wrongly criminalized, persecuted, and forcibly taken from them.

Fire suppression policies have violated treaty rights since their enactment. The Boundary Waters lies within the territory of northeastern Minnesota that was ceded in 1854, and remains under treaty rights of the Bois Forte Band of Chippewa and the Grand Portage Band of Lake Superior Chippewa; under these reserved rights is the protection of waterways, air, fish and wildlife, wild rice, and forest resources that are necessary to Ojibwe culture and practices (Marks-Marino, 2019). The language of this treaty is vague and reflects a national pattern of the advantage taken by the federal government of Indigenous people. This treaty gives the President jurisdiction over where Indigenous people can reside, and allows the government to forcibly remove them onto other lands if the designated lands are discovered to be of importance for resource extraction (*Treaty With the Chippewa*, 1854). Additionally, the treaty gives absolute power to the federal government in Article 11, giving the the right to inhabit the land only "until otherwise ordered by the President." Governmental interests are blatantly favored over tribal rights, which has significantly limited Indigenous sovereignty in the Boundary Waters.

How, then, can the Boundary Waters be managed to respect and uphold treaty rights and to empower Indigenous communities? Centering Indigenous voices in returning fire to the landscape is an important step towards renewing Indigenous stewardship of the Boundary Waters. While recognizing there is no action that can undo the indescribable harm the federal government has perpetrated on Indigenous communities, there are many steps to be taken to bring Indigenous knowledge and culture to the forefront of land management in the Boundary Waters. The great inequalities that exist in education and the exclusive qualifications often necessary for land management jobs prevent Indigenous people from even being at the table to make decisions; this quantification of knowledge to Western standards is part of a long legacy of dismissal of Indigenous knowledge in land management. The requirements of forest service jobs often include a formal baccalaureate degree in land management along with a certain number of years of 'field experience.' However, the education system and forest service have functioned as systems of the oppression of Indigenous people, and both played significant roles in the erasure of Ojibwe culture in Minnesota. While these qualifications supposedly seek to have the most knowledgeable and experienced people making decisions about land, they exclude the original stewards of this land who have managed for thousands of years. Valuing Indigenous ways of knowing as qualifications in their own right, worthy of a seat at the table, is a direct way to incorporate Indigenous voices in land management. Intentionally centering Indigenous leadership in land management, particularly in the Boundary Waters is a meaningful way of returning Indigenous people's right to live in the way of their ancestors.

One way for the U.S. Forest Service to give Indigenous people more power in the management of the Boundary Waters could be to reach out to the Indigenous People's Burning Network (IPBN), a nationwide support network among groups led by Native American elders and practitioners. The group focuses on revitalizing traditional fire cultures, and already includes land managers from the Leech Lake Band of Ojibwe. This could be a great step in reparations to Indigenous people, and in healing the Boundary Waters pine forests that are starved of fire.

However, the decision to join the IPBN, as with any non-Indigenous initiative, is not obligatory. The agency of Indigenous people in fire knowledge and practice cannot be dictated by Western scientists or government agencies.

Recommendations for conservation organizations

Conservation efforts in the Boundary Waters have grown over the past 10 years, primarily due to proposed copper mining projects; however, these movements, including Save the Boundary Waters and Friends of the Boundary Waters, are fighting for the preservation of the same “wilderness” character that has denied the rights of Indigenous communities since its establishment in 1964. The exclusion of issues of tribal sovereignty, treaty rights, and Indigenous history from these non-profit organizations, which have been involved in policy-making and lobbying, is another apparatus of erasure and oppression of Ojibwe people. The preservation of the Boundary Waters as an area protected from exploitation is a shared goal, but achieving this through the safeguarding of the area as “wilderness” excludes the Indigenous people who are best equipped to tend to the land so treasured by visitors and locals alike. It is up to these organizations to center Indigenous voices as those who have been advocating for sustainable land management practices since the beginning of European settlement.

Conclusions

Recording surface fires through tree rings contributes to an increased understanding of fire history in the Boundary Waters for Western scientists and land managers; however, it is important to consider whether or not further research is beneficial for Indigenous communities. Respecting traditional ways of knowing also means giving TKF the same merit as any other scientific fact. Studies into Indigenous knowledge and culture can easily become extractive and exploitative, regardless of intentions. Culture is not something that can or should be taken; it is something which must be willingly shared. After the cultural genocide perpetrated on Indigenous communities by Western colonization, there is absolutely no obligation for Indigenous communities to rebuild trust with the very systems that participated in their erasure. Any extensions of this Western scientific research would require willing involvement of Indigenous communities to have any merit.

