

PERSPECTIVE • OPEN ACCESS

## Western Canada's new wildfire reality needs a new approach to fire management

To cite this article: Kira M Hoffman *et al* 2022 *Environ. Res. Lett.* **17** 061001

View the [article online](#) for updates and enhancements.

You may also like

- [Circumpolar spatio-temporal patterns and contributing climatic factors of wildfire activity in the Arctic tundra from 2001–2015](#)  
Arif Masrur, Andrey N Petrov and John DeGroote
- [Critically assessing the idea of wildfire managed retreat](#)  
Kathryn McConnell and Liz Koslov
- [A review of the effects of wildfire smoke on the health and behavior of wildlife](#)  
O V Sanderfoot, S B Bassing, J L Brusa et al.

# Breath Biopsy Conference

BREATH BIOPSY<sup>®</sup>

Join the conference to explore the **latest challenges** and advances in **breath research**, you could even **present your latest work!**



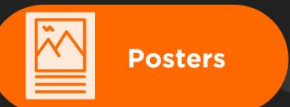
5th & 6th November  
Online



Main talks



Early career sessions



Posters

Register now for free!

ENVIRONMENTAL RESEARCH  
LETTERS

## PERSPECTIVE

Western Canada's new wildfire reality needs a new approach  
to fire management

## OPEN ACCESS

## RECEIVED

21 December 2021

## REVISED

13 May 2022

## ACCEPTED FOR PUBLICATION


25 May 2022

## PUBLISHED

7 June 2022

Original content from  
this work may be used  
under the terms of the  
[Creative Commons  
Attribution 4.0 licence](#).

Any further distribution  
of this work must  
maintain attribution to  
the author(s) and the title  
of the work, journal  
citation and DOI.

Kira M Hoffman<sup>1,2,\*</sup> , Amy Cardinal Christianson<sup>3</sup>, Robert W Gray<sup>4</sup> and Lori Daniels<sup>1</sup><sup>1</sup> Department of Forest and Conservation Sciences, Forest Sciences Centre, University of British Columbia, 3041-2424 Main Mall, Vancouver, BC, Canada<sup>2</sup> Bulkley Valley Research Centre, 3731 1st Ave, Smithers, BC, Canada<sup>3</sup> Northern Forestry Centre, Canadian Forest Service, 5320-122nd Street, Edmonton, AB, Canada<sup>4</sup> W Gray Consulting Ltd, 6311 Silverthorne Road, Chilliwack, BC, Canada

\* Author to whom any correspondence should be addressed.

E-mail: [kira.hoffman@ubc.ca](mailto:kira.hoffman@ubc.ca)**Keywords:** prescribed fire, controlled burning, cultural burning, Indigenous fire stewardship, wildfire mitigation, Western Canada

