CANADIAN WILDLAND FIRE & SMOKE

NEWSLETTER

SPRING2022

Photo: Wildfire Risk Reduction Treatments & Interface Fuel Management within 100 Mile Community Forest. Provided by FESBC

Looking forward to the 2022 fire season

By Mike Flannigan, Professor, Thompson Rivers University, mflannigan@tru.ca

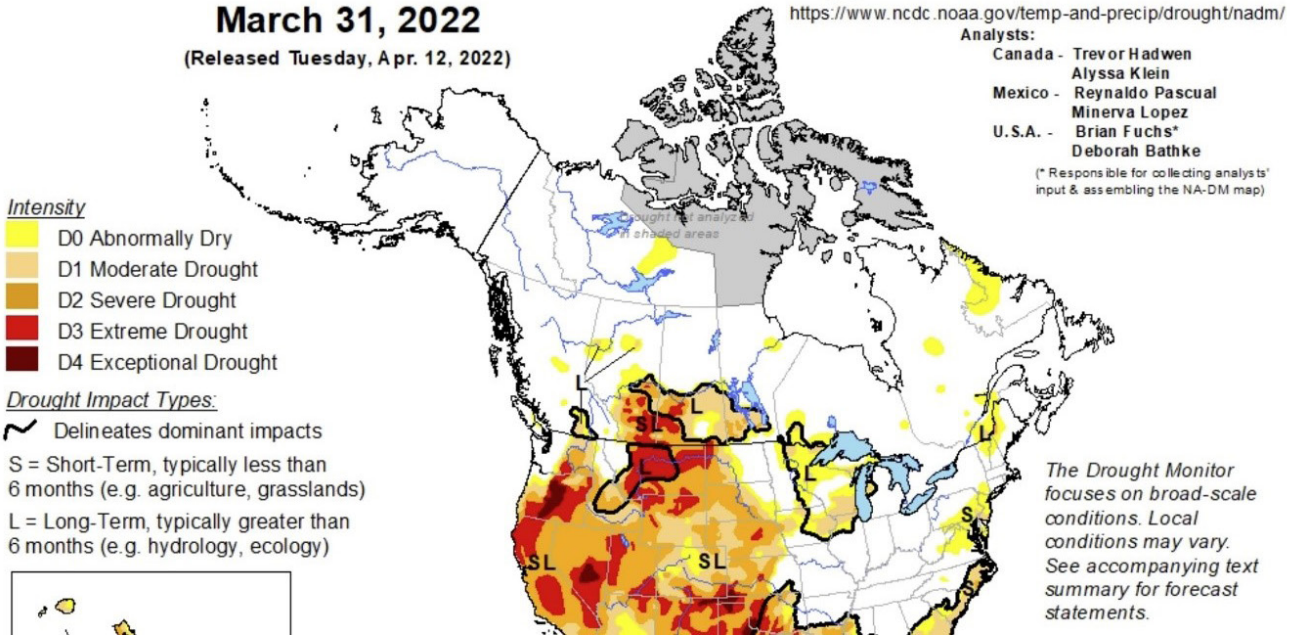
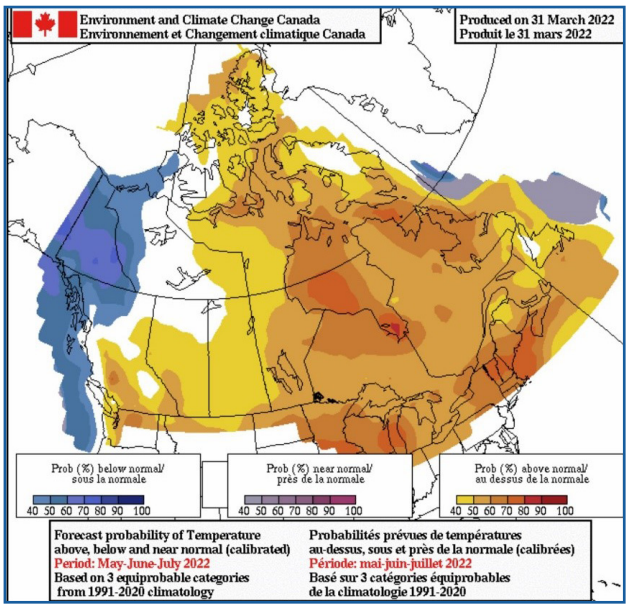


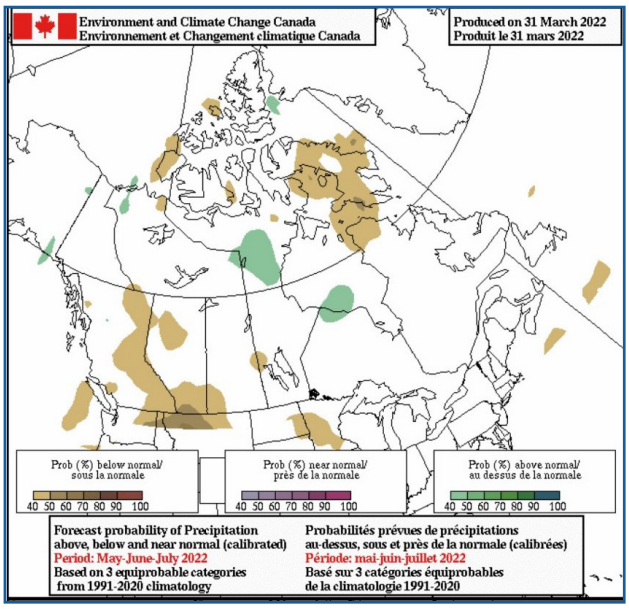
Figure 1: Drought situation as of March 31, 2022. https://www.ncei.noaa.gov/access/monitoring/nadm/maps

