BUILDING COMMUNITY RESILIENCE TO WILDIFRE RISKS IN THE ROBSON VALLEY, BRITISH COLUMBIA, CANADA

James Whitehead

Natural Resources and Environmental Studies | Department of Geography, Earth, and Environmental Sciences

University of Northern British Columbia, Prince George

A thesis submitted to the University of Northern British Columbia in partial fulfilment of the requirements of the degree of Masters of Arts

May 2023

ABSTRACT

BUILDING COMMUNITY RESILIENCE TO WILDIFRE RISKS IN THE ROBSON VALLEY, BRITISH COLUMBIA, CANADA

James Whitehead
UNBC, 2023

Advisor: Dr. Tristan Pearce
Committee members: Dr. Greg Halseth
Dr. James Ford

This thesis examines how rural communities are at risk to wildfire hazards through a case study of the Robson Valley, British Columbia, Canada. The research is guided by a vulnerability approach, which conceptualizes risk as a function of how a community is exposed and sensitive to a hazard and its capacity to adapt. Data were collected using semi-structured interviews with policymakers, forest professionals and emergency managers alongside three community meetings in rural areas without political representation, participant observation, and analysis of secondary sources. The findings show that while most communities in the Robson Valley are not directly at risk from wildfire hazards, they are indirectly exposed and sensitive to secondary and tertiary impacts, due to a single power transmission and road transportation route, that are both highly exposed to wildfire hazards. The centralization of government services has led to a change in the ways that wildfires are suppressed, which can be incongruent with diverse land values and attitudes about responding to hazards held by long-time residents and local First Nations. This thesis concludes with recommendations for how to better engage rural communities in fire prevention and suppression including the creation of a community champion position and improved legislation allowing for the participation of rural residents in fire suppression operations.

ACKNOWLEDGEMENTS

Thank you to the people of the Robson Valley, who welcomed me with open arms into their communities, homes, and lives. Thank you for sharing your perspectives, experiences, and opinions, and thank you for supporting me throughout the research process. Thank you to Dannielle Alan, whose passion, energy, enthusiasm, guidance, and support made this project what it is today. I would like to thank Dr. Tristan Pearce for believing in me, your guidance and for your abundance of patience, optimism, and enthusiasm for my research. Thank you to my supervisory committee Dr. Greg Halseth and Dr. James Ford for your advice, guidance, and mentorship. I would also like to thank my colleagues at the Environmental Change Research Group (ECRG) for their friendship, community, support, and memories, which will last a lifetime. Lastly, I would like to thank my family, my mom, dad, and sister for their perpetual support and encouragement throughout this process and Hailey May for her continual belief and faith in me, her companionship, and her encouragement throughout these last two years. I am so thankful for the support, encouragement, and guidance during this challenging period. This success is yours to share. This research was financially supported by the Canada Research Chair Program (Pearce), the Regional District of Fraser-Fort George, and the University of Northern British Columbia.

ABOUT THE AUTHOR

I came to this project after seven years working as a Wildland Firefighter in British Columbia (B.C.) on both initial attack crews focused on quickly suppressing small fires and unit crews, which are designed to respond to large-scale fire events. I have also lived in nine different communities throughout B.C., many being rural and remote, and facing significant wildfire risk. Understanding and recognising the specific needs and challenges of rural communities is a key personal focus for me. During my time living in rural and remote communities and my experience as a Wildland Firefighter, I have come to recognise that residents of rural communities can play key roles in preventing and supressing wildfires. I was drawn to vulnerability theory in natural hazards literature as it recognizes both the characteristics of the hazard and the agency of the community to deal with the hazard, when conceptualizing risk.

The idea for this thesis research started when I was working on a fire where dozens of residents defied an evacuation order and stayed behind to try and protect their properties. They used every tool at their disposal to try and fight the fire alongside professional firefighters. After a first day that was filled with hostility between residents and professional firefighters over human safety, I started to slowly build relationships with some of the residents fighting the fire, and engaged in conversations about how we could work together to manage the fire in a safer way. Over the next year, this experience stayed with me as explored graduate research opportunities. I wanted to further explore how could we could better understand and activate the capacity of local residents to manage their wildfire risk and engage them in wildfire suppression in a safe way. While my research answers neither of these questions conclusively, it has provided me with a more in depth understanding of how rural communities are at risk to wildfire hazards, and compassion for, and understanding of,

the unique challenges rural communities face. I have a new level of respect for the resourcefulness, determination, and steadfast attitude of rural communities in the face of wildfire hazards.

Throughout this thesis, I have done my best to ground the research in peer-reviewed literature and the data collected. There are occasions where I draw upon my experience as a Wildland Firefighter to help interpret and explain the data and findings.

Table of Contents

CHAPTER I: INTRODUCTION

Anthropogenic climate change has led to rising temperatures globally, with a pronounced effect on the prevalence and impact of wildfires (IPCC, 2021). The number of large fires (over 200 ha) and occurrences of catastrophic fire in Canada have spiked in recent years (Canada n.d.; Tymstra et al. 2020). In 2021, wildfires burned nearly 900,000 hectares in B.C. and cost an estimated $615 million in direct wildfire suppression (B.C. Wildfire Service n.d.). This led to widespread air pollution, economic damage and the near-complete destruction of Lytton, a community of 250 people (Cecco 2021). The 2021 fire season was the third significant fire season in B.C. since 2017, all of which have been an order of magnitude more impactful than any previous season in recent history. The trend of increasing wildfire impacts is likely to continue, and worsen in the coming decades, as the number of Canadians living in fire-prone environments is expected to increase (Erni et al. 2021), and weather conditions are likely to become more conducive to major fire events (Johnston et al. 2020; Parisien et al. 2020). Driven by climate change and compounded by land use trends along with historical fire suppression, many formerly routine and controllable wildfires have intensified into uncontrollable events, some that resemble hurricanes or earthquakes in their intensity and impacts (Cutter 2021). Rural and remote communities, notably Indigenous communities are especially at risk due to their location in wildfire prone areas, remoteness, and limited access or escape routes (Christianson 2015; Copes-Gerbitz, Dickson-Hoyle, et al. 2022; Miller 2021). For rural communities, it is often the case that surviving a wildfire is only the start of the challenge. Wildfires can often lead to cascading effects including flooding and landslides (Kemter et al. 2021).

Wildfire research has identified several factors that influence the likelihood and intensity of a wildfire. These include forest management practices (Charnley et al. 2015), climate (Abatzoglou and Williams 2016), historic fire suppression (Steel, Safford, and Viers

2015) and a warming climate, conducive to fire ignition and rapid fire growth (Wotton, Flannigan, and Marshall 2017). Together, these factors have increased the hazard potential in B.C. forests—drought and insect effected forests that lack age and species diversity, and wildfire risk—hot and dry weather conditions are optimal for wildfires. To date, most research on wildfire adaptation has focused on managing the hazard potential: government sponsored timber harvesting, brushing, and removing deadfall in and around communities. The role of human systems in managing risk is typically downplayed, with risk being viewed in terms of estimated changes in climate and forest conditions. As such, we have a limited understanding of wildfire adaptation, in terms of who and what are exposed and sensitive wildfire risk, in what ways, and what is the capacity to adapt.

This research aims to explore the concepts of community vulnerability and resilience to wildfire risk in B.C. through a case study of communities located in the Robson Valley, B.C. The findings of this research are grounded regionally yet have broad applicability to many rural communities throughout B.C. and elsewhere. The findings touch on key themes ranging from economic transitions, centralization of government services, and the empowerment of rural communities in preparing for and managing wildfires.

1.1 Aim and Objectives

This thesis examines how rural communities are at risk to wildfires through a case study of the Robson Valley, B.C., Canada. The research is guided by a vulnerability approach, which conceptualizes risk as a function of how a community is exposed and sensitive to a hazard and its capacity to adapt. The aim is expressed in four objectives:

1. characterize rural community resident's perceptions of wildfire risk;
2. document current exposure-sensitivities to wildfire risk and adaptive strategies employed to manage them;

3. identify processes and conditions that aid or constrain adaptation; and
4. explore opportunities to enhance resilience to wildfire at the local and provincial levels.

Wildfire risk is dynamic and will be continually shaped by social and ecological factors and processes. As such, this research will focus on documenting a baseline of current wildfire risk, which is intended to be updated with new information over time.

1.2 Thesis outline

This thesis is divided into eight chapters starting with the *Introduction*. The second chapter is a *Literature review* providing an overview of relevant literature focused on addressing community risk to wildfires in a changing climate. Chapter three, *Case Study* provides a broad overview of the research area, its history, and the role of wildfire. Chapter four, *Research Approach* explains the research framework used and the methods for data collection, storage, and analysis. Chapter five, *Results* identifies and describes key findings from the data analysis. Chapter six, *Discussion* links these key findings to the research aim and objectives and situates them in current scholarship on community vulnerability to wildfire risks. Finally, chapter seven, *Conclusion* summarizes key research findings and suggests future research opportunities.

CHAPTER II: Literature Review

The purpose of this literature review is to provide context for this research through addressing research on wildfire and climate change in the context of B.C. and Canada. First, the effects of climate change and the impacts of biophysical wildfire risk are discussed, then the focus shifts to research on the way in which people and communities manage wildfire risk.

2.1 Social Science and Wildfire

Despite the natural occurrence of wildfire, the long-term inhabitation of wildfire prone forests and the abundance of fire dependent ecosystems in B.C., wildfire is primarily a human issue. Wildfires occur naturally, and their severity, impact and scale are the product of a broadly linked social ecological system. This section will discuss the basis for wildfire as a natural hazard, a social-ecological system and discuss the ways in which human communities experience this hazard.

2.1.1 Wildfire as a Natural Hazard

A natural hazard can be defined as a natural process that has the potential to cause harm to humans or human values. Common examples have included floods, earthquakes, hurricanes, and wildfires. The field of natural hazards research has long been a cornerstone of geography (Montz and Tobin 2011), with the focus initially on understanding biophysical processes of natural hazards. During this research little attention was paid to social factors, outside of quantifying death, destruction, or injury. Gilbert White's 1945 work "Human Adjustment to Floods" set in motion a trajectory of hazards research that also included the societal dimensions of natural hazards (Montz and Tobin 2011). Over the coming decades, research on the human dimensions of natural hazards focused on case studies of specific hazard events before eventually diversifying and focusing on the development of conceptual models and frameworks for assessing the human dimension of natural hazards (Montz and

Tobin 2011). In natural hazards literature, there had historically been a focus on resilience frameworks, which typically consider a hazard or event as a binary and often downplayed the role that communities play in the way they experience hazards. More recently, vulnerability focused literature, which recognises the agency of humans in influencing their own experience with and response to natural hazards (Cutter 1996). This means that humans are never "bystanders" in natural hazards; instead, they play an active role in risk creation and management. This concept is still fundamental in vulnerability and hazards research today. It takes on new meaning in the light of anthropogenic climate change, where the nature of natural hazards has changed and can be amplified due to human causes (Cutter 2021).

Wildfire has long been researched independently of other natural hazards and has often been considered different due to its "controllable" nature, which differentiated it from hazards such as a hurricane or earthquake. In recent years, with the increasing prevalence of catastrophic wildfire which damages communities, infrastructure and ecosystems in a similarly sudden and uncontrollable manner, some scholars have argued for an increased overlap between the two fields (McCaffrey 2004; Moritz et al. 2014). This change in perspectives recognises humans as agents that influence their experience and response, a factor which has been historically overlooked in much wildfire reach. Much of the literature in the field of the natural hazards has come to focus on two specific fields – sensitivity and adaptive capacity. In sensitivity, research is focused on how communities experience a natural hazard and specific communities or populations may have unique sensitivities to certain hazards. In adaptive capacity, research has focused on specific mechanisms to reduce risk and ways to influence. These two factors influence overall vulnerability to natural hazards and will be explored further elsewhere in this review.

2.1.2 Wildfire as a Social-Ecological System

Understanding humans as active agents in how they experience a natural hazard suggests that hazards systems should fit the description of social-ecological systems (SES). These are complex systems which are comprised of multiple inextricably linked biophysical and social subsystems (Gallopín 2006). In other words, human and social structures are integral to nature and therefore a distinction between the human and natural is arbitrary (Adger 2006). The nature of these subsystems ensures that SES are dynamic, continually changing, and acted upon by a variety of forces or attractors. These systems are regularly impacted by gradual stresses and occasionally by perturbations (Gallopín 2006; Turner et al. 2003). These can be both slow and gradual as well as sudden and abrupt (Scheffer et al. 2001). Over many years, climate change may act as a gradual stressor and pushed the system closer to its natural limits where it is more susceptible to a sudden perturbation which may now exceed its coping range when previously a community's resilience may have allowed it to overcome the sudden perturbation had it not already been impacted by climate change.

