2017 Megafires in British Columbia: Urgent Need to Adapt and Improve Resilience to Wildfire

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Abstract—The status quo approach of addressing wildfire threat in British Columbia is not working. In 2017, wildfires overwhelmed suppression capabilities, burned 1.2 million hectares, and cost $568 million for suppression and immediate rehabilitation. From 2003 to 2017, the Provincial government spent $3.1 billion on direct fire suppression, but only $73.8 million on proactive fuels mitigation in the wildland-urban interface. A holistic, landscape view of this problem and transformative changes to wildfire and forest management are urgently needed to achieve forest and community resilience to wildfires. We propose a four-part approach to improve forest and community resilience in British Columbia: (1) increase resources for initial attack and emergency fuel reduction treatments; (2) integrate wildland-urban interface zoning and proactive landscape planning; (3) prioritize forest restoration and adaptive forest management; and (4) invest in research to inform adaptive wildfire management. Our recommendations aim to transform policies and practices to improve ecological and social resilience to wildfire. We contributed written and oral submissions to the 2018 Provincial Flood and Fire Review. The resulting report includes 108 recommendations, 44 of which are consistent with changes we proposed. Through advocacy based on our applied research, we are working toward implementation of transformative change to wildfire management in British Columbia.

Keywords: adaptive management, forest restoration, fuel mitigation, fuel reduction, landscape planning, wildland-urban interface, wildfire management

INTRODUCTION

2017 Wildfires in British Columbia

The 2017 wildfires clearly showed that forests and communities in British Columbia (BC) are not resilient to wildfire and the status quo approach of addressing wildfire threat in BC is not working. The 2017 wildfires overwhelmed suppression capabilities: more than 1.2 million ha of forests burned; and 65,000 citizens were forced from their homes during a 10-week Provincial state of emergency (Abbott and Chapman 2018). Direct costs exceeded $768 million (CAD): $568 million for suppression and approximately $200 million emergency support for evacuees. Indirect, long-term costs of human health impacts, lost cultural values, and compromised ecosystem services such as water and timber supply, livestock, biodiversity, and environmental and habitat degradation will greatly exceed direct costs (Gray et al. 2015).

BC's extreme wildfire season of 2017 was not an isolated event. It is part of a global trend of increasing megafires with tremendous social, ecological, and

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economic costs (Stephens et al. 2014). Since 2001, wildfires in BC have been driven by record-breaking high temperatures and pronounced droughts, combined with excessive fuels resulting from fire suppression, widespread forest health problems, and forest management practices. In this essay, we argue that inadequate funding and numerous policy conflicts perpetuate hazardous conditions, leaving communities vulnerable to wildfire. We outline a holistic, landscape view of this problem and advocate transformative changes to wildfire and forest management that are urgently needed to achieve forest and community resilience to contemporary and future wildfires.

Wildfire Management in British Columbia

The western-most Province in Canada, BC, covers 94 million hectares (ha; 232.3 million acres), 95 percent of which is publicly owned or "Crown" land. The Province is geographically diverse, spanning 10 degrees of latitude and crossing the Coastal, Cascade, and Rocky Mountains. It encompasses 18 different bioclimatic zones with diverse vegetation ranging from grasslands to coastal temperate rainforests to true boreal forests. Of 62 million ha (153.2 million acres) of forests, 24 million ha (59.3 million acres) are designated for management emphasizing timber, regulated by the Provincial government. On average, 200,000 ha (494,211 acres) per year are harvested within a sustained yield framework. Another 6.2 million ha (15.3 million acres) are grasslands and dry forests, < 4,000 ha (9,884 acres) of which are restored to maintain open conditions each year.