As winter finally (hopefully?) relaxes its icy grip on Canada and the snow disappears, we start asking what's in store for the 2022 fire season? Will we have another record-breaking fire season in Ontario? Will there be another Lytton fire this year? These are important questions, but we really can't say anything about the upcoming fire season at this point. Ongoing drought can play a role, and recent research suggests the high Drought Code (DC from the Canadian FWI System) levels at the end of fire season can translate into more spring-time fires. However, this research also found the amount of winter precipitation had no impact on spring fire activity. As of the end of March 2022, the current drought conditions show some areas of severe, extreme, and even exceptional drought, but these are primarily present in agricultural areas (Figure 1). Of course, significant spring precipitation can bring an end to drought conditions. Thus far, spring has been cool and moist over much of Canada, but this is not an indication of what the entire fire season will be like. Fuels can dry out quickly, and a wet forest can be ready to burn in a week. The fire season and the associated impact will be a result of conducive (hot, dry and windy) day-to-day fire weather, ignitions and fire management activities.

There are seasonal forecasts of temperature and precipitation suggesting a warmer summer over much of Canada with near-normal precipitation amounts (Figures 2 and 3). If these forecasts are accurate, and that is a very big if, this still does not necessarily translate into a severe fire season in terms of area burned or other measures like evacuations or property loss. Precipitation frequency can play a major role in fire activity, and these seasonal forecasts only give limited insight into precipitation frequency. Additionally, factors such as ignition and fire management activities can play a role in the severity of the fire season. Lastly, there is the temporal aspect of active fires. Large fires are often the result of just a few days of active fire spread (hot, dry and windy conditions). Therefore, fires can occur even if the monthly or seasonal weather variables are, on average, not conducive to fire. Skillful seasonal forecasts of the number of spread days versus the long-term average number of spread days would be useful.

There is hope on the horizon as seasonal weather forecasts and fire weather forecasts continue to improve. Also, patterns/oscillations in the ocean and/or atmosphere (ENSO and others) can persist for long periods of time and can be used for seasonal weather and fire weather forecasts. Continued research in these areas will hopefully lead to more useful seasonal forecasts, but for the time being, we will have to wait to see what the 2022 fire season brings.





Figures 2 and 3. Seasonal forecasts of temperature and precipitation for May – July 2022. https://weather.gc.ca/saisons/prob_e.html

Picea Mariana Award

The Picea Mariana Award recognizes individuals who have provided exemplary service to Canada Wildfire. We are pleased to present the award to Bruce Mayer.

Bruce was a crucial figure in the formation of the Western Partnership for Wildland Fire Science and its expansion to Canada Wildfire. He has been involved since the beginning and has remained an important contributor over the last decade. His unwavering support, effort, and dedication were critical. We appreciate his efforts to provide us with a voice, procedures, and tools to succeed.

Congratulations Bruce, from the entire Canada Wildfire team!

IMPROVE THE WILDFIRE RESILIENCE OF CONSTRUCTION, RENOVATION, AND LANDSCAPE PROJECTS WITH USER-FRIENDLY CHECKLIST

While many FireSmart practices address regular maintenance, such as keeping things that can burn away from homes and workplaces, the survivability of a property has more to do with appropriate materials than anything else. The sooner safety considerations are considered, the easier it is to incorporating suitable building designs, construction materials, and landscaping techniques can that make the finished product highly resistant to ignition.

This is why the Wildfire-Resilience Best-Practice Checklist for Home Construction, Renovation, and Landscaping was created. Intended for everyone from developers and professional builders to DIY renovators and landscapers, this potentially life-saving resource makes it easier to build wildfire resistance into any construction project. Following the checklist also makes it easier to come up with designs that increase resilience without sacrificing comfort or practicality.

SOUND ADVICE FROM TRUSTED SOURCES

The checklist represents a comprehensive approach distilled from the combined experience and expertise of private industry, homeowners, and scientists. To produce the checklist, FireSmart Canada partnered with the Canadian Home Builders Association, Canada Wildfire, and the Intact Centre on Climate Adaptation at the University of Waterloo.

The result of this collaboration is an easy-to-use collection of accepted standards, practices, guidelines, and priorities, organized as a step-by-step checklist that identifies potential hazards, grouped by building elements. Some recommendations in the checklist are common sense while others represent the latest research, and together they represent time-tested tricks of the trade and innovative solutions targeting the most vulnerable building elements of homes in the wildland urban interface.

“Home builders, renovators and landscapers are trusted by the public to help them create homes that are safe, beautiful and built to last,” says Cheryl Evans, director of flood and wildfire resilience with the Intact Centre on Climate Adaptation at the University of Waterloo.

“This user-friendly checklist that makes it easy for professionals to work with their clients to identify practical and cost-effective ways to integrate wildfire resilience into all of their projects. The Intact Centre on Climate Adaptation is pleased to support the development and use of this resource to improve wildfire resilience in communities across Canada.”