Wildfires were first studied as an SES by Chapin et al. (2006, 2008); however this research was isolated and it was not until recent years than SES have become a common approach for wildfire research (Hamilton, Fischer, and Ager 2019; Otero and Nielsen 2017; Steelman 2016). As the SES is a common approach for understanding wildfire hazard in the past several years, there is recognition that our efforts to maintain wildfires in their existing social-ecological role is unsustainable given the rapid change to climate, forest composition and WUI inhabitation (Moritz et al. 2014; Steelman 2016). Gunderson et al (1995) showed that as systems approach their tipping point government institutions are often unprepared or unable to deal with those changes. The need for change in wildfire agencies is widely understood; however, there has been little progress due to limited funding and lack of broad support (Johnston et al. 2020; Steelman 2016).

Considering wildfire as an SES recognises the complexity of environmental change is an important perspective to take. It allows researchers to better understand the complexities of systems and the relationships between them. Taking a socioecological approach is a comprehensive and effective way to explore complex issues. That said, exploring challenges though an SES lens is insufficient unless considering the dynamic and constantly changing nature of these systems (Sidle et al. 2013). This dynamic assessment should be coupled with an understanding of a system's of tipping points, which are often induced by climate change and can lead to an "episodic resetting" (Sidle et al. 2013). Acknowledging that system thresholds are dynamic and can be induced through a variety of both known and unknown factors is essential in understanding wildfire as an SES.

2.1.1 Vulnerability and Natural Hazards

Vulnerability has long been a key component of risks and natural hazards literature. The concept refers to susceptibility to harm from exposure to environmental and social stresses along with an insufficient capacity to adapt (Adger 2006). While the concept has been applied in a wide variety of fields and the outcomes have varied, vulnerability research is focused on understanding the specific factors which place people and places at risk along with what impacts their ability to respond to that risk (Cutter 2003).While vulnerability is commonly used in the natural hazards field, it is also a cornerstone of environmental change research where it is used to explore how biophysical changes to climate are affecting human systems (Ford et al. 2018).

Another way to consider vulnerability is the ability to withstand perturbations in a social-ecological system. As stresses slowly mount, vulnerability may progressively increase, and a community or system may be less capable to absorb the shocks or recover from a major perturbation (Adger 2006). While these stresses may commonly arise from environmental change, they can also arise from changes to other aspects of a community including health

and economy. Understanding this relationship concludes that factors such as marginalisation, socioeconomic status and health factors are often largely responsible for the vulnerability to and potential harm from a seemingly unrelated natural hazard. Hewitt (1997) coined this as 'the human ecology of endangerment".

The concept of vulnerability is clearly a key way to understand the potential ways in which a community or group could be impacted by a significant disturbance, it is important to note that this is not static and continually changing in complex adaptive systems (Naylor et al. 2020). In the context of wildfire, the vulnerability of a community can change depending on the time of year, the current conditions, the economic capacity of the community at hand, and the potential losses in the event of a wildfire. This can be challenging to address when vulnerability assessments are of based on the feedback of community members at a specific point and time, which often does not adequately consider the complexity of possible futures in both the environmental and community contexts (Fawcett et al. 2017).

A key component of vulnerability is adaptive capacity. Adaptive capacity can be thought of as the ability for a community to adapt to gradual changes or to alter its coping range over time. The concept of adaptive capacity has been found to be context specific – varying between people, groups, location, and time. It is also commonly dependent on its surrounding context and a resource of the community or individual (Smit and Wandel 2006). Like resilience, when adaptive capacity is exceeded, a system may leave its existing domain or regime. This can also be expressed the ability of a system to move with and adapt to consistent and directional change (Chapin et al. 2006).

Adaptive capacity is a concept that came from ecological studies and has become highly used in the context of climate change adaptation (Lindner et al. 2010; Wall and Marzall 2006) where it is used to discuss the way in which groups can decrease their

vulnerability to changes in their local climate over time. These could include improving flood protection, food security or reducing the wildfire hazard near communities.

A system's adaptive capacity is not a static concept (Smit and Wandel 2006). The range of conditions in which a system can survive will change due to local conditions, other stresses, and ecological conditions over time. Enhancing the adaptive capacity may expand the range of conditions in which a system can continue to operate normally. For example, in the context of wildfire a coping range may expand, or contract based on the local conditions, the values at risk, funding and the perceived likelihood of fires. In addition, if a system can survive and manage the impacts of a large fire, the adaptive capacity of a region may be diminished, leaving it more vulnerable to the increased sedimentation of its water sources or the increased likelihood of post fire landslides.

2.2 The Biophysical Mechanisms of Wildfire

Wildfire is fundamentally a physical process that uses the combustion of materials to release energy in the form of heat. This occurrence is highly impacted by specific fuel types and localised conditions. The following sections identify the key conditions that lead to wildfire and how they are affected by human factors such as climate change.

2.2.1 Wildfire and Climate Change in Northern B.C.

The effects of global climate change have been widely recognized, with the Intergovernmental Panel on Climate Change (IPCC) reporting a 1°C increase in global average temperature by 2017, largely attributed to anthropogenic activities (IPCC 2021). The impact of this change is particularly severe in Canada, where the average temperature has risen twice as fast as the global average (Bush and Lemmen 2019). Between the years of 1948 and 2016, the province of B.C. has seen an annual mean temperature increase of 1.9 degrees, while Canada's north experienced a more significant rise of 2.3 degrees (Prairie

Climate Centre, 2019). Available climate models indicate that this trend is likely to persist, with increased temperatures projected for both B.C. and northern Canada over the next century (Bush and Lemmen 2019).

In addition to rising temperatures, B.C. has experienced a 5% increase in precipitation, while northern Canada has seen a 32% increase, concentrated mainly in the northeast region. These trends are likely to continue over the next 50 years, with modest increases in precipitation projected for both regions based on available climate models (Bush and Lemmen 2019). Along with increased annual temperatures and precipitation, the way in which these are experienced in northern B.C. will change (City of Prince George 2020; Northeast Climate Resilience Network 2019b, 2019c, 2019a, 2019d). Very hot days will become more frequent and extreme rainfall events will increase in magnitude, making each of these potentially more damaging than in the past. In addition, northern B.C. is projected to see a reduction in winter snowpack, reduced permafrost, increased flooding, and greater risk of wildfires (City of Prince George 2020; Northeast Climate Resilience Network 2019b, 2019c, 2019a, 2019d).

Northern B.C. is exposed to the effects of climate change through various mechanisms including economic and social factors. The region's rural communities, which are heavily reliant on the forest industry, are inherently exposed to climate change through its economic dependence on abundant forest resources. The effects of climate are expected to cause a shift in tree species dispersal (Fernandez et al. 2021; Hof, Dymond, and Mladenoff 2017), and increased exposure to pathogens which thrive a warmer climate (Seidl et al. 2017; Woods et al. 2017). In the early 2000s, north central B.C. was hit by a massive outbreak of mountain pine beetle. While sporadic outbreaks of the insect had previously occurred, this outbreak was an order of magnitude large than previous outbreaks and is widely thought to have been amplified by the effects of climate change (Campbell, Alfaro, and Hawkes 2007;

Raffa et al. 2008). Overall, this outbreak killed 54% of the merchantable pine in B.C. and permanently altered the forest industry in B.C. (Meyer et al. 2018). In recent years, there has been a surge of insects attacking white spruce (*Picea glauca)* (Campbell, Antos, and vanAkker 2019), the economic lifeblood of many communities throughout the north.

Several communities in North and Central B.C. have completed recent climate vulnerability assessments which have identified potential climate impacts including: warmer winters enabling spruce beetle infestations and infrastructure damage through freeze-thaw processed; increased intensity of significant precipitation events; increase in extreme events leading to power outages, strained emergency response systems and increasing the potential for isolation due to impacted escape routes; and increased risk of wildfires throughout the spring and summer (City of Prince George 2020; Northeast Climate Resilience Network 2019b, 2019a, 2019c, 2019d).

While Northern B.C. is exposed to many of the same impacts of climate change as communities elsewhere, it is important to note that small, isolated and resource dependent communities are particularly vulnerable to significant disasters. Adapting to these events will be essential for communities in the region moving forward.

2.2.2 Impacts of a Changing Climate on Wildfire Occurrence

Throughout the global north, there have been record breaking wildfire seasons in recent years. Western Canada (Erni et al. 2021; Wotton et al. 2017), USA (Williams et al. 2019), Siberia (Flannigan et al. 2009; Kharuk et al. 2021; Ponomarev, Kharuk, and Ranson 2016), and the Mediterranean (Lozano et al. 2017) have all recorded a series of significant and anomalous fire seasons which have often been attributed to climate change. The effects of these season have included the destruction of communities (Kramer et al. 2019) and sensitive ecosystems, economic damage (Bayham et al. 2022; Kochi et al. 2010), health risks

(Finlay et al. 2012; Kochi et al. 2010; Reid et al. 2016) and occasionally the loss of human life (Cameron et al. 2009).

While attempts to attribute specific wildfire events to the effects of climate change have been relatively rare, there is strong evidence globally that a rising global temperature has substantially increased the likelihood and magnitude of extreme fire weather (Liu et al. 2022). In a local context, there is strong evidence that a warming northern climate will lead to increased wildfire activity through the a multitude of mechanisms including increased days of risk and spread potential (de Groot, Flannigan, and Cantin 2013; Wang et al. 2015), an increasing number of fires (Krawchuk, Cumming, and Flannigan 2009; Wotton, Nock, and Flannigan 2010) and a greater area burned (Flannigan et al. 2009). This change is expected to be most pronounced in northern regions, where the annual fire season may increase by up to 20 days in length (Flannigan et al. 2013) and burn double the annual area (Flannigan et al. 2009) by the end of the century. Recent significant fire events have occurred after weather events which have been amplified due to climate change. In B.C., the record breaking 2017 fire season occurred during anomalous conditions which were highly unlikely without the effects of anthropogenic climate change. This resulted in extreme fire behaviour being 2-4 times more likely and burnt area increasing by a factor 7-11 (Kirchmeier-Young et al. 2019). It is widely expected that a warming climate will lead to increasingly impactful wildfires on northern communities along with significantly higher suppression costs (Hope et al. 2016).

It is important to note that while climactic drivers of wildfire can predict generalised trends, significant fire events can vary spatially and therefore it cannot be assumed that climate change will have a uniform effect on wildfires. That said, there is widespread agreement throughout prior research and global climate models that the likelihood for conditions conducive to significant fire seasons in Northeast B.C. is likely to increase. As the temperature increases, the amount of precipitation needed to offset the effects of a rising

temperature are significant. While it does vary for different fuels, fine fuels such as leaf litter and twigs require a 15% increase in annual rainfall to offset the additional fire risk for every degree of warming (Flannigan et al. 2016). In B.C., between 1948 and 2012, the increase in precipitation was significantly below the 25-30% required to accommodate a temperature increase of 1.9°. As indicated earlier, these trends are likely to continue for the foreseeable future, which suggests that wildfires are increasingly likely to be a part of life in B.C.

2.2.3 Causes of Wildfire as a Natural and Human Hazard

Fires are a key part of many ecosystems and are often necessary to thin vegetation and aid in forest reproduction. The vast majority of British Columbia exists in fire prone forests that rely on wildfire for renewal and regeneration (Taylor et al. 2022). These ecosystems include Ponderosa pine (*Pinus ponderosa)* forests of southern B.C., where trees have thick bark meant to withstand regular, low intensity fires, and northern black spruce (*Picea mariana)* forests that reproduce through semi serotinous cones only after exposure to heat during severe wildfires. Fire intervals can vary widely and typically have a positive correlation with fire intensity, meaning that the longer the interval between regular burning, the more intense and aggressive the fire will be (Pyne 2008). Fire's role in these forest ecosystems ensures that healthy forests will have a mosaic of stands at different ages, composition, and vulnerability to wildfire.

As a result of modern fire suppression, many historic fire regimes have been altered as fire on the landscape has not been allowed to burn (Pyne 2008). The effect has been pronounced in open pine forests where smaller vegetation has been allowed to thicken and gain elevation, leading to ground fires moving to the canopy (Brown 1983). This however is less pertinent in closed canopy fuel types including boreal ecosystems which are naturally more prone to have high intensity stand replacement fires (Johnson, Miyanishi, and Bridge 2001). One cause of this lack of difference is that in northern environments, the changes to

the fire regime have been less significant due to limited population centres nearby allowing fires to burn unrestricted as there is less risk to human infrastructure.