## 1. Introduction

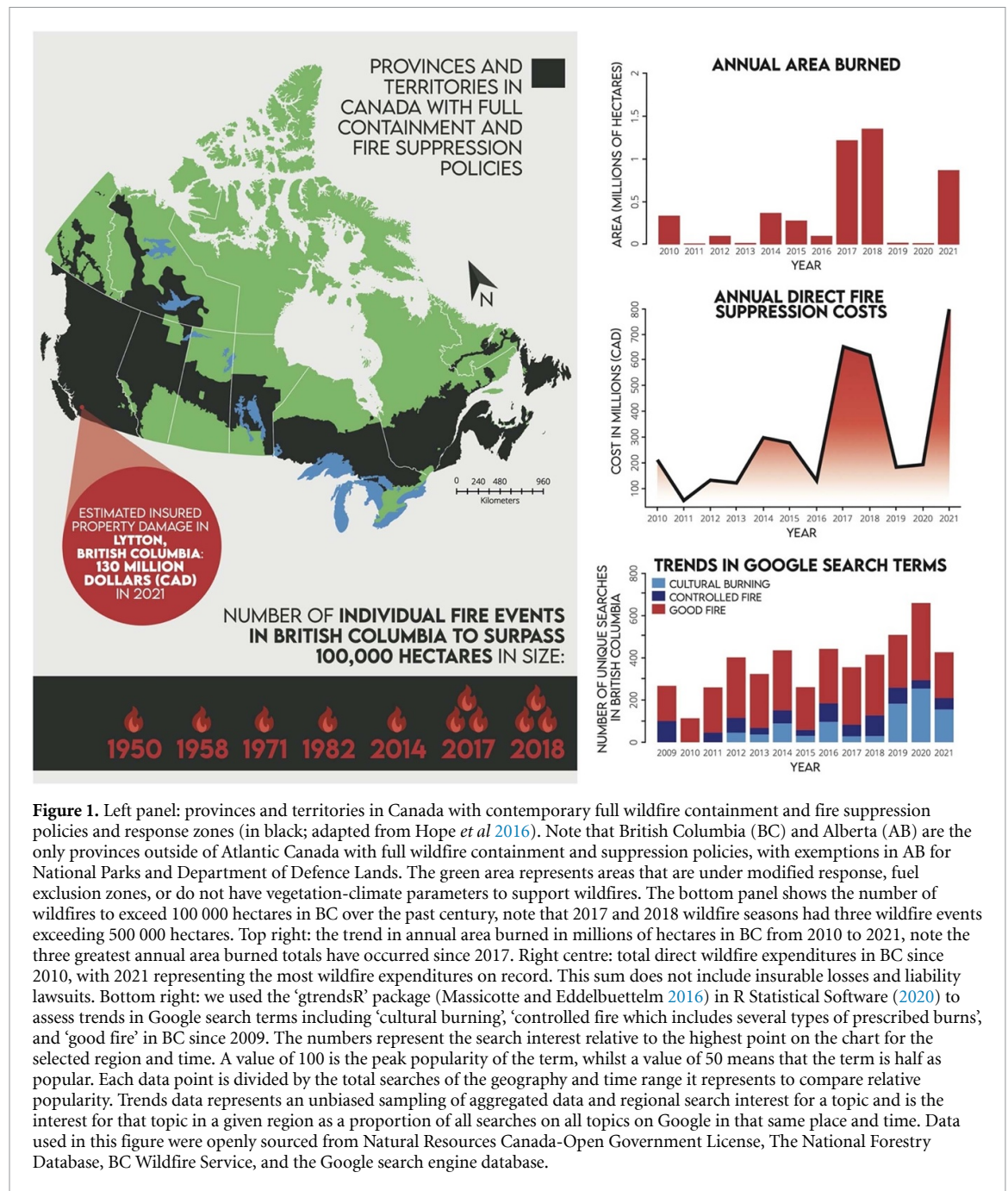
Wildfire seasons in Canada are changing. Recent uncharacteristically large and intense wildfires have exceeded abilities for fire suppression, highlighting the urgent need for improved methods and resource capacities to mitigate wildfire risk (Coogan *et al* 2019, Johnston *et al* 2020, Wang *et al* 2020). Although the overall number of wildfire events has decreased in Canada since the 1970s, the average annual area burned has doubled, with wildfire events exceeding 100 000 hectares in size becoming commonplace (figure 1).

In the past decade Canada has experienced numerous wildfires at the extremes of historical variability, destroying or seriously damaging human communities, wildlife habitat, and natural resources (Tymstra *et al* 2020, Hagmann *et al* 2021). This trend coincides with a steady increase in direct fire suppression costs, averaging \$1 billion yr<sup>-1</sup> since 2014—a threshold that was not predicted to occur until the latter half of the 21st century (Hope *et al* 2016). Direct suppression costs are only a fraction of total fire costs, and indirect wildfire costs (such as impacts to watersheds, ecosystems, infrastructure, individuals, and the local and national economies) are estimated to be two to thirty times total suppression costs (Dale 2009).

The six most impactful wildfire events in Canadian history—based on area burned, suppression costs, and the number of people evacuated—all occurred in western Canada during the last decade (figure 1, Canadian Council of Forest Ministers (2020)). These uncontrollable wildfire incidents include the 2011 Slave Lake fire in northern Alberta

(AB), which destroyed 500 properties with insured damages exceeding 700 million dollars (Natural Resources Canada 2020). In 2014, wildfires burned 3.5 million hectares in the Northwest Territories, the second largest area burned in a single fire season in Canada. In 2016, the Horse River fire drove 88 000 people from Fort McMurray, AB, the largest wildfire evacuation in Canadian history. At an estimated 9 billion dollars in direct and indirect damages; at the time, this fire was the costliest disaster in Canadian history (Johnston *et al* 2020). In 2017, British Columbia (BC) experienced its greatest annual area burned in a century (1.22 million hectares), which was quickly surpassed by another record year in 2018 (1.35 million hectares).