The checklist is divided into two categories: home or property-level considerations; and those applying to the lot on which a structure sits. The home and property-level guidance focuses on roofing, gutters, vents, cladding, openings such as doors and windows, and attachments such as balconies and decks, while the lot-level guidance focuses on landscaping aspects such as choosing the right trees and plants and placing them in manner that keeps flammable vegetation away from the structure. While the checklist is not intended to endorse products or companies, it contains appendices with examples of non-flammable, low-ignition and fire-resistant materials and plants to use, and explains how to maximize their effectiveness.

“The simplicity of the checklist makes it a versatile and effective tool for builders, renovators and landscapers,” says Frank Lohmann, director of building science with the Canadian Home Builders Association.

THE BUSINESS CASE FOR BUILT-IN WILDFIRE RESILIENCE

There is no way to eliminate wildfire risks in the wildland urban interface. However, when combined with other FireSmart practices such as regular inspections, yard maintenance, and community involvement, following the checklist and being prepared can markedly improve a home’s chances of survival during wildfire, even in extreme circumstances.

The checklist provides homeowners with an easy-to-follow tool to increase the wildfire resilience of their homes during small renovations. If renovators use the checklist early in the planning and design process of larger projects, a more substantial risk reduction can be achieved. Applying the guidance in the list and its appendices can also result in time- and money-savings, for example, by avoiding supply problems for specific products and components. All these benefits can be maximized where the list is applied to new builds or entire developments.

All the practices and recommendations in the checklist are designed to apply the most recent guidance from the National Research Council of Canada, but since building codes vary from one jurisdiction to another, it is possible that technical conflicts could arise. Accordingly, the document provides contacts and highlights other resources to help identify designs that reconcile resilience with factors such as energy efficiency. The checklist also encourages users to share feedback to ensure it is as accurate, comprehensive, and user-friendly as possible.

FireSmart® Canada

Intelli-feu Canada

Atmospheric river highlights collaboration and future needs

By Karley Desrosiers, Research Analyst, BC Wildfire Service, karley.desrosiers@gov.bc.ca

In November 2021, record rainfall over southwestern British Columbia resulted in catastrophic landslides and widespread flooding. The torrential rain began on November 13, when a major atmospheric river system made landfall on the south coast of B.C.

Several weather stations recorded record daily rainfall amounts; for example, the town of Hope recorded 174 mm of rain, five times more than the previous record of 34.7 mm set in 2018. In just three days the town received a total of 252 mm of rain, almost the November monthly-average of 295 mm. Twenty rainfall records were broken across southern B.C. between November 13 and 15, 2021.

Atmospheric rivers—commonly known as a "Pineapple Express" in British Columbia—are long, narrow bands of moisture in the atmosphere originating from tropical regions where elevated temperatures support high moisture content. The aptly named Pineapple Express originates near Hawaii and brings copious amounts of moisture to the west coast of North America. They are not a new phenomenon, nor are they uncommon; there are roughly 20-30 occurrences each storm season, and British Columbians rely on these weather events for a large portion of their consumable water.

"Initially, the models had the axis of the heaviest precipitation aimed south of the border in Washington state," recalls Matt MacDonald, lead fire weather forecaster for the BC Wildfire Service (BCWS). "On the Friday before that weekend, November 12, the models shifted the axis north of the border, and it became apparent that the biggest impacts were going to be over the Fraser Valley."

As rain continued to fall, it became clear that this storm was unlike any atmospheric river recorded in B.C. It was not long before floodwaters impacted the communities of Merritt, Princeton and Abbotsford. The BCWS reacted quickly by providing aerial support, primarily to the town of Hope. The town had become isolated as all three major highways washed out. As events unfolded, additional staff were deployed to assist in several capacities, including rapid damage assessment, digital communications, and equipment provision. By mid-December, 230 BCWS staff were supporting Emergency Management BC (EMBC) and the Ministry of Agriculture.

Like many BCWS staff, MacDonald was eager to help. "As public servants, we want to help wherever we can... as we watched the impacts unfold, we had so much empathy for the people that were living through this catastrophic event." Over the next two weeks, MacDonald and fellow BCWS fire weather forecaster, Brett Soderholm, provided regular briefings to senior management and issued spot forecasts for Incident Management Teams deployed to the Fraser Valley.

BCWS forecasters collaborated closely with Environment and Climate Change Canada meteorologists to ensure consistent messaging, aiding emergency management officials in the response. In recent years, the partnership between the two agencies has strengthened, especially through the busy 2021 fire season. The collaboration, as MacDonald explains, is vital for knowledge sharing and ensuring messaging is consistent. "The relationship between BCWS and Environment and Climate Change Canada forecasters has strengthened over the last couple years; our agencies are collaborating more and more as these large weather events unfold. Going forward, that's something that we want to continue to strengthen and develop."

Although he has become accustomed to looking at the weather through a fire behaviour lens in recent years, MacDonald worked as a meteorologist with Environment and Climate Change Canada for 18 years before joining the BCWS in 2020. His previous experience provided the tools and knowledge to shift his mindset from fire to flooding, and it turns out that there are many similarities from a meteorological perspective.