While climate change and the additional fuel load due to limited fire suppression play a significant role in increasing the likelihood and intensity of wildfires, the impacts of catastrophic wildfires are a largely a product of inhabitation and development of the Wildland Urban Interface (WUI). The WUI is the area where rural properties and fire prone, wildland vegetation meet, leading to significant risk to property and communities. Recent disasters in the WUI have led to the destruction of homes and communities, as well as deaths to both residents and firefighters (Calkin et al. 2014; Kramer et al. 2019). Inhabitation of fire prone areas has increased substantially in recent years, a trend that is likely to increase as housing prices push residents out of larger centres and a warming climate will increase the regularity and intensity of fires (Erni et al. 2021). This is a major cause for the increase in wildfire tragedies and is in some way analogous to people living on floodplains or other areas prone to natural hazards. Currently 3.8% of the of the Canadian land base exists within the WUI (Erni et al. 2021) which is home to 12.3% of Canadians, a number which could rise to 39% under severe climate projections (RCP 8.5).

2.3 Wildfire Mitigation and Vulnerability

Much of the focus in wildfire social science has centred on the ways in which people address the risk of wildfire on their property and their community. This section will discuss the ways in which individuals and communities address the risk of wildfire and the ways in which fire can have unique impacts on rural and Indigenous communities.

2.3.1 Wildfire Impacts and Mitigation

Research examining the propensity of individuals and homeowners to address wildfire risk is still a developing field. Much of the research conducted thus far has focused on the

Western USA and Australia and has been centred on risk analysis, specifically individual mitigative actions and response to fire communication (i.e. evacuation orders). While there has been social research in Canada (Christianson 2015; Faulkner, McFarlane, and McGee 2009; McGee, McFarlane, and Varghese 2009), it has been limited in comparison to other jurisdictions and much of it has focused on Indigenous communities. Common findings across studies suggest that there may be little in the way of geographical distinctions in individual wildfire response (Toman et al. 2013), indicating that research performed internationally will have significant applicability to the Canadian context.

Research has found that residents in fire prone areas have a good understanding that they exist in the WUI and the associated increased risk of fire. This finding is widely consistent across research locations in Canada, the USA and Australia (Toman et al. 2013). An increased perception of risk has been associated with increased mitigative action in wildfire (Brenkert-Smith, Champ, and Flores 2012; Ghasemi, Kyle, and Absher 2020; Martin, Martin, and Kent 2009), however common findings suggest that awareness did not automatically lead to risk reduction behaviours (Brenkert-Smith 2006; Collins 2005; Martin, Bender, and Raish 2007). Perceived effectiveness of mitigative efforts (Absher and Vaske 2006; Brenkert-Smith 2006; Ghasemi et al. 2020; Martin et al. 2009), perceived ability to mitigate own risk (Bright and Burtz 2006; Martin et al. 2009) and the actions of others (Brenkert-Smith 2006; Bright and Burtz 2006) have a greater effect than awareness on influencing residents to take action to reduce their own risk. Previous research on the correlation between previous experience with wildfire and perceived risk has been mixed, with most research finding no correlation (Martin et al. 2009; McGee et al. 2009), until Ghasemi et al. in 2020. This has yet to be replicated. A final important factor which has been shown to have an effect is that of residence continuity. People that live in a residence year-round, are more likely to engage in mitigative measures (Martin et al. 2009). Similar to

previous research in other natural hazards (Bubeck, Botzen, and Aerts 2012; Wachinger et al. 2013), perception of effective fire management agencies has also been shown to have a negative correlation with homeowner mitigation (McFarlane et al. 2011), a factor which is worth considering as the fire management agencies are increasingly beyond capacity and not able to effectively respond to all high-profile fires (Tymstra et al. 2020).

It is important to consider that wildfire risk reduction is often a balancing act, strongly effected by factors such as home ownership and seasonal inhabitation while other factors such as privacy (Brenkert-Smith 2006; Nelson et al. 2004), aesthetics (Collins 2005; Nelson et al. 2004) and shading (Collins and Bolin 2009) were also found to be significant. Previous research has identified tree mortality (change in aesthetic value) as a significant driver for people to remove the tree and therefore reduce their risk to wildfire (Labossière and McGee 2017).

Wildfire risk analysis research has largely focused on studying a series of common actions which homeowners can perform to reduce their wildfire risk at a single point in time. As a result, there is often limited distinction between a simple action such as cutting the lawn, irrigation or trimming vegetation, versus a significant procedure such as installing a fireproof roof or upgrading siding on a house. In addition, there has been little follow up research to gain an understanding of how these actions change over time and in response to significant fire seasons (Toman et al. 2013). As a result of often inconclusive findings on motivations, along with some of the shortcomings listed above, there is a clear need for further research on the influences on preparedness, evacuations decisions and fire mitigation activities at the individual level.

2.3.2 Wildfire Mitigation at the Community Level

Both Canada and the USA have seen significant loss of infrastructure and in several cases, the complete destruction of communities. Addressing wildfire risk in communities has become a significant priority of both local and provincial governments. One major effort has been to encourage the creation of Community Wildfire Protection Plans (CWPP) and more recently Community Wildfire Resiliency Plans (CWRP). These plans are typically an assessment, at the community level of areas facing significant wildfire risk which pose a direct threat to community infrastructure or values and are often used to identify and prioritise potential treatments in these areas. The recent change to CWRP planning had added considerations which better consider wildfire mitigation and take a holistic approach to assessing wildfire risk. CWP(R)Ps are often a requirement to secure funding or support from fire agencies or other levels of government. Overall, previous research has found the process of creating and implementing CWPPs increases community resilience to wildfire risk and increases adaptive capacity to a variety of environmental changes and hazards (Jakes et al. 2013).

However, the presence of a CWPP alone is not a recipe for success in reducing the risk of wildfire. Labossière and McGee (2017), who researched innovate fire risk reduction programs in Kamloops and Logan Lake, found that success in these programs required extensive planning beyond the simple creation of a CWPP. This included recognising the social context within communities, taking advantage of windows of opportunities, building collaborations and partnerships as well as identifying mitigation champions and earning the support of the public. Without considering the social context, community specific factors and the ability to implement initiatives, the CWPP is insufficient and unlikely to make a different.

Community wildfire risk reduction can be a contentious issue. While there is almost always broad general support for action over inaction (Bowker et al. 2008), and extremely

high support for fuel reduction conceptually (not linked to a specific area), community members faced with controversial decisions such performing mechanised treatments on "natural" ecosystems, or conducting prescribed burns near property and infrastructure, can often view the pros and cons of wildfire risk reduction as more complex in the local context (Bowker et al. 2008). While there is often significant pushback to wildfire mitigation activities due to ecological effects, visual effects, and a perception of what is "natural", there is a strong correlation between support for fuels mitigation and trust in practitioners (Toman et al. 2011). One area where this is most apparent is in prescribed burning, which is often perceived as a hazardous or dangerous activity by communities and is commonly preferred in rural areas (Bright and Newman 2006). This is an important finding that highlights the importance of community outreach for agencies and suggests already stretched agencies who have faced prior criticism for wildfire response may have a challenging time initiating wildfire risk reduction.

Community based risk reduction faces several barriers and challenges to implementation. That said, it is conceptually popular and can often take advantage of occasions such as significant wildfire seasons to encourage further action to reduce wildfire risk. In B.C., much of the significant wildfire risk reduction work is being done at the community level, suggesting that it is a key area for further research and exploration as well as a potential avenue for rapid and effective deployment of fire risk reduction initiatives.

2.3.1 The Impacts of Wildfire on Indigenous and Rural Communities

Indigenous communities in Canada face wildfires at a significantly higher risk than the rest of the population (Erni et al. 2021). Currently, the over 32% of the on-reserve Indigenous population lives in the WUI, in comparison to 12.3% of the Canadian population at large (Erni et al. 2021). With 80% of Indigenous communities in Canada located in fire prone area there is clearly a disproportionate sensitivity to the effects of wildfire

(Christianson 2015). This increase in exposure is often coupled with increased sensitivity to the effects of wildfire due to significant resource dependence on the local environment as well as complex jurisdictional and communication challenges between Indigenous governments, fire management agencies and provincial governments (Abbott and Chapman 2018; Dickenson-Hoyle and John 2021).

In many areas, Indigenous peoples regularly used wildfire to manage landscapes and to support a subsistence lifestyle for thousands of years pre-colonisation (Oetelaar and Oetelaar 2007; Pyne 2008). Post colonisation, the practise of burning was outlawed and the focus moved to fire suppression. As described earlier, this helped to alter the natural fire regime and likely led to higher fuel loads which have increased the risk for catastrophic wildfire. While the practise of cultural burning has largely been stopped, in many communities some knowledge of these practises still exists (Christianson 2011). Efforts to revive these practises is underway in some areas (Hoffman et al. 2022; Lewis, Christianson, and Spinks 2018) and restoring cultural burning has also been identified as a priority for legislative change in a recent review of B.C. fire management (Abbott and Chapman 2018) as well as a provincial forest policy intentions paper (Government of British Columbia 2021).

In Canada, there has been limited research done on Indigenous communities and their responses to wildfire. Much of the available research has focused on the additional vulnerabilities of Indigenous communities and the jurisdictional, social, and cultural complexities of evacuating communities at risk of fire (McGee, Christianson, and Partnership 2021). There has also been a small amount of research on understanding fire mitigation programs in Indigenous communities and the factors which enabled or constrained these opportunities to reduce risk (Christianson 2011). While research has identified several key factors, which aid in reducing risk, it is limited in its scope, and has been focused on a handful of communities mostly in Alberta. Further research in this area - especially in a new

region - would be valuable to enhance the understanding of how Indigenous people relate to and can adapt to an increasing risk of wildfire.

2.4 Wildfire Management in B.C.

Fire suppression in British Columbia has undergone significant transformations post colonisation, which have broadly matched changes in prevailing worldview and government priorities This shift in priorities has been well documented by Copes-Gerbitz, Hagerman, and Daniels (2022), who explored these shifting priorities and broadly defined five eras in the history of B.C. wildfire management. Since the early 1900s, the primary authority on fire was the provincial government and various iterations of the Ministry of Forests, who primarily sought to control and eliminate fire which was seen as a common enemy of the timber. This was done through the Bush Fire Act of 1874, and the creation of the Ministry of Forests. Over the next century, until 1974, the provincial government aimed to control and stamp out fire as a treat to B.C.'s economy. Over the 100 years between the implementation of the bush fire act and the recognition of fire as a natural force which benefitted ecosystems in 1974, the B.C. government had a full suppression policy, which aimed to stamp out all wildfire and to control eliminate this source of loss to B.C.'s Forest industry.

Between 1974 and 1995, wildfire was managed by local forest districts, with a common focus on re-introducing fire through allowing remote fires to burn and encouraging broadcast burning of logged areas. This goal was pursued but was clearly a secondary priority behind fire suppression and after a fire in 1994 burnt 18 homes, was abandoned for a suppression first approach. In addition, some communities raised concerns about the smoke and hazard potential of broadcast burns, which were eventually eliminated as standard practise in B.C.

Fire suppression in B.C. was drastically changed in 1995 when, what would later become the B.C. Wildfire Service was created as a stand-alone organisation which managed concentrated bases of professional firefighters. As a result, wildfires have since been managed by highly trained, professional firefighters, alongside certified contractors. This centralised fire management regionally, when previously local forestry offices and district managers were tasked with co-ordinating fire suppression locally. Previous research has labelled this change as a "siloing" of management, suggesting that while it was successful in centralising fire management, it created uncertainty over the responsibility of different actors to address fire management (Copes-Gerbitz, Hagerman, et al. 2022).

In recent years, after the catastrophic impacts of the 2017 and 2018 fire seasons, fire management is moving in the direction of decentralisation, with many communities, first nations and government organisations playing a role. Suppression is still largely centralised within the B.C. Wildfire Service; however other organisations, including municipal governments, regional districts, Indigenous communities, and environmental organisations are playing a significant role in identifying, responding to, and addressing local fire risk. This is often done through expensive and labour-intensive fuel thinning.

Throughout rural B.C., many residents and communities still lament the centralisation and professionalisation of fire suppression which occurred in the late 1990s and early 2000s. This lack of local capacity is a topic which has been raised publicly after each of the three major fire seasons in recent years and has become a contentious issue in parts of the province, where on several occasions residents have refused to leave their homes and communities and have cited a lack of support from government crews during complex wildfire seasons (Hergott 2021). Improved communication and community collaboration was identified as a priority for government fire agencies by the findings of the Abbott Chapman Report, which

reviewed key challenges faced by the B.C. government during the 2017 wildfire season (Abbott and Chapman 2018).

CHAPTER III: CASE STUDY

The Robson Valley is a rural region in East-Central British Columbia. The region stretches over 230 kms from Dome Creek to the Alberta border and Jasper National Park. It is connected to Prince George and Jasper by Highway 16, often known as the Yellowhead Highway and to Kamloops by Highway 5. The Robson Valley occupies the northern extent of the Rocky Mountain Trench and is the valley which separates the Caribou Mountains (the northernmost subrange of the Columbia Mountain Range) to the Southwest and the Rocky Mountains to the Northeast (Figure 1). This research focuses on the Western Robson Valley, between Dome Creek and Tête Jaune Cache.