The 2021 wildfires in BC set several new records. The wildfire season started a month earlier than average, following three days of record setting temperatures reaching almost 50° C. This 'heat dome' catalysed a series of wildfires, including one that burned 90% of the community of Lytton, BC, resulting in the loss of two lives. The 2021 wildfire season became the third largest annual area burned in BC, with the most expensive suppression price tag of any BC wildfire season at 800 million dollars. In a disturbance cascade, these wildfires contributed to the devastating landslides and floods that inundated portions of southern BC in the fall of 2021, which have now superseded the costs of the 2016 Horse River wildfire, setting a new record for Canada's costliest disaster. The analyses presented in this perspective focus primarily on BC, the province expected to be at highest risk of future extreme wildfire events in Canada (Jain *et al* 2022).



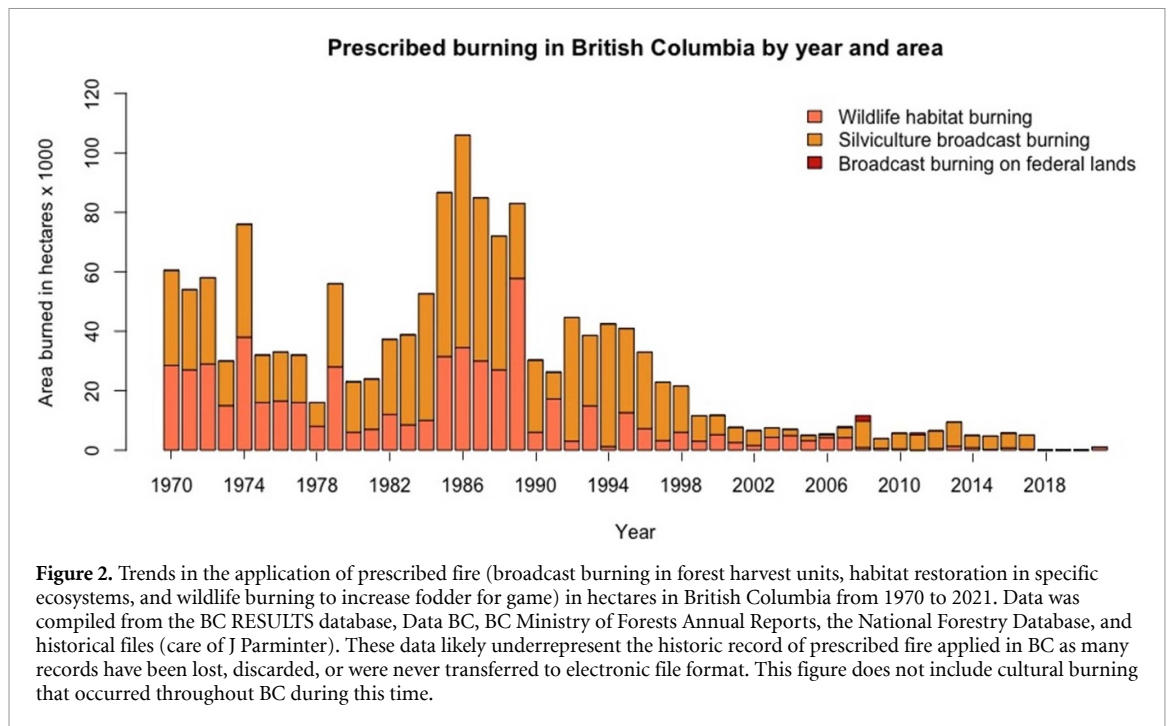
**Figure 1.** Left panel: provinces and territories in Canada with contemporary full wildfire containment and fire suppression policies and response zones (in black; adapted from Hope *et al* 2016). Note that British Columbia (BC) and Alberta (AB) are the only provinces outside of Atlantic Canada with full wildfire containment and suppression policies, with exemptions in AB for National Parks and Department of Defence Lands. The green area represents areas that are under modified response, fuel exclusion zones, or do not have vegetation-climate parameters to support wildfires. The bottom panel shows the number of wildfires to exceed 100 000 hectares in BC over the past century, note that 2017 and 2018 wildfire seasons had three wildfire events exceeding 500 000 hectares. Top right: the trend in annual area burned in millions of hectares in BC from 2010 to 2021, note the three greatest annual area burned totals have occurred since 2017. Right centre: total direct wildfire expenditures in BC since 2010, with 2021 representing the most wildfire expenditures on record. This sum does not include insurable losses and liability lawsuits. Bottom right: we used the ‘gtrendsR’ package (Massicotte and Eddebuettelm 2016) in R Statistical Software (2020) to assess trends in Google search terms including ‘cultural burning’, ‘controlled fire which includes several types of prescribed burns’, and ‘good fire’ in BC since 2009. The numbers represent the search interest relative to the highest point on the chart for the selected region and time. A value of 100 is the peak popularity of the term, whilst a value of 50 means that the term is half as popular. Each data point is divided by the total searches of the geography and time range it represents to compare relative popularity. Trends data represents an unbiased sampling of aggregated data and regional search interest for a topic and is the interest for that topic in a given region as a proportion of all searches on all topics on Google in that same place and time. Data used in this figure were openly sourced from Natural Resources Canada-Open Government License, The National Forestry Database, BC Wildfire Service, and the Google search engine database.