During the summer, fire weather forecasters often monitor precipitation amounts with tools and applications that have been designed accordingly. The main difference when it comes to flooding is a greater focus on precipitation intensity and duration in combination with freezing levels.

While it's unlikely that B.C. will experience another event of this magnitude any time soon, it's expected that atmospheric river events will continue to become both more frequent and more intense. According to a 2018 study by Espinoza et al., atmospheric rivers are expected to increase in duration and width by 25% based on future climate projections and warming scenarios. Research on this topic has expanded accordingly, focusing on tools and technology to enhance forecasting and better communicate anticipated impacts.

Environment and Climate Change Canada is working to develop an atmospheric river rating system designed to identify the severity and potential impacts of future events. Advancements in technology and data and an increased focus on research

surrounding this topic will facilitate better prediction and communication of the severity of these storms. "Catastrophic natural hazards have occurred at a more frequent pace the last number of years, and BCWS is committed to building an organization that is ready to respond when called upon to assist the people of B.C.," says Cliff Chapman, Director of Wildfire Operations.

Consequently, the BCWS continues to adapt to support all-hazards response in B.C. This includes but is not limited to:

- Continued development of predictive services tools and technologies,
- 365-day-per-year readiness strategy and a shift to more full-time resources within the BCWS,
- Continued relationship building and partnership development with First Nations, local communities, First Nations Emergency Services Society (FNESS), Emergency Management BC (EMBC), and other stakeholders.

The event that occurred in November exemplifies the catastrophic potential of these weather systems as they increase in severity.

"With our changing climate, these atmospheric rivers are forecast to become more frequent and more intense in nature," MacDonald explains, "and I think the BC Wildfire Service can anticipate being called upon more regularly to help in the response."

Forest Enhancement Society of British Columbia: helping communities throughout B.C. reduce their wildfire risk

By Steve Kozuki, Executive Director, Forest Enhancement Scoiety of British Columbia, skozuki@fesbc.ca

With an increase in the severity of wildfires impacting communities throughout the province of British Columbia (B.C.), it is becoming more top of mind for communities to take immediate action to mitigate the risks associated with this natural occurrence. The Forest Enhancement Society of British Columbia (FESBC) has been supporting communities throughout the province to reduce the risks posed by wildfires and is distributing grant funding to help make communities safer.

Over the last few years, many Indigenous communities, municipalities, regional districts, woodlots, and community forests throughout B.C. have taken action to protect themselves from wildfire. Proponents applied to FESBC for funds through an application process primarily for wildfire risk reduction treatments and some planning activities leading to treatment.

Since its inception in 2016, FESBC has funded 124 wildfire risk reduction projects worth roughly $57 million. Not only have these projects reduced wildfire risk to 120 communities and rural subdivisions, but they have generated an estimated 483 full-time equivalent jobs, and 43 of these projects have involved, or have been led by, First Nations.

Wildfire risk mitigation planning and treatments can be quite different depending on where a project is located in the province. The 124 projects that FESBC has funded are spread across the province and include communities on the South Coast and Vancouver Island, the Skeena and Omineca regions, the Cariboo region, the Kootenay region, and throughout the Thompson, Nicola and Okanagan regions.

Steve Kozuki (RPF, Executive Director of FESBC) noted that while wildfire treatments often involve spacing trees far apart and removing low branches in order to keep a fire on the ground and to reduce the amount of wood in the forest, some communities choose a different route depending on their terrain, size and threat assessment.

"Every community is different, and some communities have chosen to encourage the planting of broad-leafed trees in specific areas because they are often more fire-resistant," said Kozuki.

One such project was the Granisle Wildfire Risk Reduction Treatment project in the Skeena Region. The project was delivered by the Babine Lake Community Forest Society, a partnership between the Village of Granisle and Lake Babine Nation, focused on mitigating wildfire risk and creating a protection zone around the village by planting a buffer of deciduous trees. The idea was that planting the area with deciduous trees, like birch, would result in stands less susceptible to extreme wildfire behaviour and allow for ecological and economic diversification.

On the other hand, the Whistler Planning and Fuel Reduction project in the South Coast region, which ran along both sides of the Cheakamus Lake Forest Service Road, focused on altering wildfire behaviour by modifying forest densities and structure

Photo: Granisle Wildfire Risk Reduction Treatment

in this heavily used portion of the community forest to protect the south-facing slopes of Whistler Mountain, the community of Whistler, and the western edge of Garibaldi Provincial Park. An immediate outcome of the project was that it led to further projects to complete the entire road system and promote a safer egress route in case of wildfire.

In the Cariboo region, the Borland Valley Fuel Management Treatment not only had its eyes set on wildfire risk reduction through fuel management, but also included mule deer winter range habitat enhancement, improving a recreational trail system, biomass removal, and recovery of non-merchantable timber through machine and handwork. The treatments provided demonstration sites and examples for future treatments while providing wildfire hazard mitigation by reducing fuel loading through the removal of ladder and fine fuels. The biomass from this project went to a local cogen facility to make electricity which was sold into the grid.

The May Creek Wildfire Risk Reduction and Habitat Improvement Treatment in the Kootenay-Boundary region had the West Boundary Community Forest utilize FESBC funding and, with support from the Osoyoos Indian Band, focused on reducing excessive fuel loads to mitigate catastrophic wildfire risks, while also mitigating mid-term timber supply shortfalls by facilitating access to marginal stands. For similar projects around the province, Indigenous peoples are hopeful that more natural and ecologically resilient low-density forests will be maintained by re-introducing traditional Indigenous burning practices.