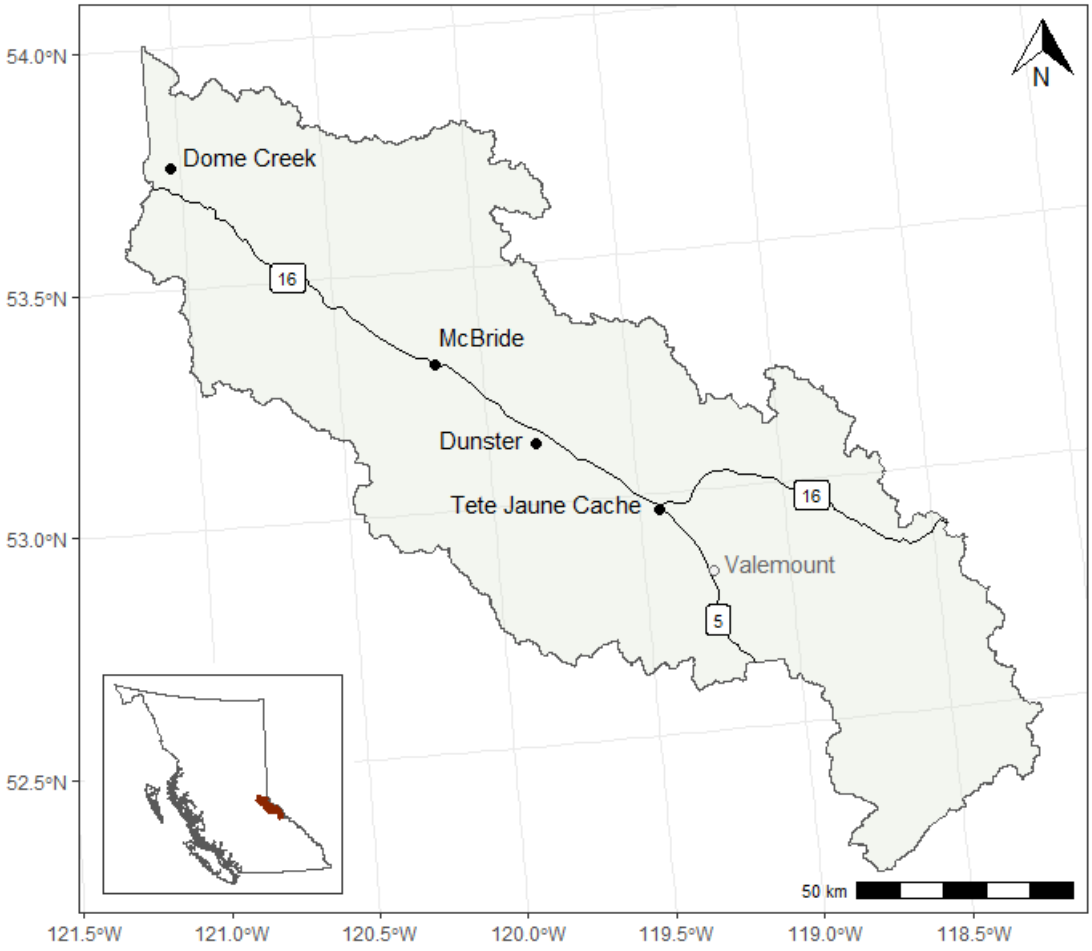

Figure 1. A map of the Robson Valley showing the location of communities and roadways. The study communities are identified in dark font.

Politically, the Robson Valley region is represented by village councils for McBride and Valemount as well as governed regionally by the Fraser- Fort George Regional District where it is classified as Electoral District H. This District is exclusive to and spans the entirety of the Robson Valley Area and therefore will be used as the defined borders for this research. The electoral area covers more than 15000 km2 and has a total population of 3229 residents combined (Government of Canada 2022; Regional District of Fraser-Fort George n.d.). For the purposes of this research, the study area extends from the western edge of RDFFG Electoral District H to the community of Tête Jaune Cache, encompassing the Village of McBride and the unincorporated communities of Dome Creek, Dunster and Tête Jaune Cache. Collectively, this area has a population approximately 2100 people (Government of Canada 2022)

3.1 History of the Robson Valley

Historically, the Robson Valley has been inhabited by several Indigenous groups including the Simpcw and the Lheidli T'enneh, who used the yellowhead pass as a major trading route (Wheeler 2008). The most modern Indigenous settlement was that of the Simpcw, near the location of what is currently known as Tête Jaune Cache. Simpcw residents were forcibly removed from this settlement in 1916, and most left to settlements in the south of Simpcw territory, notably the modern community ChuChua (Wheeler 2008). The region saw little interaction with settler populations until the late 1800s, where the valley became an important region for fur trapping (Wheeler 2008), and as a gateway to Northern B.C. Outside of these purposes, the region remained largely isolated until the mid-1910s when construction began on the Grand Trunk Pacific Railway which spanned from Winnipeg to the ocean port in Prince Rupert and Canadian Northern Railway, which was a secondary transcontinental highway, that concluded in Vancouver. The construction of the railways led to the establishment of several work camps, some of these work camps developed amenities and

eventually became established communities (Wheeler 2008). The region remained isolated, only accessible by rail and several trails (which were occasionally navigable by vehicle) until the completion of the yellowhead highway in the late 1960s (Wheeler 2008).

From the year 1910, logging and timber processing played a large role in the regional economy, initially for railway path clearing and wood, along with the supplying the needs of settlers to the valley. Over the coming decades, timber extraction and processing would play a key role in the local economy. By 1952, there were roughly 35 mills in the McBride area, many of which were mobile and used horses to transport lumber, a necessity in a valley without road access (Wheeler 2008). The timber industry in the Robson Valley saw substantial investment in 1965, when Ziedler Plywood Corporation opened a new mill, employing over 100 residents and focused on harvesting Birch, which was uncommon for mills in the area (Wheeler 2008).

Upon completion of the highway to Prince George in the 1960s, many small mills shuttered or sold, when it became more profitable for owners to use their timber license to supply logs to larger mills in the city. With closure of local mills, around which many local economies were built, smaller communities suffered substantial declines in population, services, and amenities, retaining small groups of hardy residents. Over the coming decades, some of these communities survived and eventually shifted to an agricultural focus and gradually came back to life, offering affordable land, privacy and a quieter way of life than was available in larger centres.

Despite the declines, the forest industry continued to play a central role in the economy of McBride and provided employment through harvesting, planning and transporting timber. McBride was also home to Ministry of Forest district office, which employed 30 professionals and managed forestry throughout the Robson Valley. The office

combined forest management and firefighting under the same roof and was a hub for government interaction with resident of the Robson Valley. In the late 2000s, both the veneer mill (formerly Zeidler Plywood Corporation) and the district forest office closed, leading to a substantial drop in the number of well paying, stable jobs in McBride and the surrounding areas.

3.2 A Changing Region

The loss of primary mill, decline of the forest industry and the closure of the Ministry of Forest office led to a substantial drop in the working age population in McBride. This can be seen in secondary school enrolment, which dropped from 127 to 49 students in the period from 2006 to 2022 (Province of British Columbia 2023). This period also saw the closure of elementary schools in Dunster (2010) and Dome Creek (2001).

Since the loss of many forest industry jobs, there has been a significant economic transformation in the Robson Valley, with primary industries shifting from industrial, to a diverse mix of tourism, agricultural and outdoor recreation. While resource extraction industries are still present in the valley and play a significant role in the local economy, the nature of these businesses has shifted due to the creation of community forests in Valemount and McBride, providing additional community control over these resources (McBride Community Forest n.d.; Valemount Community Forest n.d.).

The Robson Valley has also become a significant player in the outdoor recreation and tourism industries in recent years. The region is home to world class mountain biking, hiking, and snowmobiling, and backcountry skiing (VARDA n.d.). In addition, the valley is situated near Jasper National Park and includes Mt Robson Provincial Park, offering impressive mountain views and access to excellent hiking and alpine access. In 2017, the Government of British Columbia approved a proposal for the development of the Valemount Glacier Destination Resort (Valemount Glacier Destination n.d.), a proposal to develop the first year-

round glacier ski destination in North America (Mercier 2016). The resort, if constructed, will have the largest vertical drop of any ski area in North America. The resort is currently pursuing funding and is approved to start construction upon securing the funding.

Over the past two years, the eastern Robson Valley has also been home to over 2000 pipeline workers constructing the Trans Mountain Pipeline. This project has starkly altered the housing market in Valemount and the surrounding communities. A key effect of this has been the changes to the housing and rental market, most notably in Valemount, but to a lesser extent in Tête Jaune Cache, Dunster and McBride. During the construction of the pipeline, rental prices soared to as high as $5000 per month for small homes, meaning that many essential services struggled with staffing. This included the Valemount Fire Zone, who faced difficulty housing staff, who received a standard starting salary of $3800 per month.

In addition, many residents reported significant turnover of residents during a surge in house prices in 2021 and 2022, where some formerly urban residents moved to remote communities in the Robson Valley after being enticed by cheaper property, stable connectivity, and the ability to work their existing positions remotely. The incoming population was coined by one policy maker who was interviewed as “rural urbanites” who came in search of a rural lifestyle, while maintaining the expectations for services present in urban centres.

3.3 History of Wildfire

The Robson Valley has also been home to significant wildfires over the past century. Many of these fires were believed to have been the result of industrial forestry, land clearing and railway construction. The most significant of these fires occurred in 1912, and burned a large swath of the Robson Valley, from north of McBride to Dunster, nearly 30kms away (Wheeler 2008; R. Theissen, Personal Communication, 2022). The difference in forest

composition between burnt and unburned areas is still evident throughout the valley. Throughout the mid and late 1900s, residents have told of being recruited to fight fires and working with the local logging industry to do so (Wheeler 2008). Over the last century, local newspapers have described occasional fire events, which have damaged homes (RV Courier 1971; Wheeler 2008), threatened neighbourhoods (Mahoney 1998) and burned forestry equipment (Mahoney 1998). Recent analysis has found that the cedar-hemlock forest found throughout much of the valley is not predisposed to severe, stand replacement fires. Analyses conducted in the early 2000s suggested that forests in the Robson Valley saw stand replacement fires every 500-2000 years (Wheeler 2008). That said, the Robson Valley has seen significant recent wildfire 2017 and 2018. Most significant wildfire events in recent years have occurred in the southeast of the valley, in dry forests near Valemount (B.C. Wildfire Service n.d.), with the notable exception of the Dore Creek Fire in 1998 and Teare Creek Fire in 2023, both of which came within several kms of the community and saw homes threatened.

Today, Valemount is home to a small base of three Initial attack crews, which respond to fires throughout the Robson Valley. Before this, in the 1990s, McBride became home to one of the two helicopter rappel fire bases in the province, designed to provide rapid access to remote, inaccessible lightning fires (Wheeler 2008). The rappel base has since disbanded and there are currently no wildfire crews stationed in McBride.

The Robson Valley has also felt the effects of fire in other ways. This was most evident in 2003, when significant fires in Barrière damaged the single power transmission line (Narayan 2003a). The resulting power outage lasted over a week and led to widespread disruption of public services (Narayan 2003b). In addition to the challenge of power supply, most dwellings in the Robson Valley are at the valley bottom making them uniquely exposed to smoke and poor quality. Valemount has commonly been identified as having uniquely poor

air quality due to woodstoves and temperature inversions (Matthews 2022) and as a result, has developed the clean air task force on council, aimed at addressing community air quality concerns, and includes representation from the B.C. Wildfire Service (McCracken 2021).

3.4 Current Exposure to Wildfire

The Canadian Forest Fire Behaviour Prediction System is used to assess the likely fire behaviour and spread given the surrounding fuel types and the current dryness of the fuel(Wotton, Alexander, and Taylor 2009). The fuel types are named after tree species, but are typically used to represent fuel density, meaning that an appropriate fuel type may indicate a different tree species, yet may best represent the conditions seen in the region. The Western Robson Valley can be described in three different fuel types.

The first of this is interior cedar hemlock forests found in the west of the study area near the communities of Dome Creek and Crescent Spur. These forests are characterised by large, well-spaced trees, with a dense upper canopy, limited mid fuels and a thick, wet duff layer. This ICH Forest is typically resistant to significant fire in most circumstances; however, is known to be sensitive to disturbances and drought. That said, logging slash from this fuel type is known to burn intensely, even in moderate fire conditions. Using the Canadian Fire Behaviour Prediction System, Cedar – Hemlock Forests are typically classified as a C-5 Fuel Type, meaning that they resemble a stand of red and white pine in the way that they burn. At a baseline of moderate fire conditions, catastrophic significant fire conditions are unlikely in this fuel type, and most fires will struggle to rapidly spread. Two exceptions to this standard. The first is during extreme drought or fire conditions, where this fuel type can become highly reactive and is extremely difficult to suppress due to the dense vegetation and often steep slopes. The second is in logging slash, which is considered a different fuel type and can be extremely reactive.