### 1.1. Multiple contributing and compounding factors

The secondary impacts of wildfire are numerous and costly. Significant health impacts caused by smoke and stress are superimposed on the costs of evacuation, losses of property, impacts on infrastructure, as well as ecological and economic losses (Holm *et al* 2021). Critically, wildfires disproportionately affect remote and forested Indigenous communities in Canada and Indigenous peoples are 33% more likely to evacuate from a wildfire (McGee 2021). Many Indigenous communities face significant capacity restrictions and financial barriers to effectively engage in wildfire risk and hazard mitigation (Hoffman *et al* 2022). We are only beginning to understand the

physical health impacts of smoke and other environmental hazards on wildland firefighters, a tremendous cost for their efforts to protect people and communities (Navarro *et al* 2019). Emergency first responders, including wildland firefighters, also suffer increased rates of mental health issues, including post-traumatic stress disorder and suicide following destructive wildfires (Stanley *et al* 2018).

Multiple factors have converged, yielding Canada’s new wildfire reality. Climate change is driving warmer and drier summers and longer fire seasons—conditions more conducive to wildfire ignition and spread (McWethy *et al* 2019). But equally important is the condition of the forests. Over the last century, Canada has implemented widespread fire



exclusion policies across fire-dependent landscapes. Although many provinces have adapted policies to support modified response—including managed wildfires—particularly in parks and protected areas, BC and AB have a long legacy of highly aggressive fire suppression mandates (figure 1, Hope *et al* 2016, Tymstra *et al* 2020). The accumulation of large amounts of dry and dead fuel—a direct result of over 100 years of fire exclusion, cumulative disturbances, and forest management practices—is intensifying wildfire behaviour, putting firefighters and the communities they protect at greater risk (Coogan *et al* 2019, 2021). Funding for preventive approaches to wildfire remains a small fraction of direct suppression costs (in many places <10%) and although fire suppression budgets continue to grow, preventative wildfire budgets remain the same and are inadequate to support initiatives proposed by vulnerable communities (Copes-Gerbitz *et al* 2022). Simultaneously, populations are growing and the resultant communities are contributing to the wildland-urban interface problem, with many housing developments seemingly oblivious to wildfire risk (Tymstra *et al* 2020).

Of all natural disasters, we believe that solutions to wildfire are the most complex and have proven the most challenging to deploy. While the frightening and destructive impacts of wildfires dominate news headlines, fire can also be beneficial, maintaining the diversity and resilience of landscapes (Coogan *et al* 2021, Hoffman *et al* 2021). Equally underreported and undervalued is the role of fire as a fundamental Indigenous cultural practice (Lake and Christianson 2020). This conundrum is known as the ‘double fire paradox’: the consequence of attempting to exclude fire is increasing the occurrence of extreme

wildfires, which can be resolved by returning the appropriate type of fire (which can be highly variable depending on forest type) to landscapes. Canada’s predominant fire suppression approach often disregards preventative, longer-term strategies that involve fuels management—forest thinning, fuel removal, and proactive use of fire.