In the Thompson-Okanagan region, the Comstock Long-term Fire Break project allowed for fuel management prescription development and fuel reduction treatments south of Merritt. A portion of the residual (uneconomic) waste fibre resulting from the treatments was utilized by a local bioenergy plant. The avoidance of pile burning in such cases reduces greenhouse gas emissions and contributes to the achievement of B.C.'s and Canada's climate change targets.

"With thorough planning and taking action to undertake fuel management treatments in a thoughtful manner, wildfire hazards can be reduced while at the same time achieving significant environmental, social and economic co-benefits," noted Kozuki. "These 120 communities realized a multitude of other benefits such as habitat enhancement, support for timber supply shortfalls, creating green energy, improving recreational opportunities, economic activity, and more. It is crucial to look at fire not through the lens of being a fearful event but rather thinking of fire as a crucial and natural force that maintains ecological integrity and resilience

in many of our landscapes. By undertaking these projects with the advice of forest professionals, communities are working with nature to mitigate extreme wildfire behaviour adjacent to their communities."

The reason FESBC undertakes and funds these projects is simple: FESBC believes that when a community participates in reducing wildfire risk, they are not only making the community safer, but they are also improving wildlife habitat, enhancing recreational trails, and better utilizing the cleared-out fibre to make sustainable green energy. These outcomes multiply the social, economic, and environmental benefits of each dollar spent on the wildfire risk reduction projects.

"FESBC, in partnership with the province, is proud to support wildfire risk reduction treatments reducing the wildfire risk to communities across B.C.," said Gord Pratt, the operations manager with FESBC.

For a more in-depth insight on projects in 120 communities, as well as the various other projects that FESBC is involved in, visit: https://www.fesbc.ca/category/news/

For wildfire mitigation work, the B.C. government has a wildfire risk reduction funding program called the Community Resiliency Investment Program (CRI) which is a partnership with the First Nations Emergency Services Society, the Union of B.C. Municipalities, the Ministry of Forests, and others including FESBC. The CRI Program has been spearheading the FireSmart initiative to educate homeowners about actions they can take to protect themselves, such as cleaning gutters and removing flammable materials outside of homes and businesses. Other funding programs to reduce wildfire risk are administered by the Columbia Basin Trust and the B.C. Community Forest Association.

First Nations Wildfire Evacuations: A Guide for Communities and External Agencies

By Tara K. McGee, tmcgee@ualberta.ca and Amy Cardinal Christianson, amy.christianson@nrcan-rncan.gc.ca
with the First Nations Wildfire Evacuation Partnership

Thousands of Canadians are evacuated from their homes every year to protect the health and safety of residents during wildfires. Despite comprising only 4% of the Canadian population, almost 1/3 of wildfire evacuations between 1980 and 2007 involved Indigenous people. Many First Nations' reserves in Canada are in locations at high risk from wildfire. A recent analysis by the Canadian Forest Service shows that 60% (1,871 of 3,105) of First Nations' reserves in Canada either lie within or intersect the wildland-urban interface, where communities are at higher risk from wildfire. In 2011 alone, 4,216 wildfires burned 2.6 million hectares of forest throughout Canada. First Nations' communities were severely affected. Thousands of residents from thirty-five communities were forced to evacuate their lands because of their proximity to wildfire or smoke.

First Nations Wildfire Evacuations: A Guide for Communities and External Agencies is the result of research from the First Nations Wildfire Evacuation Partnership (FNWEP), which was formed shortly after the 2011 wildfire season. The book is co-authored by Dr. Tara McGee, a non-Indigenous professor at the University of Alberta who studies the human dimensions of wildland fire; and, Amy Cardinal Christianson, a Métis research scientist at the Canadian Forest Service; and FNWEP. The FNWEP brings together researchers, First Nations evacuated due to wildfires, and agencies involved in providing support during wildfire evacuations. The partnership aims to learn about how First Nation people and communities have been affected by recent evacuations and make recommendations for how to reduce the negative impacts of wildfire evacuations. This book presents the results of research that examined the evacuation experiences of seven First Nations in three provinces:

- Alberta - Whitefish Lake First Nation 459 and Dene Tha' First Nation;
- Saskatchewan - Onion Lake First Nation and Lac La Ronge Indian Band - Stanley Mission;
- Ontario - Mishkeegogamang Ojibway Nation, Sandy Lake First Nation, and Deer Lake First Nation.

Drawing on the evacuation experiences of residents from these seven First Nations between 2011 and 2015, along with a few other

examples, the book offers a detailed account of what has happened, what can happen, and what should happen during the six stages of an evacuation.

1. Deciding to evacuate
2. Putting a plan in motion
3. Troubleshooting transportation
4. Finding accommodations
5. Taking care of evacuees
6. Returning home

The book provides step-by-step guidance to developing and carrying out an evacuation plan – from deciding to evacuate to what to do when community members finally return home.