Wildfire management is the responsibility of the BC Wildfire Service. On average (2007-2016), the Province experienced 1,692 fire starts annually, with 57 percent ignited by lightning and 43 percent human-caused (table 1). The annual area burned is strongly influenced by fire suppression policies. Until 2011, the wildfire management strategy was dedicated to protecting people, property, forests, and grasslands from fire (BC Government 2006, 2010). Reportedly, 92 percent of fires were suppressed while less than 4 ha in size and within 24 hours of detection (BC Wildfire Management Branch 2012). Paradoxically, protecting some forests from fire during the 20th century has resulted in changes to forest composition and structure and increased fuel loads (Chavardès et

Table 1—Wildfire fire summary statistics for British Columbia. The 2017 season is compared with individual years and averages of the previous decade from 2007 to 2016. (Source: BC Government 2018a)

Year	Fires (N)	Total area burned (ha)	Mean area per fire (ha)	Person-caused N (%)	Lightning-caused N (%)
2017	1,353	1,216,053	898.8	552 (42%)	773 (58%)
2016	1,050	100,366	95.6	564 (54%)	486 (46%)
2015	1,858	280,605	204.9	617 (33%)	1,237 (67%)
2014	1,481	369,168	249.3	664 (45%)	817 (55%)
2013	1,861	18,298	9.8	564 (30%)	1,297 (70%)
2012	1,649	102,122	61.9	708 (43%)	941 (57%)
2011	653	12,604	19.3	444 (68%)	209 (32%)
2010	1,672	337,149	201.6	680 (41%)	992 (59%)
2009	3,064	247,419	80.8	881 (29%)	2,183 (71%)
2008	2,023	13,240	6.5	848 (42%)	1,175 (58%)
2007	1,606	29,440	18.3	687 (43%)	919 (57%)
Average	**1,692**	**151,041**	**94.8**	**666 (43%)**	**1,026 (57%)**

al. 2016, 2018; Daniels et al. 2011; Marcoux et al. 2013, 2015), potentially resulting in a shift toward more extreme fire behavior with more severe effects than occurred historically (Stephens et al. 2014). These effects are most pronounced in low-elevation dry forests, many of which form the wildland-urban interface surrounding the 161 municipalities and 203 indigenous communities and reserves in BC (UBCIC 2018; UBCM 2018). These forests also influence drinking water supplies and provide the timber and other resources that sustain rural economies. Superimposed on changes due to fire exclusion and suppression are global warming (Flannigan et al. 2016; Wotton et al. 2017) and widespread insect outbreaks (Raffa et al. 2008) that have altered fuels in many forests. With cumulative human impacts interacting with natural disturbances enhanced by climate change, the traditional engineering approach of trying to "control" fires has proven unsuccessful in recent years.

In 2012, a new Provincial wildfire management strategy was introduced. The new mandate is to "deliver effective wildfire management and emergency response support on behalf of the government of British Columbia to protect life and values at risk and to encourage sustainable, healthy and resilient ecosystems" (BC Wildfire Management Branch 2012). This mandate has resulted in a shift toward a diversity of management strategies, with three new strategic priorities in addition to fire suppression. Fuel management aims to reduce loss and damage from wildland fires through community wildfire protection planning and fuel hazard reduction. It is complemented by landscape fire management planning to create fire-adapted communities and fire-resilient ecosystems, and by innovation in wildfire management science, practices, technology, and decision support models. Although a strong conceptual framework, implementation has been inadequate and resistance from Provincial-level public and private-sector agencies has left BC citizens and communities vulnerable to wildfire.

From 2003-2017 (table 2), the cost of direct fire suppression in BC was $3.1 billion. Over the same period, BC budgeted a total of $183 million to

Table 2—Wildland fire expenditure and area burned versus treated in British Columbia since 2003. Expenditures are in Canadian dollars and do not account for inflation. (Data provided by the BC Wildfire Service, April 2018.)

Year	Suppression expenditure ($)	Area burned (ha)	Prevention expenditure ($)[1]	Prevention area treated (ha)
2017	568,000,000	1,216,046	3,028,290	245
2016	129,000,000	100,366	14,297,105	456
2015	277,000,000	280,605	3,570,483	406
2014	297,900,000	369,168	3,723,375	653
2013	122,200,000	18,298	6,951,454	1,332
2012	133,600,000	102,122	4,622,321	1,125
2011	53,500,000	12,604	7,312,059	1,524
2010	212,200,000	337,149	7,698,877	1,361
2009	382,100,000	247,419	10,871,019	2,041
2008	82,100,000	13,240	5,090,966	657
2007	98,800,000	29,440	3,129,038	862
2006	160,000,000	139,265	2,142,072	867
2005	47,000,000	34,588	1,040,925	149
2004	165,000,000	220,518	283,361	
2003	371,000,000	265,053		
Totals	3,099,000,000	3,385,881	73,761,344	11,679