The next fuel type is Deciduous birch-aspen forests which surround the populated regions surrounding McBride, Dunster and to a lesser extent parts of Dome Creek. Deciduous trees are typically wet, dense forests; yet have minimal ladder and mid-level fuels, which prevent fire from increasing in intensity and moving from the ground to the crown of trees. Deciduous trees typically reduce the intensity of fires and therefore are an effective fire barrier for the communities surrounding by this vegetation. Deciduous forests are most prone to aggressive fire during the spring before their leaves have opened and they are about to add moisture to the entire stem of the tree.

The third and final type for forest worth review is the dead pine and spruce stands of the central and eastern Robson Valley. The transition to this fuel type occurs between Dunster and Tête Jaune Cache, which is predominantly surrounded by this forest. Dead pine and spruce forests pose a significant fire risk to as they provide a high fuel load through deadfall, abundant ladder fuels through the low hanging branches of spruce and a dense spacing, which allows for rapid and significant fire spread.

It is important to contextualise the data above with the knowledge that fire is strongly affected by both wind and slope. As a long, mountainous valley, the Robson Valley commonly experiences significant wind events and typically experiences moderate winds throughout the spring and summer. This is likely to increase the hazard of a fire spreading and its impact depends on the fire location, wind direction and the location of nearby values. The effect of slope on wildfire is well known, with fire typically moving rapidly uphill. In the case of the Robson Valley, this is normally away from populations and communities. It would be unlikely for a significant fire to move rapidly downhill and threaten communities. As a result, in most areas the most likely damage from fires will be to outlying properties on the edge of communities. The primary exception to this is Tête Jaune Cache, which is the only community adjacent to a large flat area of a fire prone fuel type.

CHAPTER IV: METHODOLOGY

4.1 Research Approach

This research relies on two key approaches in informing the methodology. These are the Vulnerability Approach and a participatory approach to community-researcher collaboration informed by community based participatory research.

4.1.1 Vulnerability Approach

A common understanding of vulnerability is as a function of exposure and adaptive capacity. This builds on Cutter's (1996) understanding of humans as agents in the way they experience hazards and change. The vulnerability approach seeks to represent this by considering vulnerability as a positive function of exposure sensitivity and an inverse function of adaptive capacity (Adger 2006; Ford and Smit 2004; Smit and Pilifosova 2003). This approach considers stresses which lead to vulnerability (sensitivity and exposure) along with the ability and capacity to reduce or manage those stresses (adaptive capacity). The vulnerability approach is commonly conceptualised as (Smit and Pilifosova 2003):

$$V_{ist} = f(ES_{ist}, AC_{ist})$$

Where:

V_{ist} represents Vulnerability of a system (i) to climate stimulus (s) in time (t)

ES_{ist} represents exposure sensitivity (i) to (s) and (t)

AC_{ist} represesnts adaptive capacity of (i) to manage (s) in (t)

In this model exposure sensitivity represents the amount and the scale of stress faced by a system in regard to a specific or multiple hazards (Ford and Smit 2004), while adaptive capacity refers to the potential of a system to adapt or change in response to the hazard, allowing the system to withstand and absorb a greater level of stress (Ford and Smit 2004).

This equation therefore represents summarises the way in which a system is both exposed and sensitive to a hazard both now and in the future and contrasts that with the capacity of a system to adapt and address the hazard. The combination of both factors leads to overall vulnerability. A crucial dimension of this model is the consideration that this model is dynamic, and that the exposure sensitivity of a system will change due to changes to external stimulus on that system, as well as through actions taken to address the hazard. In the context of wildfire, this could include incorporating increased sensitivity due to a warming forest and an overgrown forest, along with an increasingly affluent population with increased capacity to address the hazard.

The vulnerability approach has not been without criticism. Ford et al (2018) used a systematic review to document some of these criticisms as well as to identify work which had been successful in addressing those issues. The vulnerability approach has at times been criticised for being one dimensional and focusing too heavily on climate change at the expense of social factors (Haalbloom and Natcher 2012; Hinkel 2011). This may have been true in early iterations of the vulnerability approach; however, the field has evolved and primarily considers vulnerability as a condition within larger socioeconomic processes. Vulnerability approaches have also been critiqued due to the vague nature of the term, which is used across disciplines and has an often-contested definition (Cutter 1996). Ford (2018) argued that this was a strength of the vulnerability approach as it can allow variety of perspectives, but only if this is explicitly noted and understood. A final, pertinent critique to the vulnerability approach is it largely focuses on community level interactions and has often struggled to account for cross-scale interactions which can often risk policy applicability and the research's overall relevance (Ford et al. 2018).

The vulnerability approach relies on the conception of vulnerability which was used by the IPCC until 2014. This earlier iteration of vulnerability is still commonly used;

however recent IPCC reports (IPCC WG2 2014) have changed to expand the scope of sensitivity and eliminate exposure from consideration. The justification for this change was that exposure should be treated as a precondition to vulnerability and removing it from the model would better allow for variable climate futures to be incorporated. The need to incorporate temporal and scenario based variability to vulnerability research was identified by (Fawcett et al. 2017; Naylor et al. 2020). The decision has been contentious in vulnerability research, with many researchers relying on the previous model and arguing that exposure must be considered beyond a simple precondition for vulnerability and potentially also as a driver (Ishtiaque et al. 2022). The choice to use the earlier iteration of vulnerability stems from the need to categorise current vulnerability and the difficulty of predicting both climate and economic futures in the study area. With the baseline of knowledge from this research, there is potential to incorporate the newer conceptualisation of vulnerability into future research on this topic.

In the context of wildfire, the vulnerability approach has seldom been used or applied. This may stem from the fact that wildfire research has largely been conducted separately from other natural hazards literature. As discussed in the literature review, this may be due to the fact that wildfires have historically been viewed as controllable and manageable compared to other natural hazards such as hurricanes or earthquakes. This arbitrary distinction has become increasingly strained in recent years, as fire behaviour has become increasingly intense and difficult to control, once again resembling the unpredictability of other natural hazards. There is little recent work of wildfire being considered under a true vulnerability framework. That said, there has been substantial work considering wildfire as part of a social ecological system and considering wildfire as a factor in the vulnerability of the larger system. This was done in the Yukon (Ogden and Innes 2008, 2009) and Alaska (Chapin et al. 2006, 2008).

This research is guided by the concept of vulnerability and the vulnerability approach (Ford and Smit 2004; Smit and Wandel 2006). Applying this approach to the context of wildfire in rural B.C. requires close collaboration with communities and individuals to build relationships and to better understand first hand conditions experienced in the communities. To ensure healthy and effective collaboration, the community-researcher relationship will be guided by the principals of Community Based Participatory Research.

4.1.2 Community Researcher Collaboration

This research was be guided by the principles of community based participatory research. In this approach, community members have an active say and involvement in the design and execution of the research. Ensuring the involvement of the community throughout the research will increase the likelihood that the research, and its findings, will be relevant and useful to the communities involved (Viswanathan et al. 2004). The research approach borrowed heavily from the work of Pearce et al. (2009) in the development of a research approach for arctic communities. While the research differs in scope and purpose, there is broad applicability of the principles identified by Pearce to researching rural communities and environmental change. Due to limited funding and there being less cultural and language differences to navigate, this research did not provide local employment. Aside from that, the research was able to follow the principals identified by Pearce et al. (2009)

Early communication was initiated with the Regional District of Fraser Fort-George, and community leaders from Valemount and McBride. This took the form of a pre research meeting, with representatives of Valemount and the Regional District, along with regular contact throughout the planning process. During the early research phase, the scope was contracted to exclude Valemount, which was then included in a septate research project currently being undertaken by the University of Leeds. During research, community partners were frequently contacted and played a role in suggesting participants, assisting with logistics

and ensuring that research remained relevant and applicable to the participating communities. During the research process, the research team was also working with local representatives to develop and implement fire risk reduction initiatives outside of the research focus. The most notable of these initiatives was the development of a grant proposal and distribution procedures for 240 fire home sprinkler kits, which will be distributed to residents throughout the Robson Valley who have completed a basic fire safety home assessment.

Upon completion of the research, disseminating the research to the involved communities is of key importance. For this research, the dissemination will take three forms. The first being a community meeting, where key research finding will be shared with attendees, along with a series of fire safety resources, which will be developed in conjunction with the Regional Districts. The second key dissemination output will be a policy brief and presentation for local town councils, community associations and the Regional District of Fraser-Fort George. This brief will outline the key findings from this research and recommend potential policies to address the findings. The third output will be an academic publication of the research, which is currently in progress.

In addition, this research has undergone an extensive ethics review process through the University of Northern British Columbia to ensure that the research upholds baseline ethical standards and does not place individuals at risk. All primary researchers have completed the Government of Canada TCPS 2 Course on Research Ethics. In addition, this research has a COVID 19 Safety plan that allows participants to complete research activities remotely, should they request it.

4.2 Data Collection

Data was collected through a mixed methods approach including key informant interviews, a series of community meetings, analysis of secondary sources, and reflective

diaries. Interviews and community meetings were conducted by the primary researcher who was assisted in planning by local community associations and groups. Data collection occurred over a period of four weeks in May 2022 and another four weeks in September 2022.

4.2.1 Key Informant Interviews

Twelve formal interviews were conducted with individuals who have an active role in decision making around wildfire management in the Robson Valley as well as forest industry professionals with significant experience suppressing historic wildfires, along with several informal or off-the-record discussions. These individuals who were selected included community leaders such as mayors, regional district representatives, and councillors from local first nations, along with forest professionals, representatives of emergency services organisations including both structural and wildfire management agencies. The questions focused on the perception of wildfire risk and vulnerability, that of other hazards the identification of community and personal capacity to address the hazards. The themes are identified in Table 1 below and the questions are listed in detail in Appendix 1. Interviews were usually conducted in public locations, or at a location of the participant's choosing, with several interviews occurring over Zoom due to the availability and location of participants during the research period. The interviews were conducted on the condition that participants would have the opportunity to review their interview transcripts and edit or remove any comments before publication. Participants were granted anonymity and identified only by a general description of their position (if direct quotes were used), but warned that in a small community, this may be sufficient for identification. Interview participants were selected both through professional identification and through snowball sampling.

Semi-structured interviews are a widely used technique in qualitative research and commonly applied to the fields of human-geography and environmental change. This method

is widely popular it allows for systematic, guided and directed interview, without restricting or limiting the scope of the conversation or the details of the response (Dunn 2021). The flexibility, inherent in a semi-structured interview, ensures a conversational nature which allows the researcher to continue with important lines of questioning beyond the baseline and the ability to pick-up on potentially valuable non-verbal clues (Dunn 2021). Semi-structured interviews provide participants with agency and flexibility, which allows for discussion of novel ideas and the consideration of diverse experiences, behaviour, and perspectives.

This technique is common in environmental change research (Dadzie et al. 2018; Morioka and Carvalho 2016; Pearce et al. 2010) and has also seen limited use in the context of wildfire (Christianson 2011; Labossière and McGee 2017), where much of social science research has been conducted via survey. The use of semi-structured interviews has primarily focused on exploring prior experiences with wildfire and has commonly focused on community leaders and decision makers to assess.

The interviews consisted of an unguided introductory component along with a guided interview. Most of the guided interviews were recorded and most of the introductory component were documented by researcher notes. The interviews focused personal experience and concern about wildfire along with participant identified vulnerability and adaptive capacity, both personally and within the community. To ensure flexibility of interviews, the guide was used as a starting point for many conversations, which were shaped by the areas of focus for the participants. The guided interview primarily focused on perspectives on wildfire vulnerability and adaptive capacity, while the introductory conversation often included stories and prior experiences of the participants. As many of the key informant interviews occurred early in the research process, they were also used, alongside observation and informal conversation to identify key research themes and to guide areas of inquiry for later research. The full interview guide can be found in Appendix 1.

4.2.2 Sampling

Semi structured interviews consisted of a non-probabilistic sample, meaning that the sample in not intended to be perfectly representative of the community members in the Western Robson Valley area and instead will focus on individuals who play an active role in managing wildfire risk and those who have had significant experience working on wildfires in the Robson Valley. The intent of this is to direct the focus of the research onto individuals who can and are likely to play a role in addressing community or personal wildfire risk and those who have a strong understanding of the changes to fire suppression in recent years. The initial semi-structured interviews were sampled by identifying key institutional stakeholders in addressing wildfire risk in the Robson Valley area. These include mayors, regional district leaders, fire management leaders and community forest director. The breakdown of particpants is outlined in *table 1*. Further interviews were identified through the "snowball method", which entails asking participants "who else should I talk to?" at the end of each interview.