The book targets four audiences:

1. Government agencies and other organizations involved in evacuating or providing support during wildfire evacuations of Indigenous peoples. The book is valuable for this audience because although they carry out evacuations or provide support, they may not have a good understanding of how Indigenous peoples experience wildfire evacuations.
2. Scholars and specialists. We anticipate that this book will be of interest to scholars in the human dimensions of wildfire and hazard social scientists more broadly. It will also be of interest to wildfire specialists in academia and government.
3. First Nations. The First Nations involved in the FNWEP have expressed a strong interest in learning from other First Nations' experiences. We expect that many First Nations in Canada that are at risk from wildfires will be interested in this book.

Finally, although this book focuses on the experiences of First Nations and is tailored to First Nations, its guidance is also valuable to all communities that wildfires may threaten.

To learn more about the FNWEP go to https://sites.google.com/ualberta.ca/awe/home. First Nations Wildfire Evacuations: A Guide for Communities and External Agencies is available from UBC Press https://www.ubcpress.ca/first-nations-wildfire-evacuations

Understanding occupational health risks for wildland firefighters

By Katie Cornish[1] & Chelsea Pelletier[2]
[1]Research Associate, Health Research Institute, University of Northern British Columbia
[2]Associate Professor, School of Health Sciences, Faculty of Human and Health Sciences, University of Northern British Columbia, chelsea.pelletier@unbc.ca

As climate change alters seasonal weather patterns, wildland fires are increasing in intensity and complexity. The changing landscape of wildland fire subsequently changes the roles and risks for wildland firefighters. There is an increasing need to understand the occupational health impacts associated with wildland fire, including identifying the physical, mental, emotional, and social health risks. Research in this area must consider the priorities and perceived health risks of relevant workers to ensure the development and use of strategies to reduce risk fit within the organizational context of wildland fire management.

The goals of this project were to:

1. Explore the impact of occupational exposure to wildland fire on health outcomes, including physical, mental, and emotional wellbeing.
2. Examine the characteristics and effectiveness of prevention, mitigation, or management strategies previously used to reduce negative health outcomes.
3. Identify research priorities and health concerns of BC wildland firefighters and people working in related roles.

To address these aims, our research team at the University of Northern British Columbia conducted a scoping review of previous studies, and a survey and interviews with wildland firefighters and people working in related roles.

Understanding health risks: scoping review of literature

A scoping review is a type of literature review that aims to map the extent, range, and nature of research in a particular field to provide an overview of main findings and inform new research [1,2]. We collected research from academic sources, government agencies, industry groups, and organizations from around the world. We developed criteria to screen articles for relevance to occupational health outcomes for wildland firefighters or related personnel [3].

Of the 100 items included in our final sample, 76 were academic research papers, and 24 were reports from government agencies, industry groups, or organizations. Health outcomes studied included acute injuries (falls, sprains, strains) and fatalities (burn overs, vehicle and aviation accidents), mental health (post-traumatic stress disorder; PTSD), respiratory health and lung function, inflammation and oxidative stress (airway and systematic inflammation), fatigue and sleep quality and quantity, hydration, cardiovascular health (cholesterol, vascular health), temperature regulation (skin temperature and sweat rate), hearing, and nutrition (energy expenditure and eating practices; Table 1) [3]. The included studies evaluated short-term outcomes measuring changes across a single shift or wildland fire season. Most research was conducted with wildland firefighters and excluded other personnel (e.g., aviation crews, contract crews, and incident management teams). Five articles reported direct study of a risk mitigation strategy, focusing on the potential usage of masks, advanced hygiene protocols to reduce exposure, fluid intake to manage hydration and core temperature, and glutamine supplementation to reduce fatigue [3].

Photo: BC Wildfire Service personnel performing a controlled burn.

Health outcome	Key findings
Acute injuries and fatalities	Most commonly slips, trips, and falls that occur in peak/late season [4]
Mental health	PTSD was the most common psychological impairment among wildland firefighters [5]
Respiratory	Significant decrease in lung function measures (FEV1 and FVC) cross shift [6–8]
Inflammation and oxidative stress	Absorbed polycyclic aromatic hydrocarbons increased in urine samples post-shift through dermal exposure [9]
Fatigue and sleep	Wildland firefighters reported significantly higher levels of fatigue and decreased alertness with increasing days on deployment [10]
Hydration	Ad libitum drinking (drinking when thirsty) does not adequately hydrate firefighters throughout a shift [11,12]
Cardiovascular	Significant associations between experience in wildland firefighting and hypertension [13], risk of cardiovascular disease mortality [14], particulate matter exposure and oxidative stress may lead to increased arterial stiffness [15]
Temperature regulation	Measures of thermal stress were significantly higher in participants exposed to higher temperatures while performing wildland firefighting tasks in a simulated environment [16]
Hearing	Noise exposure regularly exceeds occupational limits [17]
Nutrition	Discrepancy between total energy expenditure and total energy intake [18]

Table 1: Summary of key findings by health category.

Identifying health research priorities: modified Delphi survey and interviews

To gain a better understanding of the lived experiences of wildland firefighters and associated personnel, we used a two-round modified Delphi approach to obtain a ranked list of research priorities (Table 2). Surveys were followed up with interviews to provide a nuanced description of health concerns and future research directions [19].