[1] Prevention expenditures were from the Strategic Wildfire Prevention Initiative, plus $11,160,000 from the Forest Enhancement Society in 2016.

proactive, preventative wildfire management, although research shows the cost of reducing wildfire extent and severity through proactive fuel management is lower than the cost of fighting extensive wildfires. Funding was allocated to three programs: $78 million to the Strategic Wildfire Prevention Initiative for treatment of the wildland-urban interface treatments starting in 2004; $85 million to the Forest Enhancement Society of BC (FESBC) for landscape treatments starting in 2015; and $20 million to the Ecological Restoration Program for ongoing management of grasslands and open forests. In 2004, the Provincial government designated a 2-km-wide zone surrounding communities as wildland-urban interface (WUI). The Province-wide strategic threat assessment of fuel hazards classified 685,000 ha as high to extreme hazard and another 970,000 ha as low to moderate wildfire hazard in the WUI (BC Forest Practices Board 2015). By 2017, only 10 percent of hazardous fuels around high-risk communities had been treated (BC Forest Practices Board 2015), 11,679 ha of which were directly funded by the Strategic Wildfire Prevention Initiative (table 2). Other treatments were by the BC Wildfire Service (5,000 ha), BC Ecological Restoration Program (33,600 ha), and harvesting in the WUI by industry (25,880 ha). Although credited as fuels mitigation, only 10 percent of industrial harvesting was specifically for mitigation. Few of the industrial harvesting treatments included mitigation of slash using prescribed burning; so, without posttreatment assessment and monitoring, efficacy remains unknown. Most communities in BC remain vulnerable to wildfire despite concerted efforts over the past decade to inform communities and engage them in mitigation.

The high cost and low return of the Strategic Wildfire Prevention Initiative program raises concerns. In 2015, BC's Forest Practices Board reported the average cost of fuels mitigation was $10,000 per hectare, although extremely high treatment costs in some communities skews this value. The median or midpoint cost was closer to $5,000 per hectare. At this cost, $3.425 billion is needed to treat the 685,000 hectares of WUI classified as high to extreme hazard in 2004; another $4.85 billion would be needed to treat the 970,000 hectares that were classified as low to moderate hazard. Increasing fuel hazards over time and expansion of the WUI exacerbate this problem. Given the necessity of fire suppression near communities, additional fuels have accumulated in the absence of treatments. Some areas that were considered low or moderate hazard in 2004 may have shifted to moderate or high hazard, increasing the urgency for immediate treatments. Moreover, the total area of WUI likely expanded since 2004, given the rapid population growth taking place in some parts of BC. For example, the population of the Central Okanagan Regional District increased by c.15,000 people between 2011 and 2016, led by the City of Kelowna that increased by 8.4 percent, according to the 2016 Canadian census (Statistics Canada 2016). Today, most BC communities remain vulnerable to adverse wildfire behavior and total area at risk is increasing, although it has been more than a decade since the implementation of funding programs to mitigate fuels.

The Need for Transformative Change and Adaptation

In response to catastrophic interface wildfires in 2003, a Provincial review was commissioned and the resulting Firestorm 2003 report provided a road-map for addressing the wildfire hazard to communities throughout BC (Filmon 2004). On the operational side, in areas of emergency response coordination and communications, there has been substantial improvement. However, in the area of fuels and forest practices, which is the largest component necessary to reduce wildfire severity and threats to communities, there has been little action. Implementation of the Filmon Report recommendations has been inadequate and resistance from Provincial-level public and private-sector agencies has left BC citizens and communities vulnerable to wildfire. A holistic, landscape view of this problem and transformative changes to wildfire and forest management are urgently needed to achieve forest and community resilience to contemporary and future wildfires.

RECOMMENDATIONS TO IMPROVE FOREST AND COMMUNITY RESILIENCE

In this paper, we propose a four-pronged approach and provide specific recommendations to improve forest and community resilience in BC. Our recommendations reiterate several from Filmon's

(2004) Firestorm 2003 report that need to be fully implemented and include new recommendations to address problems that have become apparent in the past 13 years. Below, we summarize the four approaches by identifying urgent needs, providing constructive criticism of current actions, and recommending ways that change can be effectively implemented.