As discussed earlier in this paper, Kipfmueller’s study followed the route of the fur trade to determine sampling sites for fire stumps. The portages and waterways traveled by Europeans during the fur trade represent only a fraction of Indigenous canoe routes (Brown, Eccles, & Heldman, 1994). Areas off site include the eastern lakes connecting the Boundary Waters to Lake Superior via the Grand Portage; this eight and a half mile trail, traveled by Ojibwe people to avoid low rivers and waterfalls, was crucial for reaching the maple stands on the shores of Lake Superior in the late winter and spring, an integral landscape for the Ojibwe seasonal round. Exploring sites off route for fire scars could contribute to a better understanding for Western scientists of how frequently sites were being burned in this region; furthermore, a comparison between these sites and the sample sites along the route of the fur trade could draw meaningful insights about change, or lack thereof, of traditional management practices due to European contact and trade. Understanding how frequently sites were being burned could potentially deepen and fill in gaps in knowledge of Indigenous history and the importance and frequency of cultural burnings in this eastern region.

Observations of culturally modified trees found in the Boundary Waters could be another avenue of creating a more holistic understanding indigenous land use and management. These pines have scars left from the collection of pine pitch that was used to mend canoes. The presence of these trees near canoe routes would further emphasize that Indigenous people were here and interacting intentionally with this ecosystem.

Indigenous communities of Minnesota have been here for thousands of years. Their knowledge of the land and the use of fire is unparalleled. Their ancestors set the fires that are recorded in the tree ring data we have analyzed here. What would Ojibwe elders see in these fire-deprived pine forests that our analysis failed to capture? Validating Indigenous fire knowledge is an important result, but it would not be necessary without the erasure, invalidation, and dehumanization of Indigenous people, culture, and knowledge. It is time for oral histories and TFK to be treated as a legitimate way of informing our fire policy, on its own merit. Indigenous knowledge should not need to be substantiated by Western science in order to be accepted. It is time to return land stewardship to Indigenous caretakers, return cultural agency to Indigenous people, and return Indigenous fire to the Boundary Waters.

Appendix A: Artist's Note

A pine cone is small enough to fit in your hand, but inside is the future of giants. A few small seeds can grow into towering trees that transform their surroundings. I invite you to take a close look and see the forest hidden inside the pine cone. Pictured are flora and fauna native to the Boundary waters that rely on and are affected by the red pine either directly or indirectly. The red squirrel and chickadee rely on red pine seeds for food. This in turn, affects the populations of predators like foxes and bears. Mushrooms like the chanterelle form ectomycorrhizal relationships with pine roots underground, helping the trees acquire nutrients in poor soil. Iconic Minnesota boreal plants like Canada bunchberry, bluebead lily, bearberry, and blueberry grow in the pine forest understory. When a red pine dies, the pine sawyer beetles will gnaw its wood to start the process of decomposition and help cycle the nutrients back through the forest.

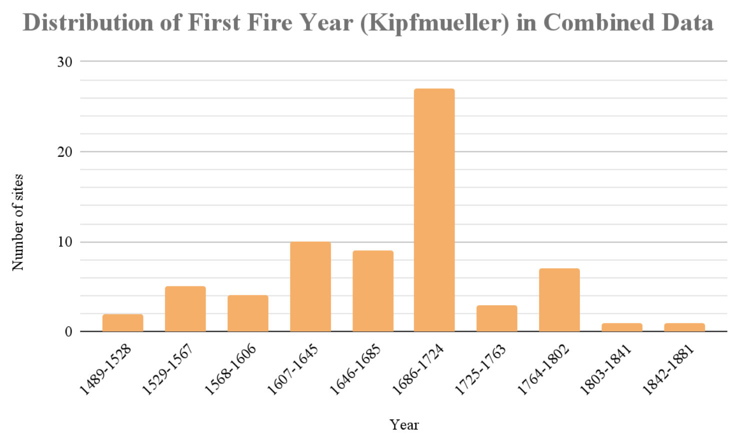
Why does saving the red pine matter? Why should we care about preserving our current biodiversity in the face of rapid global climate change and human-caused climate destruction? It's because everything is so delicately interconnected. But for reductionist Western Scientists, who only see a solitary tree and not its relationships, this is difficult to capture. This view also has historically excluded humans from this delicate web.