During the interviews, participants expressed general agreement with the identified research priorities and excitement about future research possibilities. Participant 5 said, "that's why I'm so pumped about this research, because it's like wow, real things that crew members actually care about." Participants further identified areas of focus within each research topic and discussed the need to understand health risks across different roles (e.g., people who work in office environments or different roles on the fire line) and consider the impact of variable work schedules and exposures. It was also important for participants that strategies used to reduce risk be developed collaboratively to fit within the organizational context and realities of working in different wildland fire settings [19]. Participant 3 expressed their concern about appropriate personal protective equipment (PPE): "I think most firefighters are aware that it's not good to be breathing it [smoke] in, but we're just at this standstill; it seems like finding the right PPE that's appropriate for the job."

Research priorities identified by participants
1. Effects of smoke inhalation on respiratory health
2. Fatigue and sleep
3. Mental health impacts
4. Stress
5. Long term risk of disease

Table 2: Top ranked research priorities by wildland firefighters and associated personnel

Recommendations and suggestions

Data on long-term occupational health impacts associated with wildland firefighting is limited as there were few longitudinal studies measuring changes in health outcomes across multiple seasons. Notably, research should focus on respiratory health, mental health, fatigue and sleep, long-term risk of disease, and stress to align with stakeholder priorities. Future interventions and risk mitigation studies within the context of BC need to be adaptable and responsive to unpredictable fire seasons. Workers should be considered in all research decision-making and early in the development of mitigation strategies.

Acknowledgements and funding

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Reconstructing past fire and vegetation dynamics from lake sediments in boreal forests of eastern Canada

By Marianne F.S. Vogel[1,2,3,*], Marion Blache[1,2,3,*], Dorian M. Gaboriau[1,2], Adam A. Ali[1,3], Sébastien Joannin[3], Hugo Asselin[4,5], Laurent Millet[6], Damien Rius[6], Pierre Grondin[7], Yan Boulanger[8], Martin P. Girardin[5,8], Jonathan Boucher[8], David Gervais[8], Raphaël D. Chavardès[1,2], Yves Bergeron[1,2,5]

[1]International Research Laboratory on Cold Forests, Université du Québec en Abitibi-Témiscamingue, Rapide-Danseur, QC, Canada
[2]Forest Research Institute, Université du Québec en Abitibi-Témiscamingue, Rouyn-Noranda, QC, Canada
[3]ISEM, Univ Montpellier, CNRS, IRD, Montpellier, France
[4]School of Indigenous Studies, Université du Québec en Abitibi-Témiscamingue, Rouyn-Noranda, QC, Canada
[5]Centre for Forest Research, Université du Québec à Montréal, Montréal, QC, Canada
[6]UMR6249 CRNS Chrono-Environnement, Université de Bourgogne Franche-Comté, Besançon, France
[7]Direction de la Recherche Forestière, Ministère des Forêts, de la Faune et des Parcs, Québec, QC, Canada
[8]Laurentian Forestry Centre, Canadian Forest Service, Natural Resources Canada, Québec, QC, Canada
*Corresponding researchers: mariannefrancesarah.vogel@uqat.ca; marion.blache@uqat.ca

English version (French version below)

The International Research Laboratory on Cold Forests of the University of Québec in Abitibi-Témiscamingue (UQAT, Canada), in collaboration with the Institute of Evolutionary Science of Montpellier (ISEM, France), is conducting two research projects in eastern Canadian boreal forests to better understand past fire and vegetation dynamics. During February and March 2022, teams of researchers collected lake sediment cores in La Mauricie National Park and Aiguebelle National Park. The cores will provide different kinds of information for each project.

At La Mauricie National Park, the research led by PhD student Marion Blache in collaboration with Parks Canada (Kim Charron-Charbonneau) and Natural Resources Canada, aims to reconstruct the dynamics of two endemic Canadian pine species, white pine (*Pinus strobus* L.) and red pine (*Pinus resinosa* Sol. ex Aiton), which have undergone a decline in their distributions over the past few centuries (Anand et al. 2013; Uprety et al. 2014). Up to 4.8 meters of sediments were extracted from five lakes located within 0 to 2 km of prescribed fires to determine whether these types of fires provide a different signal in charcoal records relative to other historical and hypothetically higher-severity wildfires. Various indicators will be identified including charcoal, pollen grains, plant macro-remains, chironomid remains, and geochemical elements to reconstruct the long-term natural dynamics of vegetation, fire, and climate over the last 10,000 years. Ultimately, this research project extending until 2024, will help address conservation issues related to white and red pine in eastern Canada.

The research at Aiguebelle National Park is led by the International Research Laboratory on Cold Forests in relation with the PhD project of Marianne Vogel. For this project, sediment extraction was conducted in collaboration with the Société des établissements de plein air du Québec (Thibaut Petry). The project aims to reconstruct the early dynamics of fire and vegetation on ancient islands of proglacial lake Ojibway that became hilltops in the current landscape following the drainage of the lake into James Bay about 8,200 years before present (Godbout *et al.* 2020). Like Marion's research, Marianne's will identify similar indicators in addition to ancient plant and fungi DNA. Combining multiple lines of evidence will help determine whether the former islands were colonized through long-distance seed dispersal mechanisms. The results of the research will also help assess whether Lake Ojibway was a barrier limiting postglacial forest migration or if the islands were colonized first and then acted as outposts facilitating colonization of lowlands following lake drainage.