1. Initial Attack and Emergency Fuel Reduction Treatments

British Columbia needs significant increases in human resources for all facets of wildland fire management, including wildfire suppression, managed wildfire, and prescribed fire. Additional seasonal staff on initial attack and unit crews are needed. Additionally, BC has a large pool of very experienced seasonal staff that should see advancement to fulltime positions doing landscape fire planning as well as prescribed fire planning and implementation. Hiring, training, and promoting local people will build capacity in First Nations communities and rural municipalities. Managed wildfire needs to be used more as a landscape-level tactic and long-term resource management strategy; however, its use must be science-based rather than guided by economics. Prescribed fire needs to be used extensively to reduce hazardous fuel accumulations in the WUI as well as the larger landscape around communities. When applied correctly, it is a highly effective fuel treatment that can reduce fuel continuity over large areas and establish a safe work environment for wildland fire fighters. Researchers have determined that prescribed fire, in combination with manual/mechanical thinning, is the most effective fuel treatment available when compared to thinning or burning as stand-alone treatments (Schwilk et al. 2009; Stephens et al. 2009, 2012). Where prior thinning is not available, prescribed burning is the best option. Prescribed fire also has substantial ecological and cultural benefits for many of BC's terrestrial ecosystems. BC faces a significant deficit in qualified, experienced prescribed fire practitioners capable of delivering the scale of burn program necessary. In order to build this capacity and address concerns over liability, we encourage the Province to adopt the following 15 recommendations.

Wildland Fire Resources

- Increase the number of full and part-time BC Wildfire Service (BCWS) staff in order to increase capacity for prescribed fire planning and operations and landscape wildfire management planning.
- Fund First Nations governments to employ and train fire management staff and planners.
- Train and certify a number of contract crews to the Provincial Type 1 crew standard.
- Hire additional unit crews during prescribed burning and wildfire seasons.

Resourcing Fuel Reduction Treatments (Including Thinning and Prescribed Burning)

- Provide prescribed fire training and extend the Provincial certification to non-agency personnel. This training and certification must not be limited to just burn bosses; it must include all support positions.
- Add fire effects and burn planning courses to the required Provincial Burn Boss Certification curriculum (e.g., adopt the Parks Canada course for burn planning and the US RX-310 Fire Effects course).
- The Province must certify and track certification currency for all prescribed fire personnel regardless of their employer.
- All burn plans on Crown land must be reviewed and approved by a certified burn boss with certification equal to or exceeding the level of the burns they are reviewing.
- The Province must develop regional multi-party prescribed fire modules in order to address the current short-fall in qualified practitioners.
- The Province must provide adequate funding to BCWS and First Nations crews for prescribed burning.
- The Province must provide timely funding for early spring prescribed burns to ensure that the timing for prescribed fire is not missed in any given year.

- The Province must address smoke constraints to prescribed burning. Either change the ventilation index (BC Government 2018b) approach to an approach focused on actual airshed pollution capacity (under PM2.5 criteria) or provide greater flexibility in ventilation index thresholds (e.g., allow burns under "fair" conditions).
- The Province must set limits on liability. For approved burn plans conducted by trained and certified personnel, there should be less liability. The Province self-insures so it can set limits on liability.
- The Province must implement a burn monitoring process based on burn objectives and scale of operations. Fire effects predicted in burn plans must be measured during burns to determine if/how desired fire behavior is being achieved. Ecological and forest effects of prescribed burns must be measured before and after burns to determine if management objectives are being met.
- The Province must implement a process of open and transparent after-action reviews of plans, operations, and efficacy of all prescribed burns. This is needed to build the knowledge base, expertise, and capacity.