## 1.2. Mitigation

Prescribed fire is the intentional use of controlled burning to manage fuels and landscapes, and cultural burning is the intentional use of fire by Indigenous peoples to achieve cultural objectives. When used safely, prescribed fire and cultural burning are effective fuel reduction tools, providing significant benefits to fire-dependent ecosystems, wildlife, and human communities (Dickson-Hoyle *et al* 2021) But fighting fire with fire is also one of the most controversial and underutilized wildfire mitigation technique (Kolden 2019). For example, the use of prescribed fire in BC has fallen dramatically in recent decades (figure 2), despite substantive research revealing long-term positive effects (Weber and Taylor 1992). Nevertheless, a query of the search terms ‘cultural burning’, ‘controlled fire’, and ‘good fire’, in BC since 2009 revealed that the public is becoming increasingly interested in learning about other ways of managing and living with fire (figure 1).

Wildfire management agencies across Canada are beginning to show a renewed interest in the application of prescribed fire and cultural burning to reduce wildfire risk. But although Indigenous peoples have maintained fire stewardship practices and continue to be keepers of fire knowledge, western-trained scientists and resource managers often remain sceptical of,



or unfamiliar with, Indigenous fire knowledge, which has been consistently devalued by wildfire management agencies (Dickson-Hoyle *et al* 2021, Hoffman *et al* 2022). Importantly, prescribed burning is distinct from cultural burning, primarily in the burn objectives, techniques used to burn, and who is conducting the burn. Indigenous knowledge is not a ‘thing’ that can be captured and appropriated into plans by agencies to inform wildfire management (Hoffman *et al* 2022).

We believe that wildfire planning, mitigation, and prevention needs to be decentralized, with Indigenous Nations and Indigenous communities empowered to lead and engage in wildfire management that aligns with cultural and ecological values. Overcoming existing systematic barriers will require educating the public on risk reduction techniques, enhancing technical training across cultures and areas of expertise, and collaborating with communities and regional districts on wildfire mitigation. In 2019, the Province of BC became the first jurisdiction in Canada to implement the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP). Under UNDRIP, BC has committed to respect traditional cultural expressions, science, and knowledge, thus transforming how fire and forest statuses are interpreted (Hoffman *et al* 2022).

Fire suppression will remain critical to protecting lives, communities, and infrastructure on a subset of the landscape, and we must recognize and support the first responders who put themselves in harm’s way to protect lives and property. However, deciding where and when to suppress wildfires versus managing wildfires by monitoring their spread and impacts and intended fire regimes will be key to living more safely with fire now and in the future.

## 2. Conclusions

As large, high-severity wildfires become more commonplace, it is clear that Canada needs to evolve its approach to managing wildfire. This will mean transforming wildfire policies that reflect both the best available science, practical ‘boots on the ground’ experience, and millennia of Indigenous knowledge (Dickson-Hoyle *et al* 2021). Full containment fire suppression tactics are often impractical, unsustainable, and ecologically detrimental in fire-prone landscapes (McWethy *et al* 2019). We believe that the reluctance of decision makers to apply prescribed fire and support Indigenous-led cultural burning, which at a landscape-scale can expand suppression tactics and greatly improve suppression success, stems from a perceived lack of public understanding and lack of experienced personnel, along with largely unfounded fears of fire escape and air pollution. This undermines millennia of Indigenous knowledge and

the wealth of place-based experience Indigenous and non-Indigenous fire practitioners bring to mitigating wildfire risk.

As we face the challenges posed by Canada’s new wildfire reality, increasing the use of prescribed fire and supporting Indigenous-led cultural burning will reduce wildfire risk to communities while enhancing the health of forest and grassland ecosystems across the broader land base.

## Data availability statement

The data generated and/or analysed during the current study are not publicly available for legal/ethical reasons but are available from the corresponding author on reasonable request.

## Acknowledgments

This research was supported by funds from the Natural Sciences and Engineering Research Council (Postdoctoral Fellowship; K M Hoffman) and the British Columbia Ministry of Forests, Lands, Natural Resource Operations and Rural Development, BC Wildfire Service through its membership with the Canadian Partnership for Wildland Fire Science.