Table 1: Distribution of interview participants

Occupation	Number of Interviews
Elected Representatives	2
Community Forest Representatives	2
Local Forestry/Mill Business Owners	2
Regional District Officials	3
Local Fire Management Professionals	2
Representatives from Simpcw First Nation	1

4.2.3 Community meetings

Three community meetings were conducted in Tête Jaune Cache, Dunster and Dome Creek. These meetings were held on weeknight evenings, provided snacks, and were typically advertised through flyers, posts on community message boards and Facebook pages. All meetings were open to any interested resident who had interest in wildfire surrounding

their community and were intended to be casual, welcoming and discussion based. The meetings began with broad overview of the research at hand, and then asked a series of questions which are shown in *table 2*. These questions aimed to explore concern of fire, representation from fire agencies, community vulnerability and resilience. Participants had the opportunity to respond to any of the prompts in an open discussion format.

These meetings drew from the technique of focus groups, a commonly used method in human geography, which involve a group of four to ten individuals sitting together discussing a particular topic or prompt (Cameron 2021). Focus groups are effective as they encourage "synergistic effect" that allows participants to build on previous comments and attain a level of depth that would be more difficult to reach in a one-on-one conversation. This synergistic effect proved to be a strong enhancement to wildfire discussions and led to neighbours and other residents connecting over shared perspectives and planning actions to better prepare for fire season. The meetings differed from focus group methodology as they were open to all willing participants, were built into a larger presentation and the focus of the event was centred on information sharing and less structured discussion. The goal of the community meeting was to achieve the synergistic effect of a focus group in a less structured environment.

The format for the community meetings was designed in part to reflect some of the key themes and challenges that were identified through early informal conversations and through key informant interviews. As the community meetings all occurred during the later phase of the research in September, there was an opportunity to incorporate key themes into both the presentation and discussion questions. Having this baseline of understanding of key issues allowed for increased credibility among participants of the community meeting. The discussions were recorded with the consent of the participants, who were advised that their comments would not be personally attributed, but that confidentiality could not be guaranteed

in a public event. A meeting was arranged in McBride; however, received minimal turnout and was therefore cancelled.

Table 2: A list of questions presented to attendees of community meetings.

Community Meeting Questions
What is your level of concern with wildfire in your community?
What is the likelihood of fire impacting your community in your lifetime?
Brainstorm some of the impacts that a fire might have on your community. 2. Social 3. Economic 4. Environmental 5. Long term
Which of these impacts is of greatest concern?
Do you feel well protected by government fire agencies?
In what ways is your community specifically vulnerable to the impacts of wildfire?
In what ways is your community specifically resilient to the risk of wildfire?

4.2.4 Sample

The sample from the community meetings was once again non-probabilistic and was based on turnout and participation. Participants were recruited, with assistance from community groups using public flyers, word of mouth and a post on each of the community Facebook groups. As a result, participants likely skewed towards populations who had strong concerns or a significant interest in wildfire. The overall participation is laid out in Table 3

Table 3:Participants present in each community meeting

Dunster	Tête Jaune Cache	Dome Creek
8	4	6

4.2.5 Reflective diaries

Throughout the research period, the primary investigator documented many causal interactions with residents to provide context and additional viewpoints. Much of this documentation was done through reflective diaries of the research experience, and after notable conversations with interested community members. This documentation allowed for a better analysis of the research period, the ability to note trends and common themes in informal conversations. The reflective diaries were an important reference process throughout data collection, analysis and writing stages. They also helped to guide coding and the identification of key themes.

4.3 Data Analysis and Storage

Upon completion of field work, the recordings, and notes from the key-informant as well the recorded community meetings were coded to encrypted and anonymised to ensure the anonymity of data. After this, all audio files were transcribed manually and verified for tone and accuracy. Some portions of audio were omitted to maintain clarity and relevance to the research question at hand. Upon completion of the transcription, relevant information from researcher notes were added to each of the text files which were then compiled in an encrypted folder.

All interview participants were then given the opportunity to “member check” their transcripts. This allowed them to review their test, edit statements, retroactively add or remove information and to request the deletion of their data and their removal from the research. The addition of member checking was an important factor for the participation of some local government officials and was only used sparingly by certain officials to formalise the tone of conversations.

Upon completion of the transcription and member checking, the transcriptions were then entered into NVivo, where all were analysed using latent content analysis to identify reoccurring themes and associated tones. Through this process, relevant sections of interviews discussions were highlighted and coded to specific themes. Upon conclusion of the coding, these themes were analysed and used, alongside field notes to inform large parts of the results.

4.3.1 Coding

Data from both the community meetings and interviews were coded using in NVivo using the principals from the vulnerability approach (adaptive capacity, exposure, and sensitivity) as well as key themes which had been identified during the interviews and community meetings. Statements were initially sorted into primary groupings by larger themes such as perception of fire risk, vulnerability, resilience, adaptation, and barriers to adaptation. Statements were then assigned secondary groupings which were primarily thematic, including factors such as economic and demographic changes, perceptions of fire suppression, individual actions, and government services. The secondary groupings were largely informed by the information gathered during previous stages of research including informal conversations, observations, interviews, and community meetings. Any comments which touched on multiple areas were included in both. Using this process created a catalogue of quotes and comments which guided the creation of the results chapter and allowed for specific comments and quotes to be included in this research. The full table of primary and secondary coding themes can be seen in *Appendix 2.*

4.3.2 Biophysical Risk Analysis

To assess the biophysical likelihood of significant wildfire in the Robson Valley, manual observations of vegetation types were taken surrounding the four communities researched. This information was then best matched to an identified fuel type in the Canadian

Forest Fire Behaviour Prediction (FPB) System (Wotton et al. 2009), which outlines expected fire behaviour in a wide array of potential future outcomes. In certain circumstances, where the FPB system did not adequately describe an identified fuel type, further research was used to define the likely fire risk. For clarity, the results of this research were included chapter 3.4 rather than the results as the data were important to contextualise fire risk.

4.3.3 Analysis of Secondary Sources

Relevant literature including peer-reviewed and grey literature, such as government and municipal documents were analysed to gain a stronger understanding of the effects of wildfire on communities and the actions taken to address this. These secondary sources included climate change research, emergency preparedness documentation and peer reviewed literature on community adaptation to wildfire risk. In addition, secondary sources that were used to conduct community fire risk analysis include weather and climate data, IPCC reports, peer-reviewed fire and climate research and provincial government wildfire interface data.

4.4 Evolution of the Research Approach

The initial approach to this research was focused on primarily ethnographic approach to understanding the impact of wildfire risk in the lives of residents in the Robson Valley. This entailed detailed observations, key informant interviews and structured focus groups centred around different industries in the Robson Valley. During the first research period (May 2022) this methodology was altered slightly in several ways to address the realities of the Robson Valley.

First, ethnographic observation took on a lesser importance than initially planned. This shifted the focus towards formal interviews and community engagement. This was to reflect the fact that wildfire is a sporadic hazard and one which has not played a substantial role in the region for nearly two decades. As a result, wildfire was not a common discussion

point for many residents during the research period. This changed in 2023 after the Teare Creek Fire burned nearly 600 ha near McBride and reignited discussions about wildfire management in the area.

The second change was a shift from planned industry specific focus groups, which were focused on understanding how specific impacts of fire might be experienced by different sectors of the local economy to community meetings, which had a focus on the local context to residents in the area. This change was intended to address the unique regional variances throughout the valley and to acknowledge that while communities were interconnected their specific constraints were a product of their location. The transition from a formal focus group to a community meeting which shared information on fire safety was also intended to create a more open environment for all participants and to encourage a diversity of perspectives from different communities.

The third significant change to the research plan was the addition of a fourth objective: identify opportunities to enhance resilience to wildfire. The intended purpose of this additional objective was to provide actionable recommendations to community groups and local governments as well as to identify key changes that could be made at the provincial level.

While the changes to the research did alter the type of data collected and add an additional objective, the overarching goals of the research remained constant through the process and have been addressed in the results section of this thesis. Ensuring flexibility in the research process to better accommodate for local conditions was key to the research process and allowed for better and more relevant findings to residents and local governments within the Robson Valley.

4.4 Research Dissemination

The results of this research were disseminated to the communities and participants involved through a series of community presentations in Tête Jaune Cache, Dunster, McBride and Dome Creek. These presentations were conducted in June 2023 and consisted of an overview of the research process, results, and recommendations. In addition, participants were also given an overview of fire smart resources and regional district programs in the area. In many of the communities, this event was coupled with the launch of a fire sprinkler distribution program, developed by the research team and local community associations to distribute home fire protection kits to residents in at risk areas.

CHAPTER V: RESULTS

In the Robson Valley, changing social and economic conditions are responsible for altered vulnerability to wildfire. Changing climactic conditions as well as recent catastrophic fire seasons in both B.C. and Alberta were commonly referenced during discussions on wildfire risk. The results from this research are categorised into exposure-sensitivities, adaptive capacity, and barriers to adaptive capacity. Table 4 outlines some key elements from the results, which are further explained below.

Table 4: A list of key themes and findings from this research

Theme	Current Exposure Sensitivity	Current Adaptive Strategies	Potential Future Strategies
Isolation	Long, exposed power line to the RV - Dependency on refrigeration - Limited connectivity - Impacted Emergency Services	Addition of local generation capacity Battery and generator backups for some essential services Many residents with personal generation	Connecting to Prince George power grid to add redundancy. Community refrigeration solution i.e. root cellar
	Exposed transportation corridors - Potentially sensitive to cascading impacts of fire. - Some areas with single access and escape route	Local highway rescue and emergency services Potential use of aviation for medical transfers and food delivery	Expanded local food supply and Storage. Enhanced public services to reduce dependence on travel
Government Services	Diverse set of land values and jurisdiction between industry, governments, municipalities, individuals and first nations.	Some land planning and collaboration. Encouragement of individual fire adaptation activities	Co-ordinate strategic partnerships and funding between stakeholders. Plan community and neighborhood level grants and fund matching. Implement community fire coordinator program
	High risk of fire for many rural properties, with mitigation initiatives restricted by - Land ownership - Financial Capacity - Jurisdiction	Fire smart education CRI funding available for governments	Funding supports for landowners and collaboration between levels of government
	Centralized Fire management Services		Changed legislation to allow for community wildfire response
Economic Changes	High economic dependence on at risk resources - Forestry - Tourism	Economic diversification	Further diversification and investment into attracting stable, remote workers to the region.

5.1 Exposure-Sensitivities

Residents of the Western Robson Valley are exposed and sensitive to wildfire due to a changing economy, high levels of rural inhabitation and isolation, the fire propensity of pine forests found in the east of the study region, and the exposed, power supply for the entire

valley, and transportation route. A combination of changing climatic conditions, a transitioning regional economy, and the resulting impacts on livelihoods and demographics have led to significant changes and, in part, altered exposure-sensitivity to wildfires in the region. Many of the identified exposure-sensitivities are related to the jurisdictional and financial barriers to fire risk reduction and the impact of changing demographics in the Robson Valley.

5.1.1 Economy, Livelihood and Demographics

Exposure-sensitivity to the potential impacts of wildfire in the Robson Valley has been altered by economic and demographic transitions that have occurred in recent years. The local economic and demographic changes have varied by location, and therefore changes to local exposure have been unequal throughout the Valley and impacted how certain communities prioritise and value differing impacts of wildfire.

The key change to the regional economy in recent years has been the decline of the forest sector. The forest sector, which includes occupations ranging from forest management to logging and milling has seen significant decline which can be attributed to declines in the sector overall, as well as the centralisation of milling in B.C. This largely occurred during the mid-2000s, around the same time that McBride also saw the loss of a forestry district office. Due to distinctions in census data, it is difficult to fully account for the change in employment within the region, there has been a key decline in forestry, which has cost the community many young families, led to school closures and forced the region to diversify its economy. As stated earlier, this can be seen through school enrolment numbers at McBride Secondary School, which saw its student body drop from 127 in 2006 to 49 in 2022 (Province of British Columbia 2023). A clear indication of the loss of working families.

The declines to the forestry sector can be attributed to a variety of factors including broader market conditions, the high cost of timber extraction in remote areas, planned

declines to annual allowable cut allotments, old growth management protections and caribou habitat logging restrictions. Recent old growth deferrals have led to further reductions in the local timber supply and led concern among mill owners and forest professionals throughout the Robson Valley.