Here I try to find our place in this web. I chose not to place humans at the pinnacle or the center of the forest, but in a more humble spot. We're just another animal that relies on these giants. We're just another animal trying to survive in the forest.

The red pine has so many gifts to offer to the plants, animals, and humans surrounding it, and it's our time to reciprocate these gifts, by burning the forest. We've learned how fire is necessary for the reproduction and regeneration of red pine. If we bring fire back, we can engage in reciprocity with the red pine, allowing it to make new generations of forest. We can return to be part of the ecosystem and return to be part of this delicate web. We've been unraveling this web, and it's time for us to return to weave the relationships and make them stronger.

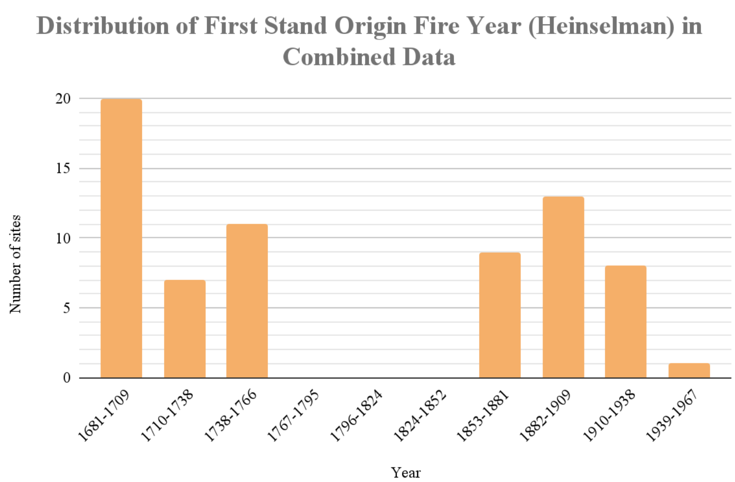

Appendix B: Data

Figure A: Distribution of First Fire Year in Kipfmueller Data



Mean: 1676
Median: 1689
Standard deviation: 73.1 years
Minimum: 1489
Maximum: 1881

Figure B: Distribution of First Stand Origin Fire Year in Heinselman Data



Mean: 1729
Median: 1759
Standard deviation: 97.8 years
Minimum: 1681
Maximum: 1967

Table 1

Site	First Fire (Kipf)	Stand Origin Fire (Hein)	MFI (Kipf)	Marschner Vegetation	Latitude	Longitude
East CMG SW	1779	1864	17	Mixed White Pine and Red Pine	47.977	-92.0833
East CMG SC	1685	1712	47	Mixed White Pine and Red Pine	47.9839	-92.0729

Site	First Fire (Kipf)	Stand Origin Fire (Hein)	MFI (Kipf)	Marschner Vegetation	Latitude	Longitude
East CMG NW	1664	1864	21.143	Jack Pine Barrens and Openings	48.0008	-92.074
West CMG C	1794	1864	15	Jack Pine Barrens and Openings	47.9937	-92.1215
West CMG S	1764	1894	18.667	Aspen-Birch (trending to Conifers)	47.9868	-92.1321
Big Moose Portage	1749	1755		Aspen-Birch (trending to Conifers)	48.0177	-92.072
Ramshead Lake	1695	1681	39.333	Aspen-Birch (trending to Conifers)	48.1798	-92.1054
Dahlgren Portage	1688	1894	51.667	Aspen-Birch (trending to Conifers)	48.1922	-92.0295
Stuart East	1554	1894	62.5	Jack Pine Barrens and Openings	48.1859	-91.9981
Agnes South	1689	1681	45	Mixed White Pine and Red Pine	48.2196	-92.043
Agnes Central	1552	1681	38.667	Mixed White Pine and Red Pine	48.2257	-92.0426
Agnes North	1706	1681	78	Mixed White Pine and Red Pine	48.2313	-92.0374
Oyster Lake	1694	1681	13	Mixed White Pine and Red Pine	48.2277	-92.1154
Shell Lake	1881	1759	49		48.2065	-92.2139
Lynx Lake	1708	1917		Mixed White Pine and Red Pine	48.2163	-92.1891
West LLC	1781	1759			48.3271	-92.2665
North Snow Bay	1790	1864		Mixed White Pine and Red Pine	48.3455	-92.2517
Fortyone Island	1699	1759	46		48.342	-92.2191
Smudge Island	1695	1759	16		48.3089	-92.0603
Kelsey Lake 1	1695	1681	47	Mixed White Pine and Red Pine	48.293	-92.0387
Kelsey Lake 2	1704	1681	30	Aspen-Birch (trending to Conifers)	48.2921	-92.0239
Rock Knob	1694	1681	18.167	Aspen-Birch (trending to Conifers)	48.2974	-92.0316
Teton Island	1725	1681	51		48.2985	-92.0164