The teams involved in these research projects are glad to share two photos of work completed in February 2022 (Images 1 & 2).

Image 1. Setting up the field site on top of thick ice to collect lake sediment samples in February 2022 from Lake Sam in La Mauricie National Park, QC / Installation du site de terrain sur un épais couvert de glace pour prélever des échantillons de sédiments lacustres en février 2022 au lac Sam au parc national de la Mauricie, QC. Photo credit / crédit photo: D.M. Gaboriau.

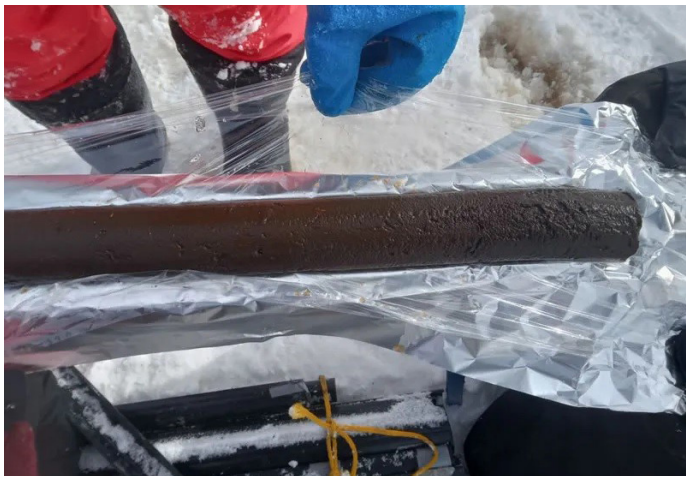

Image 2. Wrapping up a freshly extracted sediment core collected in February 2022 from Rey Lake in La Mauricie National Park, QC / Emballage d'une carotte de sédiments fraîchement extraite, prélevée en février 2022 au lac Rey au parc national de la Mauricie, QC. Photo credit / crédit photo: D.M. Gaboriau.

Version française

Reconstruction de la dynamique des feux et de la végétation du passé à partir de sédiments lacustres dans les forêts boréales de l'est du Canada.

Le Laboratoire international de recherche sur les forêts froides de l'Université du Québec en Abitibi-Témiscamingue (UQAT, Canada), en collaboration avec l'Institut des Sciences de l'Évolution de Montpellier (ISEM, France), mène deux projets de recherche dans les forêts boréales de l'est du Canada afin de mieux comprendre les dynamiques passées des feux et de la végétation. Au cours de février et mars 2022, des équipes de recherche ont prélevé des carottes de sédiments lacustres dans le parc national de la Mauricie et le parc national d'Aiguebelle. Les carottes prélevées fourniront différents types d'informations pour chaque projet.

Au parc national de la Mauricie, la recherche menée par Marion Blache, étudiante au doctorat, en collaboration avec Parcs Canada (Kim Charron-Charbonneau) et Ressources naturelles Canada, vise à reconstituer la dynamique de deux espèces de pins endémiques au Canada, le pin blanc (*Pinus strobus* L.) et le pin rouge (*Pinus resinosa* Sol. ex Aiton), dont les répartitions ont connu un déclin au cours des derniers siècles (Anand et al. 2013; Uprety et al. 2014). Jusqu'à 4,8 mètres de sédiments ont été extraits de cinq lacs situés dans un rayon de 0 à 2 km de feux dirigés afin de déterminer si ce type de feu fournit un signal différent dans les enregistrements de charbons comparativement à d'autres feux de forêt historiques et hypothétiquement de plus grande sévérité. Divers indicateurs seront identifiés, notamment du charbon de bois, des grains de pollen, des macro-restes végétaux, des restes de chironomes et des éléments géochimiques, afin de reconstituer la dynamique naturelle à long terme de la végétation, du feu et du climat au cours des 10 000 dernières années. Ce projet de recherche qui doit s'étendre jusqu'en 2024, aidera à résoudre les problèmes de conservation liés au pin blanc et au pin rouge dans l'est du Canada.

En parallèle, la recherche au parc national d'Aiguebelle est menée par le Laboratoire international de recherche sur les forêts froides en relation avec le projet de doctorat de l'étudiante Marianne Vogel. Pour ce projet, l'extraction des sédiments a été réalisée en collaboration avec la Société des établissements de plein air du Québec (Thibaut Petry). Le projet vise à reconstituer la dynamique du feu et de la végétation d'anciennes îles du lac proglaciaire Ojibway, devenues des sommets de collines dans le paysage actuel, suite au drainage du lac dans la Baie James environ 8 200 ans avant aujourd'hui (Godbout *et al.* 2020). Les recherches de Marianne identifieront les mêmes indicateurs que celles de Marion, en plus de l'ADN végétal et fongique ancien. La combinaison de plusieurs sources de données permettra de déterminer si les anciennes îles ont été colonisées par des mécanismes de dispersion de graines à longue distance. Les résultats de la recherche permettront également de déterminer si le lac Ojibway était une barrière limitant la migration postglaciaire des forêts ou si les îles ont d'abord été colonisées, pour ensuite servir d'avant-postes facilitant la colonisation des basses terres après le retrait du lac.

Les équipes impliquées dans ces projets de recherche sont heureuses de partager deux photos de travaux réalisés en février 2022 (images 1 et 2).

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