2. Integrate Wildland-Urban Interface Zoning and Proactive Landscape Planning

British Columbia needs to develop a new relationship with its rural communities, including First Nations, when it comes to reducing the threat of wildfire. There have been many positive outcomes following the 2003 Firestorm report (Filmon 2004), such as increased awareness of wildfire threat and the need for proper community planning. On the other hand, several aspects of the Province's approach to solving the problem have been detrimental to relations between the three levels of government. Local government was expected to lead in the planning and operational treatment of wildfire hazard across the WUI, including hazards on Crown land. Those governments are severely hampered by existing forest and wildlife management policies that were not intended to mitigate wildfire hazard as a priority land management objective (e.g., as guided by existing Commission on Resource and Environment plans and Land and Resource Management Plans). We recommend the Province set the long-term maintenance of a low fire hazard condition in the forests and on rangelands in the vicinity of rural communities as the primary land management objective. Depending on landscape configuration and land use patterns, the maintenance of such WUI buffer zones may be required for up to 15 km from some communities. Additionally, we offer 13 specific recommendations for addressing existing policy that run counter to community resilience.

- The Province must work with local governments and First Nations to adjust spatial limits on the WUI buffer based on local forest, fuels, topography, and values at risk, as is the practice in other jurisdictions. Municipal governments, First Nations and the Ministry of Forests, Lands, Natural Resource Operations, & Rural Development (FLNRORD) must work together to determine the best way to ensure that the work is done in a way that maximizes actual fire risk-reduction and increased resilience and that it protects and enhances community values and benefits.
- All municipal lands in need of treatment must be eligible for funding regardless of where it is in the WUI. Currently, municipal land beyond a 2-km buffer is ineligible for funding from both the Strategic Wildfire Prevention Initiative and the Forest Enhancement Society of BC, even if they received prior operational treatment with funding from Strategic Wildfire Prevention Initiative.
- All Crown land outside the municipal boundary must be directly managed by FLNRORD.
- All Crown land in the WUI must be taken out of the timber harvesting land base. However, this does not preclude future fiber recovery from these lands.
- Tree restocking requirements in the WUI must be abolished. Where relevant, upper limits of stocking standards on other Crown land must be lowered to reduce risk of high-severity wildfire. As stands develop, forest companies would be required to thin overstocked stands, with the exception of deciduous species.

- Wood from fuel treatments on Crown land in the WUI must be auctioned off with the profits fed back into WUI treatment and maintenance funds managed by the community and local Resource District.
- Where necessary, the Province must subsidize the removal of low-value wood and make it available under auction to local bioenergy facilities or other users.
- The Province must provide funding to assess fuel hazards on private land in the WUI.
- The Province must provide funding programs for fuel reduction treatments on private land and for home renovations to increase resistance to wildfire in accordance with FireSmart recommendations.
- The Province must provide carbon-offset opportunities for land treated to reduce fuels in the WUI (e.g., lands on which fuels mitigation requires canopy cover less than the critical criterion used in the Zero Net Deforestation Act) or exempt the WUI from the Zero Net Deforestation Act.
- The Province must remove or modify barriers to fuel treatment and wildfire hazard reduction in the WUI (e.g., mule deer winter range constraints and old-growth management areas that constrain treatment options).
- Where wildfires have impacted treated areas, postfire research is needed to determine what elements of the prescription and its implementation have or have not worked. These treatment effectiveness monitoring opportunities should be published and provided as a resource to practicing foresters to facilitate adaptive management.
- The Province must revise existing land use plans with the requirement that WUI special management zones and other updates must be added.

3. Forest Restoration and Adaptive Forest Management

Compromised resilience of many of BC's grasslands and forests makes them vulnerable to severe wildfires, as witnessed in 2017. Ecological restoration aims to increase resilience by focusing on key processes (not stable states) to assist the recovery of degraded ecosystems (BC Government 2018c). Understanding the causes and consequences of altered forest composition, structure, and ecological processes is essential to guide effective solutions. In BC, wildfire is a primary driver of forest dynamics, with historical frequency, size, and magnitude varying among forest types (Daniels et al. 2017). Disruption of fire regimes since the late 19th century was due to colonial actions to eliminate indigenous traditional fire use, land use change, increasingly effective suppression, and forest management focused on optimizing stand-level timber production (Chavardès et al. 2016, 2017; Daniels et al. 2011; Green et al. 2017; Marcoux et al. 2013, 2015). Reduced fire occurrence and extensive timber harvesting with little attention to landscape-level impacts has decreased forest diversity (yielding uniform forest structures), contributed to widespread forest health problems (e.g., mountain pine beetle and Douglas-fir bark beetle outbreaks), and increased fuel loads across landscapes and elevational gradients. Other consequences include, but are not limited to, loss of habitat for 30 percent of BC's species at risk, increased fuel hazards surrounding many communities, and reduced carbon sequestration and storage in dense, overstocked forests. Given the many values at stake in our forests, adaptation must include transformative restoration and management informed by science and traditional ecological knowledge to counter unintended consequences of the past and increase ecosystem resilience in the future.