## ORCID iD

Kira M Hoffman  <https://orcid.org/0000-0001-8896-2797>

## References

- Canadian Council of Forest Ministers (Conseil canadien des ministres des forêts) 2020 National Forestry Database (Base de données nationales des forêts - Canada (Version 2.0.0) [Data set]. Natural Resources Canada—Ressources naturelles Canada (<https://doi.org/10.5281/zenodo.3690046>)
- Coogan S C P, Daniels L D, Boychuk D, Burton P J, Flannigan M D, Gauthier S, Kafka V, Park J S and Wotton B M 2021 Fifty years of wildland fire science in Canada *Can. J. For. Res.* **51** 283–302
- Coogan S C P, Robinne F-N, Jain P and Flannigan M D 2019 Scientists’ warning on wildfire—a Canadian perspective *Can. J. For. Res.* **49** 1015–23
- Copes-Gerbitz K, Hagerman S M and Daniels L D 2022 Transforming fire governance in British Columbia, Canada: an emerging vision for coexisting with fire *Reg. Environ. Change* **22** 48
- Dale L 2009 The western forestry leadership coalition *The True Cost of Wildfire in the Western US*
- Dickson-Hoyle S, Ignace R E, Ignace M B, Hagerman S M, Daniels L D and Copes-Gerbitz K 2021 Walking on two legs: a pathway of Indigenous restoration and reconciliation in fire-adapted landscapes *Restor. Ecol.* **30** e13566
- Hagmann R K *et al* 2021 Evidence for widespread changes in the structure, composition, and fire regimes of western North American forests *Ecol. Appl.* **31** e02431
- Hoffman K M *et al* 2022 The right to burn: barriers and opportunities for Indigenous-led fire stewardship in Canada *FACETS* **7** 464–81

- Hoffman K M, Davis E L, Wickham S B, Schang K, Johnson A, Larking T, Lauriault P N, Le N Q, Swerdfager E and Trant A J 2021 Conservation of Earth's biodiversity is embedded in Indigenous fire stewardship *Proc. Natl Acad. Sci.* **118** e2105073118
- Holm S M, Miller M D and Balmes J R 2021 Health effects of wildfire smoke in children and public health tools: a narrative review *J. Expo. Sci. Environ. Epidemiol.* **31** 1–20
- Hope E S, McKenney D W, Pedlar J H, Stocks B J and Gauthier S 2016 Wildfire suppression costs for Canada under a changing climate *PLoS One* **11** e0157425
- Jain P, Castellanos-Acuna D, Coogan S C P, Abatzoglou J T and Flannigan M D 2022 Observed increases in extreme fire weather driven by atmospheric humidity and temperature *Nat. Clim. Change* **12** 63–70
- Johnston L M *et al* 2020 Wildland fire risk research in Canada *Environ. Rev.* **28** 164–86
- Kolden C A 2019 We're not doing enough prescribed fire in the Western United States to mitigate wildfire risk *Fire* **2** 30
- Lake F K and Christianson A C 2020 Indigenous fire stewardship *Encyclopedia of Wildfires and Wildland-urban Interface (WUI) Fires* (Cham: Springer International Publishing)
- Massicotte P, Eddelbuettel D and Massicotte M P 2016 Package 'gtrendsR'
- McGee T K 2021 Evacuating first nations during wildfires in Canada *Fire Saf. J.* **120** 103120
- McWethy D B *et al* 2019 Rethinking resilience to wildfire *Nat. Sustain.* **2** 797–804
- Natural Resources Canada 2020 Canadian wildland fire information system *National Wildland Fire Situation Report* (available at: <https://cwfis.cfs.nrcan.gc.ca/report>)
- Navarro K M, Kleinman M T, Mackay C E, Reinhardt T E, Balmes J R, Broyles G A, Ottmar R D, Naher L P and Domitrovich J W 2019 Wildland firefighter smoke exposure and risk of lung cancer and cardiovascular disease mortality *Environ. Res.* **173** 462–8
- R Core Team 2020 R: A language and environment for statistical computing (Vienna: R Foundation for Statistical Computing) (available at: <https://www.R-project.org/>)
- Stanley I H, Hom M A, Gai A R and Joiner T E 2018 Wildland firefighters and suicide risk: examining the role of social disconnectedness *Psychiatry Res.* **266** 269–74
- Tymstra C, Stocks B J, Cai X and Flannigan M D 2020 Wildfire management in Canada: review, challenges and opportunities *Prog. Disaster Sci.* **5** 100045
- Wang X, Studens K, Parisien M-A, Taylor S W, Candau J-N, Boulanger Y and Flannigan M D 2020 Projected changes in fire size from daily spread potential in Canada over the 21st century *Environ. Res. Lett.* **15** 104048
- Weber M G and Taylor S W 1992 The use of prescribed fire in the management of Canada's forested lands *For. Chronicle* **68** 324–34