How can Prescribed Burning and Indigenous Cultural Burning Reduce the Impacts of Wildfires in Canadian Forests in Response to Climate Change?

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Abstract

This paper was originally written for Tara Holland's Geography 266W course *Geography in Practice*. The assignment asked students to ask and answer a question related to any topic in geography through a question proposal, annotated bibliography, and final literature review including at least fifteen sources. The paper uses APA citation style.

The relatively recent uptick in extreme wildfire seasons in Canada is linked to a history of fire suppression management and accelerated climate change, creating discussion on prescribed burning and Indigenous cultural burning for proactive forest management. The literature review analyzes several studies on the use of prescribed burning, primarily in coniferous forests similar to those found in western Canada, to reduce fuel buildup on the forest floor. The literature review also emphasizes the importance of Indigenous-led, collaborative forest management based on traditional Indigenous burning practices. Findings indicate that prescribed burning and Indigenous cultural burning have significant impacts on wildfires through reducing forest fuel load and increasing the resistance of forest ecosystems to fire. These results reveal the potential for prescribed and cultural burning in active forest management in Canada and invite further research into these methods.

Introduction

Wildfire seasons in Canada have seen rampant increases in severity and destructiveness in the past several decades, marked by intense single fires that burn across massive areas of forested land. The most recent wildfire season in

2023 has been described as Canada's worst fire season yet, resulting in the highest number of hectares burned in recorded history at over 16.5 million hectares (Natural Resources Canada, 2023). This is consistent with reported trends in which the number of large fires and the average amount of area burned has increased since the 1970s (Hoffman et al., 2022b), generating much concern among Canadians about the implications of these patterns going forward. Increases in wildfire severity have led to calls for change in how forests and wildfires are managed, opening up discussion on techniques such as prescribed burning and Indigenous cultural burning for proactive management. As wildfire severity continues to trend upwards in step with warmer and drier seasons due to climate change, it is becoming progressively more important to consider how these strategies may be able to mitigate the impacts of wildfires on forests in Canada.

To understand how active fire management can regulate wildfires, it is important to discuss several key points including the effects of climate change and long-term fire suppression on wildfires, and the current research on prescribed burning and Indigenous cultural burning. Fire suppression is a management strategy used in Canada over the past century that aims to mitigate wildfire damage by extinguishing fires wherever possible (Jurvélius, 2004; Hoffman et al., 2022b). In contrast, prescribed burning involves intentionally burning an area with the goal of reducing fuel material such as downed trees and plant litter, and it aims to lessen wildfire damage on natural and human communities (Brodie et al., 2024). It's important to note that prescribed burning is different from Indigenous cultural burning, which is a traditional practice used by Indigenous peoples to manage their resources and reduce the risk of wildfire on their lands (Hoffman et al., 2022a). Both methods are forms of active management that require conscious interaction with fire and forest ecosystems.

While using fire to fight fire and maintain forests is a practice that has existed in Indigenous communities throughout time, it is only just beginning to receive recognition in Western research and management systems (Dickson-Hoyle et al., 2022). Recent research explores how prescribed burning and Indigenous cultural burning may be essential to wildfire management going forward. This literature review aims to discuss how prescribed burning and Indigenous cultural burning can reduce the impacts of severe wildfires in Canadian forests, and the implications that this could have for dealing with the current and projected effects of climate change.

Impacts of Climate Change and Fire Suppression: The Need for Active Fire Management

Climate change and fire suppression are two of the most significant contributors to the current and future state of severe wildfires in Canada (Hoffman et al., 2022b). Changes in seasonal conditions have accelerated due to increases in greenhouse gas emissions driven by industrial activities. Hessburg et al. (2021) outline how climate change has increased the amount of forested area burned, highlighting warmer temperatures, drier summers, earlier snowmelt, and lower levels of precipitation as key factors. Wasserman and Mueller (2023) link warmer temperatures and lower precipitation to reduced fuel moisture, causing forests to become more susceptible to extreme wildfires. Adapting management strategies for longer and more intense wildfires seasons is consequently becoming more important than ever. This is emphasized in projected climate models for the next century, in which the effects of these climate factors and the number of extreme disturbances are expected to increase over time (Wasserman & Mueller, 2023). This puts a strain on current systems to reevaluate how forests and wildfires are treated in order to deal with climate change.