While the forest industry has declines, it still plays a substantial role in the local economy, with the three community forests located in McBride, Dunster, and Valemount, several small mills and many residents still employed in the industry. That said, the declines have led to a diversified economy that has reduced economic reliance on timber extraction. As a result, there is a lessoned exposure to wildfire through a lessoned reliance on fire prone timber. While there are still significant local impacts to a wildfire impacting local forests, the decline in forestry and resulting economic diversification has lessened the potential impact of a catastrophic fire eliminating a large portion of the local timber supply, and lessoned the footprint in which a wildfire would have a substantial economic impact through the loss of merchantable timber.

While the diversified economic dependencies of Robson Valley communities have reduced the potential exposure to the impacts of wildfire, the resulting changes to communities have reduced adaptive capacity to address some of the risk of fire. This has occurred as the reduced forest industry has less capability to direct forestry activities towards reducing local fire risk and fewer community members with the training, skillsets, and equipment to suppress local wildfires. One local government official described this loss of capacity:

> *When you understand what fire is and how important it is, and you act upon things right away. In this area, we had we had a lot of people that had a lot of knowledge about fire, that understood it, and were willing to help people all with the Forest Service. They're all gone now. It's a huge difference with what people now know. There's no way to really teach them other the fact that some of them might work, you know, on a fire crew that summer, when they're younger.*

While the forestry industry has declined, one area of hope for many in the region is tourism. In recent years, Valemount has invested heavily in tourism by leveraging its location alongside Jasper Natural Park and its unique access to local backcountry into becoming a primary tourism destination for a variety of activities including mountain biking, hiking, and skiing. McBride, and other communities have struggled to attract the same level of visitation; however, McBride has a significant snowmobile industry in the winter and has identified tourism and outdoor recreation as a key area of growth in the local economy (Expedition Consulting 2020).

The declines in forestry have a complex dynamic with a burgeoning tourism industry in the region. Much of the local tourism is accessed through forestry infrastructure including road and bridges. Presently, much of this infrastructure is maintained by the local forest industry or community forests, meaning that further declines to the forest industry may also jeopardise certain elements of the tourism industry. In addition, the decline in forest infrastructure lessons response capacity to wildfires in the region; by removing quick access to certain areas of the local backcountry for fire crews. In this area, forestry infrastructure provides a key support for both the tourism industry and local wildfire response capacity.

Alongside the decline in the local forest industry, the increase of tourism in the Robson Valley has introduced new sensitivities to the impacts of fire in the valley. These sensitivities include changes to visibility and viewscapes, along with air quality concerns, both largely caused from smoke, which is often from far away fires and therefore a hazard which communities in the region have essentially no control over. Increases in smoke levels also present a health hazard to residents of the Valley, most notably, children, elderly people, and those with breathing difficulties. Smoke levels also impact the ability to conduct physical labour outdoors, providing yet another economic sensitivity to the significant smoke events from fires elsewhere.

The economic diversification of the Robson Valley has been accompanied with some concern and conflicts from residents, specifically those in with interests in forestry and fuel mitigation. While the economic importance of forestry to the valley may have diminished, residents have suggested that the increased focus on tourism in the valley has increased the likelihood of wildfire starts (through abandoned campfires, cigarettes and offroad vehicles) as well as reduced the adaptive capacity inherent in forestry by prioritising visual concerns over forest management. Residents (some of whom owned private woodlots) expressed concern that tourists in the valley do not have a sense of ownership over the area, face limited consequences in the event of a fire and therefore may be inclined to act recklessly or without care while having a campfire or operating off road vehicles. One described this tension:

> *"I get really upset in this area, not just Tête Jaune but also down the west Canoe when you've got high levels of [Fire] conditions and we have free camping like crazy down the west and east Canoe. They're tourists. They don't have a forest industry; they were on holidays, and they don't care about what happens here for industry. There are no control mechanisms to stop tourists, they might say oh no campfires, but there's ATVs, there's motorcycles there's driving around. In the olden days, I would have to say there was a fire marshal who would stop people and, say the road is shut down or something like that. If there's a fire in the West Canoe or East Canoe, it doesn't affect the tourists. It doesn't affect their pocketbook. If there's a fire in Tête Jaune we have there's our First Nations wood lot in this area, we have a woodlot up the quinoa, if it burns down, it does affect our pocketbook. It affects your economy and employment here in the forest industry."*

This transition between tourism and forestry also plays out in the conflict over further logging in the region, as many locals and foresters identified forestry as a key method to reduce fire hazard surrounding communities; however, felt that the recent shifts to tourism were preventing logging which may reduce fire risk in the name of aesthetics for tourists. This, they argued, restricted the capacity of the community to reduce hazards in the surrounding area.

Local economic and demographic changes have had a substantial impact on local vulnerability to wildfire. The changing economy has altered how communities in the Robson

Valley are exposed to wildfire risks, how they are able to address those risks and the capability within the community to respond to wildfires. As the region transitions towards tourism; wildfire vulnerability will persist; yet the way in which communities are vulnerable may continue to change and adapt to new and everchanging economic conditions.

5.1.2 Exposed Power Supply and Transportation Networks.

The Robson Valley is at the end of a remote, nearly 300km power line that is routinely exposed to various natural hazards, including treefall, windstorms, avalanches, and wildfire. The valley has been exposed to prolonged power outages in the past, notably in 2003, when a wildfire in the community of Barrière damaged power lines and led to an outage for over 7500 people, including the entire Robson Valley. Through a mix of independent power producers, added generation and prioritization of users, this outage lasted between several days for some individuals in developed areas to over two weeks for mills and other industrial operations (Narayan 2003a, 2003b). In addition, many rural residents also lost phone service, meaning there was no contact for emergency services (McCracken 2003). In recent years, there have been efforts to enhance the resilience of the local power grid; however, it is still a source of insecurity in the region, which participants commonly identified.

As a region with significant agriculture, the Robson Valley depends on refrigeration and freezing capacity, which creates an increased sensitivity to power outages. Resultingly, large quantities of food are potentially exposed to spoilage during prolonged power outages due to a lack of refrigeration. When discussing wildfire impacts, residents commonly brought up stories of the 2003 outage as a potential impact of fire and described the effect it had on the community. Following the start of the outage, there was a “scramble for generators” with none available between Prince George and Jasper. Eventually the regional district was able to

source a refrigerated “reefer” truck, which was used to store food and supplies. This was described by one Dunster participant:

> *The other thing is that it's very expensive due to the loss of our freezers in that because in small communities, we pack it fall in the fall needs everything else. And in 2003 everyone was scrambling for generators to keep your freezer going but ended up putting in some reefer (refrigerated) trucks to take their food. So, you know, that's a huge cost to people. You couldn't find a generator in anywhere before Jasper.*

After the significant outage of 2003, there have been substantial investments in power security for the Robson Valley. In 2010, McBride was outfitted with significant diesel generation capacity, in the form of three 1.5 MW biodiesel powered generators, which have the capacity to power homes within 20kms of McBride (B.C. Hydro 2010). In addition, there are Independent Power Producers in the region, who provide backup power in the event of an outage (Keil 2021). During recent outages, there has led to minor disruption for most of the valley, with only very rural residents losing power. The lone exception was a significant outage for the entire valley in March 2022, where the McBride Diesel Generator did not turn on and water levels were insufficient for Independent Power Producers to produce adequate power (Arnold 2022). While there remains the potential impact of a long-term outage, it has been considerably lessened from the long duration outage that occurred during the summer of 2003.

Alongside the exposed power supply, the Robson Valley is also isolated due to limited transportation corridors. There are only three roads exiting the valley (two on the west side), all of which are remote, mountainous roads exposed to adverse weather conditions. These exposed roads have been closed for car accidents, washouts, avalanches, and snow conditions. As a result, there are times when access to and from the Robson Valley is limited, and the movement of residents and goods is restricted. This is problematic for medical emergencies, where the nearest significant hospital would be Prince George and for food supply in the event of a significant power outage. While wildfire has not been a common

cause of road closures in the past, a fire could foreseeably close one or more access points to the valley while damaging the power supply. Local emergency services commonly mentioned road access as a challenge and noted the challenges in responding to emergencies and a significant source of concern in the event of a catastrophic fire including one participant who described the challenges:

> *Highway closures would be the biggest impact of a potential disaster. We had a closure out by Goat river, to the west, which shut us totally down for any western traffic for months, for a washout. My highway rescue area is beyond that, so we had to arrange people to take over from the other side.*

The community of Dome Creek is also uniquely vulnerable to entrapment and isolation as it is a 7km drive to the highway, meaning that there is only one maintained roadway and in the event of an emergency, there may only way in and one way out. This vulnerability is amplified by a railway crossing, which could foreseeably hold up traffic during a sudden evacuation. Residents described this as a significant concern when discussing fire and other emergencies.

5.1.3 Diverse Land Values

The Robson Valley is a region with a diverse set of land users, a changing economy, and a variety of differing values on land management. This has inherently led to conflicts within the community and on a broader scale. An apparent conflict is balancing environmental conservation, tourism, and forestry in the valley. As referenced earlier, several residents felt they were restricted in fire mitigation activities (logging) in their surrounding area due to a recent focus on tourism and protected land. In addition, workers in the forest industry suggested that environmental regulations, restrictions, and deferrals impacted the ability of the forest industry to survive and expand.

Residents of Tête Jaune Cache, identified strongly with this sentiment. The community is located beside Jackman Flats Provincial Park, a 615ha park which contains

dense vegetation, dead timber, and a dry microclimate. As a result of park restrictions, residents described being required to live beside a "tinderbox" and not having the capacity to address this. Residents recognised the role of fire in a pine dominated landscape and suggested that much of the area around Tête Jaune Cache was "overdue" for a fire:

> *We have our beautiful Jackman flats. Yes. We love it. But, you know, I think Mother Nature had her way she would have had this all burned out long ago. We're so good at putting out fires*

In addition, local First Nation expressed unique sensitivities to how fire was managed in their territory. The Simpcw First Nation, a group who were forcibly removed from a settlement in what is now known as Tête Jaune Cache in 1916 (Wheeler 2008) has still maintained a strong connection to and a role in the stewardship of their traditional territory, including the Robson Valley. Today, the Nation has timber interests, hunting territory, and significant cultural values in the Robson Valley. The current fire management prioritisation system does not allow for adequate representation of traditional, cultural, and spiritual values in the traditional territory of the Simpcw First Nation, which was described by an elected representative of the nation:

> *We started an Indigenous initial attack crew last year in 2021 because of that wildfire season, which was in North Thompson and the Robson Valley. What we saw in our traditional territory was, there was fires all around us and when we call B.C. wildfire, they said those are a category four or a level four threat to us which means it's not near structures or human lives so they weren't actioning them and we actually had a pretty frank conversation with them at the time being like well it's a priority one for Simpw First Nation. We're watching our territory burn. You can move people out of the way you, can insure structures but you can't insure the timber and on top of that, we have culturally sensitive areas, we have like the trees, the land, the medicines, everything burning because it's a priority four in B.C. wildfire's eyes and that that was a huge turning point for us and we really pushed to have our own crew.*

Understanding the diversity of values on the land in the Robson Valley is essential context to the complexity of addressing wildfire risk in the area. As there are differences in

the priorities of different groups on the land base, the potential impacts and consequences of a fire will inevitably differ. Recognising this complexity is a crucial step to being able to understand the ways in which residents of Robson Valley communities are vulnerable and at risk of fire.

5.1.4 Potential Cascading Effects

Wildfires are known to lead to an increased likelihood of several significant biophysical hazards. These include landslides, sedimentation, and flooding, all of which is impacted by the presence of a former burn, which destabilises slopes, decreases the ability of slopes to absorb water and leads to increased sedimentation and flooding issues (Reneau et al. 2007; Warrick et al. 2012). Outside of several policy makers, there was little recognition of these longer-term effects and the ways in which they could impact the communities in the Robson Valley. Considering most of the study area consists of valley bottom communities, near a river and surrounded by steep slopes, there was little discussion about the long-term cascading impacts of fire.

5.2 Current Adaptive Strategies

Residents of the Robson valley have a long history of adapting to changing environmental, social, and economic conditions. This occurred within Indigenous communities who thrived in the Valley pre-settlement, relying on innate knowledge and a unique skillset to adapt to environmental changes and harsh conditions as well as settler populations who were forced to overcome isolation, natural disaster, and economic shocks. Through significant social and economic upheaval, isolation and community collaboration, residents of the Robson Valley have been able to overcome significant setbacks for generations.

The resilience of residents in the Robson Valley likely stems life before the highway was built in the 1960s, when the only way in and out of the Robson Valley was by rail.

Communities were required to deal with environmental challenges as they came, maintain self-sufficiency, and support the rest of the community (Wheeler 2008). Disasters which residents have had to respond to, adapt to and overcome have included wildfires, avalanches, landslides, and floods. Dealing with these issues is a way of life for many residents in the valley, which presents a unique level of adaptive capacity.