Site	First Fire (Kipf)	Stand Origin Fire (Hein)	MFI (Kipf)	Marschner Vegetation	Latitude	Longitude
Requiem Island	1699	1864	40.25	Jack Pine Barrens and Openings	48.3123	-92.0965
Disappointment Island	1701	1759	21.714		48.3063	-92.0604
Coleman Island E-1	1698	1967	25.5		48.3029	-92.0171
Coleman Island E-2	1782	1894	22	Aspen-Birch (trending to Conifers)	48.3054	-92.0352
Coleman Island E-3	1767	1864	31	Aspen-Birch (trending to Conifers)	48.3141	-92.04
Fish Stake Narrows	1625	1864	19.167		48.3001	-92.0264
Nook Island	1686	1681	33		48.2976	-92.0184
Penny Island	1627	1759	34.429		48.2984	-92.0438
Coleman Island W-1	1718	1739	14.4	Mixed White Pine and Red Pine	48.3067	-92.0852
Coleman Island W-2	1718	1681	34.6	Mixed White Pine and Red Pine	48.3094	-92.076
Shower Island	1653	1681	22.818		48.3053	-92.0512
Pit Island	1594	1681	22.583		48.3019	-92.0755
Lady Boot Bay	1596	1759	31.375	Mixed White Pine and Red Pine	48.2732	-92.0723
Boulder Bay South	1690	1681	28.5	Mixed White Pine and Red Pine	48.2365	-92.0042
Boulder Bay East	1689	1894	63	Mixed White Pine and Red Pine	48.2372	-91.9979
Boulder Bay Northeast	1607	1681	61	Mixed White Pine and Red Pine	48.2408	-91.9981
Boulder Bay North	1489	1681	28.875	Mixed White Pine and Red Pine	48.2404	-92.0042
Boulder Island	1629	1894	34.167		48.2406	-92.0089
Boulder Bay West	1563	1894	25.556	Mixed White Pine and Red Pine	48.2487	-92.0166
Tiger Bay West	1620	1894	44	Mixed White Pine and Red Pine	48.2521	-92.0106
Tiger Bay South	1708	1681	15	Mixed White Pine and Red Pine	48.2466	-92.0057
Tiger Bay East	1708	1894	51.667	Mixed White Pine and Red Pine	48.25	-92.0063
Tiger Island	1600	1681	80	Mixed White Pine and Red Pine	48.2521	-92.0061