As mentioned, the effects of climate change on wildfires are intensified by Canada's reliance on fire suppression for management. Although fire suppression has protected communities and economically important forest resources from wildfires (Cardil et al., 2019), it has also coincided with prescribed burning bans and the outlawing of Indigenous fire stewardship starting in the 19th century under colonialism (Copes-Gerbitz et al., 2022). This long period of fire suppression has resulted in high levels of fuel buildup on the forest floor and denser forests (Wasserman & Mueller, 2023), where low-severity fires set during traditional burning previously reduced the amount of forest material consumed in wildfires. As greater fuel loads evidently result in greater wildfires, governments have given more acknowledgement to the consequences of fire suppression in recent times (Natural Resources Canada, 2021). Prescribed burning and Indigenous cultural burning maintained low-severity fire regimes before fire suppression, which is increasingly important to consider with regards to climate change. Consequently, reintroducing these methods could lessen the damages caused by severe wildfires in Canada.

Impacts of Prescribed Burning: Fuel Reduction and Forest Composition

The search for alternative solutions to fire suppression has generated renewed interest in prescribed burning, primarily for reducing fuel load on the

forest floor. While the effects of prescribed burning on fuel load vary depending on fuel moisture, climate type, and seasonal conditions, studies show that it is most effective in seasonally dry forests (Arkle et al., 2012; Hessburg et al., 2021). This indicates that it could see success in western Canada, where dry forest conditions in the summer intensify severe wildfires. Brodie et al. (2024) discuss prescribed burning combined with forest thinning to lessen fuel load in a northeast California pine forest, in which treatments were applied over a nine-year period. The researchers measured lower fuel loads in all treated areas, which was positively correlated with reduced fire severity and tree mortality following the Antelope wildfire that swept through the study area in 2021 (Brodie et al., 2024). The findings are consistent with prior research by Arkle et al. (2012), where prescribed burning applications and GIS data measured reduced fuels and predicted lower wildfire severity in a dry coniferous forest. This is a strong example of how fuel reduction treatments can mitigate wildfires in seasonal climates similar to western Canada. As forests are becoming drier with climate change, the success of prescribed burning under these conditions could be especially valuable in the future.

As supported by additional research, prescribed burning can also reduce wildfire severity by matching natural fire regimes. Cowman and Russell (2021) provide a key example of this in their research on prescribed burning in a coastal redwood forest in California, an ecosystem that relies on fire disturbances to mitigate high fuel buildup. Wood fuels were found to be 41% lower in burned areas compared to unburned areas, with duff depth nearly 50% lower and litter depth around 12% lower (Cowman & Russell, 2021). This exemplifies how fire often serves as a natural process that removes high levels of forest floor material. As discussed, reduced fuel load and lower tree mortality limit the amount of material that fires can consume, especially when combined with forest thinning to manage density (Brodie et al., 2024; Cowman & Russell, 2021). Prescribed burning removes downed trees and litter accumulated over time, matching historical fire regimes that burned fuels at natural rates (Hessburg et al., 2021). In short, the research reveals the measurable effects of prescribed burning on fuel reduction, making a case for its use in managing climate-induced wildfires by proactively burning fuels.

In addition to fuel reduction, prescribed burning also affects forest composition by providing opportunities for regeneration in the understory and encouraging fire-resistant adaptations. It creates intermediate disturbance rates in contrast to the extreme disturbances caused by wildfires, allowing forests to

become more tolerant to fire over time. Prescribed burning generally reduces species dominance without harming understory composition, as multiple studies found little variation in the number of plant species after treatment (Casals et al., 2016; Cowman & Russell, 2021). This has implications for using prescribed burning to maintain optimal disturbance levels. Furthermore, prescribed burning can reduce wildfire severity by reverting forest composition in areas with preexisting fire adaptations. Schiks et al. (2024) discuss its effects on species cover in a white pine forest in Ontario, where fire-tolerant white pine was overtaken by balsam fir under fire suppression. Similarly to the Cowman and Russell (2021) study, Schiks et al. (2024) found that applying low-severity prescribed fire shifted species dominance back to white pine, leading the ecosystem to exhibit a higher resistance to wildfire. Overall, the current research reveals a strong link between prescribed burning and fuel reduction, while maintaining understory composition and reintroducing fire tolerance. This provides evidence for the benefits of prescribed fire in mitigating wildfire disturbances in forest ecosystems.