Proaction to Increase Resilience to Wildfire

- Reintegrate BCWS and Ministry of Forests, Lands, Natural Resources, and Rural Development to address the institutional barriers that artificially disconnect and disregard fundamental relations and feedbacks between fire and forests.
- Prioritize and fund ecological restoration of grasslands, open forests, and early-seral habitats for species at risk.

- Adjust landscape planning priorities. Allocate land to be managed for wildfire resilience rather than relying on the current "protection" approach.
- Retain and promote more land cover in deciduous species that form natural firebreaks.
- Landscape management must conform to natural firesheds. Under the current approach, managed wildfire is only permissible on parts of the landscape free from administrative constraints or resource allocations.

Reaction to Enable Ecosystem Recovery Following Wildfire

- Following wildfire, the Province must monitor for potential negative impacts on natural regeneration of trees and native plant species (e.g., invasive species and noxious weeds) resulting from seeding burned areas with nonnative plants and salvage logging that disrupts soils and seedbanks.
- The Province must encourage and support the production and use of native grass and legume seed for use in erosion control on burned areas, replacing the practice of using nonnative plant species.
- Develop and apply innovative postfire management strategies for ecosystems in the driest climates (e.g., Ponderosa Pine and Interior Douglas-fir biogeoclimatic zones) where contemporary and future climate, combined with fire damage to soils, may render sites unable to support conifer trees.
- Develop and apply postfire replanting strategies for dry forests that enhance resilience rather than optimize timber projection (e.g., adjust preferred species and reduce stocking standards). Apply silvicultural treatments such as juvenile spacing, thinning and pruning to the monocultures of dense lodgepole pine that are legacies of past forest practices and form hazardous fuels over long periods.
- The Province must consider not replanting sites that have been burned repeatedly in recent years (i.e., reburns). Research shows reburns can function as dedicated landscape fuel breaks (Prichard et al. 2017; Coppoletta et al. 2016).
- Ensure restoration and salvage logging strategies after fire reduce the risk of future high-severity fires. In locations near the WUI or in landscape fuel breaks this will include leaving large trees and snags (i.e., biological legacies valuable for wildlife) while removing all small-diameter trees, yielding forest structures similar to shaded fuel breaks. Some costs may need to be subsidized. Monitoring must be used to reduce the likelihood of substantial burn severity should the site burn again.

4. Research to Inform Adaptive Wildfire Management

British Columbia must incorporate current knowledge of fire regimes and ecosystem function into wildfire management. In the absence of empirical fire ecology evidence, policy and practices developed in the 1980s and 1990s were based on expert knowledge and observational science that did not acknowledge fire suppression impacts, and antiquated ecological concepts such as linear, directional succession and stable, climax forests (British Columbia Ministry of Forests and Ministry of Environment, Lands, and Parks 1995). We now have a much more complete picture of the complexity of BC fire regimes, their interaction with other disturbance agents such as insects, and the shifts we can expect under a changing climate (Burton and Boulanger 2018; Daniels et al. 2011, 2017; Haughian et al. 2012).