Site	First Fire (Kipf)	Stand Origin Fire (Hein)	MFI (Kipf)	Marschner Vegetation	Latitude	Longitude
Iron Lake South	1687	1875			48.2228	-91.9567
Iron Lake North	1698	1894	30.25		48.2258	-91.9545
Fish Taco Point	1684	1755	39.75		48.2029	-91.7606
Pike Island	1684	1894	13.455		48.199	-91.7391
Cable Point	1675	1894	15	Mixed White Pine and Red Pine	48.1964	-91.7246
Crooked Lake East	1674	1894	53.667		48.1968	-91.7176
Basswood River West	1754	1921	26.75	Mixed White Pine and Red Pine	48.1112	-91.6981
Basswood River East	1675	1921	9.6667	Aspen-Birch (trending to Conifers)	48.1091	-91.6602
Hausons Island	1642	1921	38		48.0995	-91.6092
Jackfish Bay	1682	1921	21.5	Aspen-Birch (trending to Conifers)	48.054	-91.7291
Washington Island	1681	1921	33.5		48.047	-91.5854
South Kawishiwi River	1701	1920	42	Aspen-Birch (trending to Conifers)	47.8779	-91.6143
Knife Lake	1613	1921	27.143	Mixed White Pine and Red Pine	48.1152	-91.1849
Ester Lake	1823	1864	29	Mixed White Pine and Red Pine	48.1597	-91.0752
Zephyr Lake	1707	1692	45.5	Mixed White Pine and Red Pine	48.1805	-91.029
Voyageurs Island East	1552	1681	15.538		48.2244	-90.9082
Blueberry Island	1503	1712	49.5		48.2307	-90.9058
Unnamed 1	1615	1712	35.5		48.2335	-90.8903
Horseshoe Island	1627	1712	57.333		48.2316	-90.8876
Unnamed 2	1556	1712			48.2366	-90.8914
Bradly Island	1698	1712	128		48.2425	-90.8855
Campers Island	1598	1747	30.75		48.218	-90.8816
Oskenonton Island	1607	1712	17.846		48.2354	-90.8677

References

Anderton, J. B. (1999). Native American, Fire-Maintained Blueberry patches in the coastal pine forests of the northern great lakes. *The Great Lakes Geographer*, *6*(1/2), 29-39.

Berkes, F. (2012). *Sacred Ecology* (2nd ed.). Taylor & Francis Group. https://doi.org/10.4324/9781315114644

Brown, J. S. H., Eccles, W. J., & Heldman, D. P. (1994). *The Fur Trade Revisited: Selected Papers of the Sixth North American Fur Trade Conference, Mackinac Island, Michigan, 1991*. https://www.jstor.org/stable/10.14321/j.ctt130hjp6

Cajete, G. (2000). *Native Science: Natural Laws of Interdependence*. Clear Light Publishers.

Christianson, A. C., Sutherland, C. R., Moola, F., Bautista, N. G., Young, D., & MacDonald, H. (2022). Centering Indigenous Voices: The Role of Fire in the Boreal Forest of North America. *Current Forestry Reports*, *8*, 257-276. https://doi.org/10.1007/s40725-022-00168-9

Cronon, W. (1996, January). The Trouble with Wilderness; or, Getting Back to the Wrong Nature. *Environmental History*, *1*(1), 7-28. https://doi.org/10.2307/3985059

First Recorded Fire [map]. (2022). https://arcg.is/1PPabb

Goebel, T., Waters, M. R., & O'Rourke, D. H. (2008, March 14). The Late Pleistocene Dispersal of Modern Humans in the Americas. *Science*, *319*(5869), 1497-1502. https://doi.org/10.1126/science.1153569

Heinselman, M. L. (1973). Fire in the virgin forests of the Boundary Waters Canoe Area, Minnesota. *Quarternary Research*, *3*(3), 329-382. https://doi.org/10.1016/0033-5894(73)90003-3

Holding Eagle III, M., & Marohn, K. (2022, July 27). Once-ignored Indigenous knowledge of nature now shaping science. *MPR News*. https://www.mprnews.org/story/2022/07/27/onceignored-indigenous-knowledge-of-nature-now-shaping-science

Huffman, M. R. (2013). The Many Elements of Traditional Fire Knowledge: Synthesis, Classification, and Aids to Cross-cultural Problem Solving in Fire-dependent Systems Around the World. *Ecology and Society*, *18*(4). http://dx.doi.org/10.5751/ES-05843-180403

Indigenous Peoples Burning Network. (n.d.). Conservation Gateway. Retrieved December 16, 2022, from https://www.conservationgateway.org/ConservationPractices/FireLandscapes/Pages/IPBN.aspx

Kipfmueller MFI [map]. (2022). https://arcg.is/1zjj180

Kristoff, M. (2019, October 28). *Fire Ecology and Indigenous Knowledge with Frank Lake*. Your Forest Podcast. Retrieved December 4, 2022, from https://yourforestpodcast.com/good-fire-podcast/2019/10/16/fxk6gvcl10gjnex2zu8jtdo6gbhgbt

Larson, E. R., Kipfmueller, K. F., & Johnson, L. B. (2020, June 30). People, Fire, and Pine: Linking Human Agency and Landscape in the Boundary Waters Canoe Area Wilderness and Beyond. *People, Fire, and Pine: Linking Human Agency and Landscape in the Boundary Waters Canoe Area Wilderness and Beyond*, *111*(1), 1-25. https://www.tandfonline.com/doi/full/10.1080/24694452.2020.1768042

Lewis, H. T., & Ferguson, T. A. (1988). Yards, corridors, and mosaics: How to burn a boreal forest. *Human Ecology*, *16*, 57-77.