Impacts of Indigenous Cultural Burning: Traditional Management and Restoration

Although prescribed fire is often presented as a relatively new solution for managing wildfires, traditional burning in Indigenous communities has been used for centuries in Canada preceding colonialism. As discussed by Dickson-Hoyle et al. (2022), Indigenous knowledge is instrumental in restoring fire suppressed ecosystems and reintroducing fire stewardship throughout Canada. A key focus of their study is in the Secwépemc community in British Columbia, where over a decade of cultural burning increased ecosystem resilience and restored keystone plant species (Dickson-Hoyle et al., 2022). Similar to prescribed burning research by Schiks et al. (2024), regular burning practices increased fire adaptations in plant species, decreasing wildfire damage in turn. Conversations with Secwépemc Elders revealed their generational knowledge on optimal burning times and their dedication to upholding traditional burning under fire suppression laws, allowing forests and meadows to persist through severe wildfires (Dickson-Hoyle et al., 2022). The value of Indigenous cultural burning is further exemplified in research on Garry oak ecosystems in southwest BC (Barlow et al., 2021). As Garry oaks are vulnerable to climate change and reliant on fire for intermediate disturbances, evidence of traditional burning in tree rings suggests that burning practices ensured their survival (Barlow et al., 2021). Dependence on cultural fire regimes in

these ecosystems consequently proves how they can mitigate climate-induced wildfires.

In contrast to other forms of forest and fire management, Indigenous cultural burning emphasizes the interconnectedness between multiple ecosystem components to mitigate extreme disturbances such as wildfires. Eisenberg et al. (2019) explore these spatial relationships surrounding Indigenous burning practices in Alberta following the high severity Kenow wildfire in 2017. Short fire regimes similar to those set by Indigenous peoples were experimentally employed to reduce aspen forest cover and restore prairies, resulting in higher resilience and fire tolerance under extreme wildfire conditions (Eisenberg et al., 2019). While this initially matches previous findings such as the research by Brodie et al. (2024), Eisenberg et al. (2019) acknowledge hindrances in their restoration goals due to the lack of bison in the region, which were historically maintained by Indigenous peoples. The influences of bison on ecosystems and their impacts on fire management show that Indigenous knowledge involves a deeper understanding of effective burning, therefore making a case for Indigenous-led management in modern systems.

Evidence of Indigenous fire stewardship indicates the substantial value of reintroducing cultural burning in wildfire management, with research outlining key steps for implementing these practices and barriers that must be surpassed in the process. Hoffman et al. (2022a) discuss a lack of understanding of cultural burning practices as one of the largest barriers for Indigenous fire stewardship, as cultural burning requires extensive traditional knowledge of optimal burning times and shared community experiences. While this may present challenges for adaptation in current systems, Indigenous-led burning practices have been shown to reduce wildfire severity and restore ecosystems when implemented in collaborative ways. The "walking on two legs" conceptual restoration model discussed by Dickson-Hoyle et al. (2022) provides an example of Indigenous-led cultural burning in management systems. With one leg guided by Indigenous knowledge and the other guided by western knowledge, Indigenous cultural burning is practiced in BC forests under Secwépemc stewardship (Dickson-Hoyle et al., 2022). This ultimately allows for a collaborative understanding of how Indigenous cultural burning can reduce the impacts of wildfires, inviting opportunities for wider implementation of these practices throughout Canada.

Conclusion

As outlined in this literature review, climate change and fire suppression highlight the need for new management strategies to mitigate wildfires in Canada.

With climate change projected to increase severe wildfire conditions, looking into proactive management has become increasingly important for the long-term health of forests and surrounding communities. The research indicates that prescribed burning and Indigenous cultural burning are beneficial in reducing conditions that lead to extreme wildfires in Canada. Prescribed burning effectively removes fuel buildup on the forest floor without adversely changing forest composition, and it can also reduce species dominance and encourage fire-resistant adaptations to develop in some ecosystems. Indigenous cultural burning has traditionally upheld fire tolerance characteristics in plant species and signifies a deeper understanding of the interplay between fire regimes, keystone species, and wildfire severity.

Although some limitations are still present in current research and in applying proactive fire management to modern systems, the success of prescribed burning treatments and Indigenous-led burning has shown that these practices and methods are worth exploring further. Additional research may need to be conducted to understand how prescribed burning and Indigenous cultural burning affect different forest types across Canada, and how this may shape management going forward. Overall, prescribed burning and Indigenous cultural burning show promise in their ability to reduce wildfire severity in Canada. These practices could have major implications for the way Canada deals with the progressing impacts of climate change on wildfires over time.

References

Arkle, R. S., Pilliod, D. S., & Welty, J. L. (2012). Pattern and process of prescribed fires influence effectiveness at reducing wildfire severity in dry coniferous forests. *Forest Ecology and Management*, *276*, 174–184. https://doi.org/10.1016/j.foreco.2012.04.002

Barlow, C. M., Pellatt, M. G., & Kohfeld, K. E. (2021). Garry oak ecosystem stand history in Southwest British Columbia, Canada: implications of environmental change and indigenous land use for ecological restoration and population recovery. *Biodiversity and Conservation, 30*(6), 1655–1672. https://doi.org/10.1007/s10531-021-02162-2