Constrained by inadequate funding for research, wildfire management in BC largely remains an exercise of emergency command-and-control, independent of new scientific knowledge. Given rapidly changing climate, the Intergovernmental Panel on Climate Change (2014) advocates adaptation to increase resilience of ecosystems and communities to extreme events such as wildfire. It is globally recognized that wildfire policies and practices must shift from control of ecosystems wrongly assumed to be stable, toward strategies to manage the capacity of ecosystems to function and adapt to cumulative environmental changes that are exacerbated by a warming climate. Effective transformation of wildfire management must be evidence-based to overcome current limitations. Fortunately, BC has outstanding

universities capable of helping to lead ecosystem-specific research efforts and help guide management through these tumultuous times. Below, our eight recommendations provide a framework to facilitate research to guide effective adaptation:

- Increase and sustain funding for wildland fire research in the fields of ecology, fire science, social science, and economics to provide up-to-date science as the basis for adaptive management.
- Foster collaborations with First Nations to integrate traditional ecological knowledge with western science as a key component of successful adaptation.
- Identify priority topics based on the Blueprint for Wildland Fire Science in Canada (2018-19 to 2028-29) that is being developed by experts from across Canada, including several representatives from BC.
- Develop an unbiased framework for adjudicating proposals and allocating funds that is independent of the forest industry, which is already represented on boards such as that of FESBC (e.g., adopt frameworks used by the National Science and Engineering Research Council [NSERC] or the U.S. Joint Fire Science Program).
- Make funding available to academia. Incentivize or require collaboration with academia when allocating funds to applied research and development agencies.
- Incentivize collaborative research with academia to assess efficacy of WUI- and landscape-level fuel mitigation supported by the Strategic Wildfire Prevention Initiative and Forest Enhancement Society of British Columbia (e.g., expand the U.S. Fire Surrogate Study to BCs forest ecosystems).
- Funding must be administered in a form that is eligible for Federal matching funds under programs such as MITACS Canada and NSERC-Collaborative Research and Development programs, thereby benefiting the research community, collaborating agencies, and the Province.
- Allocate resources within government (e.g., funding, in-kind support and staff time) to enable applied research and training opportunities for postsecondary students who are developing expertise in wildfire science and management (e.g., support outreach and dissemination of results; fund mutually beneficial internships; partner on proposals to NSERC-Collaborative Research Experience and Training program).

IMPLEMENTATION OF RECOMMENDATIONS

The timing of the 2017 wildfire coincided with the first substantive change in political leadership in BC in 17 years. On July 7, 2017, dry lightning ignited more than 190 wildfires, many of which resulted in intense, fast-spreading fires near many communities and a Provincial state of emergency was declared. Ten days later, the Honorable John Horgan was sworn in as the newly elected Premier of British Columbia. The combination of the extreme wildfires and political change provided a unique opportunity to advocate for much-needed transformation of wildfire and forest management policy.

On September 26, 2017, we submitted the above recommendations as an open letter to Premier John Horgan and Mr. Doug Donaldson, the Minister of Forests, Lands, Natural Resource Operations, and Rural Development. Signatories included 20 academics from six universities in BC and 14 others from university research forests, municipalities, First Nations, and conservation groups. Our letter urged that the 2017 wildfire season cannot be just another "wake-up call." The 2017 wildfires revealed the tremendous vulnerability of our forests and communities and shortcomings of past mitigation efforts. Without immediate action, large and intense wildfires will undoubtedly burn, escalating economic, social, and ecological costs. As signatories, we urged the Province to engage with leaders from First Nations, Municipalities, Regional Districts, and expert fire and land managers to mitigate wildfire hazards and implement the recommendations to transform policies and practices to improve resilience to wildfire.

We also submitted the letter to the independent review of BC's wildfire practices and emergency management systems that was commissioned in December 2017. We met with the commission co-chairs, Chief Maureen Chapman, the hereditary Chief of Sq'ewá:lxw (Skawahlook) First Nation, and Mr. George Abbott, former Member of the Legislative Assembly and Cabinet Minister of BC. As well, we participated in a forum to develop a framework for updating the four phases of emergency management operations: planning and preparedness, prevention and mitigation, response, and recovery.

Responses to our letter and recommendations from the Provincial government have been positive. Over the past 9 months, we have met with representatives from the BCWS and Minister of Forests, Lands, Natural Resource Operation, and Rural Development to discuss ongoing policy reviews and program changes. The report on the findings of the BC flood and fire review includes 108 recommendations (Abbott and Chapman 2018), 44 of which reflect changes that we proposed. Although the review recommendations are not legally binding, they provide a framework for changes to policy and practice across local to landscape scales. We remain committed to working in collaboration with public- and private-sector forest management agencies to apply our research findings to transformative change to wildfire management in British Columbia.

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