Marks-Marino, D. (2019). *Tribe: 1854 Treaty Authority - Tribes & Climate Change*. nau.edu. Retrieved December 16, 2022, from https://www7.nau.edu/itep/main/tcc/Tribes/gl_trAuth

Marschner. (1930). Native Vegetation at the Time of the Public Land Survey 1847-1907 [map]. In *Minnesota Department of Natural Resources*. Retrieved November, 2022, from https://gisdata.mn.gov/dataset/biota-marschner-presettle-veg

Minnesota Historical Society. (n.d.). Logging History | Forest History Center | MNHS. Retrieved December 4, 2022, from https://www.mnhs.org/foresthistory/learn/logging

Murphy, J. (2022, September 20). How Indigenous Knowledge Reconnects Us All to Fire. *YES! Magazine*. https://www.yesmagazine.org/environment/2022/09/20/fire-indigenous-traditional-ecological-knowledge

Nowacki, G. J., & Abrams, M. D. (2008). The Demise of Fire and "Mesophication" of Forests in the Eastern United States. *Bioscience*, *58*(2), 123-138.

Paulson, A. K., Sanders, S., Kirschbaum, J., & Waller, D. M. (2016). Post-settlement ecological changes in the forests of the Great Lakes National Parks. *Ecosphere*, *7*(10). https://doi.org/10.1002/ecs2.1490

Presettlement Vegetation and Fire History Data [map]. (2022). https://www.arcgis.com/home/webmap/viewer.html?webmap=a72bbf894b6c49cbbaf7c322c3992aad&extent=-92.7367,47.4749,-89.4985,48.5843

Ryan, K. C., Knapp, E. E., & Varner, J. M. (2013). Prescribed fire in North American forests and woodlands: history, current practice, and challenges. *Frontiers in Ecology and the Environment*, *11*(s1), e15-e24. https://doi.org/10.1890/120329

Spangler, G. R. (2022). Closing the Circle: Restoring the Seasonal Round to the Ceded Territories. https://glifwc.org/minwaajimo/Papers/Spanger%20paper%20-%20FINAL.pdf

Steel, Z. L., & Safford, H. D. (2015). The fire frequency-severity relationship and the legacy of fire suppression in California forests. *Ecosphere*, *6*(1), 1-23. https://esajournals.onlinelibrary.wiley.com/doi/full/10.1890/ES14-00224.1

Swain, A. M. (1973). A history of fire and vegetation in northeastern Minnesota as recorded in lake sediments. *Quaternary Research*, *3*(3), 383-396. https://www.sciencedirect.com/science/article/abs/pii/0033589473900045

Treaty with the Chippewa. (1854, September 30).

US Forest Service. (n.d.). *History of the BWCAW*. Superior National Forest - Special Places. Retrieved December 4, 2022, from https://www.fs.usda.gov/detail/superior/specialplaces/?cid=stelprdb5127455

van Wagner, C. E. (1970, August). Fire and Red Pine. *In Proceedings of the Tall Timbers Fire Ecology COnference*, *10*, 211-219. https://talltimbers.org/wp-content/uploads/2018/09/211-VanWagner1970_op.pdf

Vinyeta, K. (2022). Under the guise of science: how the US Forest Service deployed settler colonial and racist logics to advance an unsubstantiated fire suppression agenda. *Environmental Sociology*, *8*(2), 134-148. https://www.tandfonline.com/doi/abs/10.1080/23251042.2021.1987608

White, W. (n.d.). *Evolution of the Superior National Forest*. USDA Forest Service. Retrieved December 4, 2022, from https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd532398.pdf

Wilderness Act. (1964). In *16 U.S.C. § 1131-1136*. https://winapps.umt.edu/winapps/media2/wilderness/NWPS/documents/publiclaws/The_Wilderness_Act.pdf