Brodie, E. G., Knapp, E. E., Brooks, W. R., Drury, S. A., & Ritchie, M. W. (2024). Forest thinning and prescribed burning treatments reduce wildfire severity

and buffer the impacts of severe fire weather. *Fire Ecology, 20(*1), 17. https://doi.org/10.1186/s42408-023-00241-z

Cardil, A., Lorente, M., Boucher, D., Boucher, J., & Gauthier, S. (2019). Factors influencing fire suppression success in the province of Quebec (Canada). *Canadian Journal of Forest Research, 49*(5), 531–542. https://doi.org/10.1139/cjfr-2018-0272

Casals, P., Valor, T., Besalú, A., & Molina-Terrén, D. (2016). Understory fuel load and structure eight to nine years after prescribed burning in Mediterranean pine forests. *Forest Ecology and Management, 362*, 156–168. https://doi.org/10.1016/j.foreco.2015.11.050

Copes-Gerbitz, K., Hagerman, S. M., & Daniels, L. D. (2022). Transforming fire governance in British Columbia, Canada: an emerging vision for coexisting with fire. *Regional Environmental Change, 22(*2), 1–15. https://doi.org/10.1007/s10113-022-01895-2

Cowman, D., & Russell, W. (2021). Fuel load, stand structure, and understory species composition following prescribed fire in an old-growth coast redwood (Sequoia sempervirens) forest. *Fire Ecology, 17*(1), 1–13. https://doi.org/10.1186/s42408-021-00098-0

Dickson-Hoyle, S., Ignace, R. E., Ignace, M. B., Hagerman, S. M., Daniels, L. D., & Copes-Gerbitz, K. (2022). Walking on two legs: a pathway of Indigenous restoration and reconciliation in fire-adapted landscapes. *Restoration Ecology, 30*(4), 1–9. https://doi.org/10.1111/rec.13566

Eisenberg, C., Anderson, C. L., Collingwood, A., Sissons, R., Dunn, C. J., Meigs, G. W., Hibbs, D. E., Murphy, S., Kuiper, S. D., SpearChief-Morris, J., Little Bear, L., Johnston, B., & Edson, C. B. (2019). Out of the ashes: ecological resilience to extreme wildfire, prescribed burns, and Indigenous burning in ecosystems. *Frontiers in Ecology and Evolution, 7*, 1–12. https://www.frontiersin.org/articles/10.3389/fevo.2019.00436

Hessburg, P. F., Prichard, S. J., Hagmann, R. K., Povak, N. A., & Lake, F. K. (2021). Wildfire and climate change adaptation of western North

American forests: a case for intentional management. *Ecological Applications, 31*(8), 1–17. https://doi.org/10.1002/eap.2432

Hoffman, K. M., Christianson, A. C., Dickson-Hoyle, S., Copes-Gerbitz, K., Nikolakis, W., Diabo, D. A., McLeod, R., Michell, H. J., Mamun, A. A., Zahara, A., Mauro, N., Gilchrist, J., Ross, R. M., & Daniels, L. D. (2022a). The right to burn: barriers and opportunities for Indigenous-led fire stewardship in Canada. *FACETS, 7*, 464–481. https://doi.org/10.1139/facets-2021-0062

Hoffman, K. M., Christianson, A. C., Gray, R. W., & Daniels, L. (2022b). Western Canada's new wildfire reality needs a new approach to fire management. *Environmental Research Letters, 17*(6), 1–6. https://doi.org/10.1088/1748-9326/ac7345

Jurvélius, M. (2004). HEALTH AND PROTECTION | Forest Fires (Prediction, Prevention, Preparedness and Suppression). In J. Burley (Ed.), *Encyclopedia of Forest Sciences* (pp. 334–339). Elsevier. https://doi.org/10.1016/B0-12-145160-7/00277-5

Natural Resources Canada. (2021, July 7). *Fire management.* https://natural-resources.canada.ca/our-natural-resources/forests/wildland-fires-insects-disturbances/forest-fires/fire-management/13157

Natural Resources Canada. (2023, September 7). *Canada's record-breaking wildfires in 2023: A fiery wake-up call.* https://natural-resources.canada.ca/simply-science/canadas-record-breaking-wildfires-2023-fiery-wake-call/25303

Schiks, T., Bell, F. W., Searle, E. B., & Lynham, T. (2024). Prescribed fire promotes regeneration in a mature eastern white pine forest. *Forest Ecology and Management, 553*, 1–15. https://doi.org/10.1016/j.foreco.2023.121590

Wasserman, T. N., & Mueller, S. E. (2023). Climate influences on future fire severity: a synthesis of climate-fire interactions and impacts on fire regimes, high-severity fire, and forests in the western United States. *Fire Ecology, 19*(1), 1–22. https://doi.org/10.1186/s42408-023-00200-8

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