The risk of wildfire has long been present in the Robson Valley. In the early 1910s, much of the valley burnt down, which cleared much of the valley bottom of dense timber and drastically altered the wildfire risk for the region moving forward (Wheeler 2008). In the proceeding years, the community faced various significant fires which did damage to various mills, outlying residences, and timber lands. A key element of the region's acceptance of this hazard was the community efforts in suppressing fires, which commonly included whole neighbourhoods and whoever else was present to help. Fire was largely considered a part of life and when a fire occurred, community skills, competence and networks played a key role in managing this hazard. The forestry industry took a leading role in managing the risk of fire. Many loggers, millers and foresters reflect with pride on their efforts suppressing fires and protecting their communities in the past.

5.2.1 Firesmart Programming

In recent years, the Regional District of Fraser-Fort George (RDFFG) has worked to provide Firesmart education, assessments, and information to residents throughout the Robson Valley. As a result of the dispersed population throughout the RDFFG and some of the jurisdictional barriers (described earlier), the Regional District is limited in the fire adaptation and hazard reduction services it can offer. Accordingly, the primary focus of the RDFFG programming is on educating residents and homeowners throughout the Robson Valley. The Firesmart representative was able to provide free home fire hazard assessments as well as educational material to community groups and organizations.

Several officials from the regional district identified a reluctance of some rural residents to engage with government organizations, especially when it came to home property assessments. Residents had expressed concern of allowing officials on property, to record information about their property and concern about the potential that officials saw illicit items and reported them. Another concern was whether the information would be passed on to insurance companies. The employees involved in Firesmart assessments had no mandate to record or document any information about resident's properties; however, the concerns were pervasive in rural areas. Officials at the regional district attempted to manage this by focusing on education and making resources available instead of prioritizing home assessments. One official described some of the concerns that they had heard from residents:

Then I had a few that were concerned of the government scoping out what they physically had just, you know, materials. I found I found I spent a fair amount of time, you know, clarifying that I have no background and in bylaw or development services, I have no knowledge of that. I couldn't tell you if you're doing something illegal, even if you were and that COVID vaccines are not applicable in this situation. I think I heard a little bit of it all. Some of those fears were alleviated when I said that I don't record anything, everything that I write down when I'm on the property goes back to the homeowner, I don't take any pictures I you know, basically the only thing that I leave with is knowing where your address.

5.2.2 Infrastructure Investment

Aided by the regional district, communities throughout the region are starting to invest in infrastructure to enhance community resiliency. A notable example of this is the recent purchase of more than 200 wildfire sprinklers through local grants provided by the RDFFG, which will be installed and used to protect public infrastructure throughout the Valley, including community centres, general stores, post offices, etc. along with homes that have completed a basic fire safety home assessment. In addition, the region has taken significant steps to enhance its emergency services to withstand power outages. McBride has invested in backup generation for several critical pieces of infrastructure and is home to several Independent Power Producers (Keil 2021). While a major outage may still lead to

power insecurity, the region has taken significant steps to enhance the resilience of the local power grid.

To address challenges with food insecurity allowing, certain community members and leaders have also advocated for a root cellar in communities throughout the Valley. A root cellar would provide long-term refrigeration and food storage without electricity, the region to have a supply of backup food stocks in the event of a significant transportation blockage and refrigeration in the event of a significant power outage.

5.2.3 Community and Connection

Residents in the Robson Valley are no strangers to natural disasters and environmental disruptions to lifestyle. These disruptions include power outages, road closures, and small disasters impacting community members. As a result of these challenges, residents of the Robson Valley, specifically the unincorporated regions, are fiercely self-sufficient and prepared to survive without outside assistance for extended periods of time. Residents have been able to overcome and abundance of hazards through mutual support and connection, and a fierce can-do attitude. A commonly discussed example of this was the rescue of horses abandoned in the alpine during winter. Over the course of eight days, community members dug a 1 km long trench through more than 2m of snow reach and rescue the abandoned horses. This testament to the community spirit and attitude found in McBride was later adapted into a book (Stutz and Scanlan 2010) and film (which was released in 2012)

In addition to the resourcefulness and self-sufficiency, the resilience of Robson Valley communities lies in the close linkages bonds between residents and the support systems inherent in those bonds. These bonds have built up over decades and in many cases generations. They include close relationships across the community, local trade, a deep connection to place, and a supportive culture prioritizing the common good and shared success and security. Social networks such as these are crucial to building adaptive capacity

as they have been shown to enable people to collaborate for a common purpose in good faith (Adger 2003; Woolcock and Narayan 2000). Community connection and culture was continually identified by residents when discussing sources of resilience to the risk of wildfire. Many community members described stories of the community coming together to respond to a fire on a neighbour's property:

> *From experience, your neighbours will show up. We had, I don't know what the official population of Dunster is, but we had over 100 people on our place for a 10-hectare fire.*
>
> *I phoned one person, and she got on the phone and phone other people. I mean you could see it too. But, yeah, we had pieces of equipment show up. But I mean, it helped that husband's equipment operator, too, but it's your community that will help.*

Another recent example of the community working together to respond to an emergency occurred in 2017. During a significant wildfire event elsewhere in B.C., many evacuees travelled through the Robson Valley. Community members set up an unsanctioned aid station, which provided food and rest areas to evacuees on their journeys (Matthews 2017). Residents spoke of donating items, sharing meals, opening private rooms in their own homes to evacuees so they could rest before resuming their journeys. Many respondents recalled this event and spoke fondly of the experience of being part of a large support network to evacuees facing hardship elsewhere.

5.2.4 Personal Actions

Along with the education and awareness campaign conducted by the RDFFG, many residents of the Robson Valley have taken action to address fire risk on their properties. Activities described have included fuel reduction through the removal of dead trees, low limbs, and deadfall, moving wood piles and fuel tanks from beside houses, purchasing personal fire suppression equipment and implementing personal sprinkler systems on private property. Some homeowners have been able to make these changes; however, others are

limited by various factors, including financial capacity, poor water pressure, aesthetic concerns, and jurisdictional restrictions on their property. Some of these concerns, such as financial capacity and aesthetic concerns, are well documented in other communities and have required additional funding to address (Labossière and McGee 2017; McFarlane et al. 2011).

5.3 Barriers to Adaptation

Communities in the Robson Valley face several significant barriers preventing improved adaptation and resilience to the effects of wildfire. This section aims to outline and identify the causes for each of these barriers.

5.3.1 The Changing Nature of Fire Suppression

Nearly 30 years after the centralisation of government wildfire management away from district forest managers (Copes-Gerbitz, Hagerman, et al. 2022), it remains a point of contention for many residents of the region, who formerly spent time working on fires or responded to fires in advance of formal fire suppression. Residents expressed frustration over being essentially excluded from fire suppression, not knowing local fire managers, and occasionally being forced to stand down when working on existing fires. A key theme in residents' concern was feeling like they couldn't respond to fires immediately while they were still small and, instead, had to wait until fire suppression services arrived. Several residents identified times when the community had rallied to contain aggressive grassfires. These stories were common in community meetings, where community members remembered working with their neighbours to protect their community with pride.

Residents expressed concern about not being "certified" to respond to local fires and a "forced dependency" on government services. This was identified in all three community meetings. One area that was symbolic of this was the removal of several fire suppression

trailers, which the B.C. Wildfire Service distributed to different communities throughout the valleys. These trailers contained basic fire suppression gear, including a small tank and pump to allow residents to suppress small grass fires before government crews arrived on scene. Allegedly, some of the trailers had been misused, which had led to their removal, but there was a clear frustration among many residents over their removal. This was outlined by a participant in Tête Jaune Cache:

> *Now I know, other people that, like me, are not really all that interested in joining the workforce anymore and going fighting a fire, but if there's fire here, we just take it into our own hands, we're just going to do what we want to do, because I don't feel that the government is capable. Because all the red tape and lack of foresight into how to actually do it, because you know, you got to be a professional, well, I don't know about that. You don't have to be a professional to fight a fire. You just have to get out there and do it.*

Residents identified the need for legitimized, professional firefighters yet struggled with not being "certified" to help when a fire threatened their property or livelihood or to respond in advance of fire crews arriving on scene. In communities without a local fire department (all communities except McBride), residents described being without resources until government crews showed up and identified this as a barrier to adaptive capacity.

Alongside the professionalization of fire services, some residents identified a corresponding loss of fire suppression skills and competence within the forest industry, as experienced workers have retired or left the profession, and young workers have not had the opportunity to work on fires. An experienced forester identified that the capacity for communities in the Robson Valley to respond to a local wildfire had significantly declined (in addition to regulatory barriers) due to this loss of experience and capacity.

While residents and some local experts reflected the frustration with professionalization, the perspective was not universal. Some officials, and all stakeholders involved in emergency response disagree with this notion and suggest that the legislative and

bureaucratic landscape has changed and is less forgiving of informal emergency response. Due to numerous pieces of legislation, along with liability considerations, responder safety is a top priority, and as a result, non-sanctioned responses are difficult to endorse. As a result, some local officials identified a need to legitimize this community response to account for safety and liability concerns. Accordingly, the short-term response capacity of communities in the Robson Valley has declined both from bureaucratic and safety hurdles, along with the loss of skillsets through the decline of the forestry industry. This was described by an official from the RDFFG:

> *The days of somebody running over and grabbing their cat (bulldozer) and coming over to somebody else's house, legitimized by local government or any level of government are gone. So that is that is why I'm against that. If higher levels of government were to legitimize that type of behaviour, it would be different. But it's not. Because the odds of somebody getting hurt or killed or otherwise are not acceptable to save property.*

5.3.2 Barriers to Fire Hazard Reduction

As the Robson Valley is divided between municipal, crown and private land, conducting significant fire hazard reduction work has been an ongoing challenge. The jurisdictional divides segment the land base, and substantially increase the complexity of any fire risk reduction initiatives to occur at a scale that would be sufficient to address fire risk. The challenge of jurisdiction was commonly identified by policy makers, who cited it as a key barrier to large scale initiatives.

McBride is surrounded by agricultural land; yet serves a much larger population including residents who reside on hillsides. The community, with a footprint of 4.64km^2 does not encompass any area with a significant fire risk, and therefore does not have a significant incentive or obligation to address fire hazard. That said, the community serves a much larger area and many services for the municipality, including the fire department (funded through the RDFFG) work with residents residing in fire prone regions. Through the McBride

Community Forest, the community does have some agency over fire risk reduction in its tenure surrounding the community, it is also beholden to the financial constraints of managing a profitable business.

The RDFFG, as the primary local government agency in the Robson Valley, is responsible for emergency response and management in the region. This includes services such as fire departments and fire smart education. The regional district is responsible to address emergencies throughout the unincorporated parts of the Robson Valley; yet has no agency in the management of provincial "crown" land, meaning that any significant hazard reduction work would have to be conducted exclusively through the provincial government; or in partnership with a variety of municipal and provincial agencies. As a result, the Regional District has focused almost exclusively on resident and homeowner education to encourage fire risk reduction on private land. This management challenge was described by a regional district official:

> *It's the King's land (Crown land) so we don't have any control or authority or jurisdiction on what happens on landscape management and decisions like what happens as far as logging activities, resource development….We don't see any revenue from royalties for stumpage, you know, anything like that. We might have some land use planning decisions around zoning and whatnot, but again, it doesn't really influence the crown land.*

Much of the populated valley bottoms in the Robson Valley is comprised of private land; therefore, any fire mitigation efforts are exclusively funded and initiated by the landowner. As the regional district has taken the step to provide firesmart assessments, residents are able to access the information needed to commence fire risk reduction projects and complete much of the manual work which accompanies the hazard reduction. That said many recommendations to address fire hazard include large and expensive initiatives such as changing roofing material, significant fuel thinning and structural changes to both homes and accessory buildings. As there is no public funding available to Regional District residents for

fire risk reduction on private land, many residents have limited capacity to make substantial changes to their home or properties. Throughout community discussions; residents frequently discussed substantive and expensive components of fire risk reduction; with significantly less attention to more accessible actions such as moving woodpiles, cutting grass, and removing vegetation touching the house.

Much of the populated regions in the Robson Valley area are in the valley bottom and bordered by other private land and crown land. As a result, in many areas fire risk reduction on private land may be directly dependent on the fire hazard of crown land and neighbour's property. Regional District representatives identified this as a key are of concern for residents considering making fire smart investments on personal property. Without funding supports and efforts to address fire risk as a neighbourhood or group or residents, it is challenging to ensure that fire risk reduction initiatives will be effective.

Most local initiatives focus on encouraging individual actions, making fire protection initiatives financially unattainable for government some homeowners. In some cases, this meant that landowners could not substantially reduce the risk of fires on their property, nor the risk of the fire spreading to nearby property and infrastructure. Without the financial capacity to address some of the inherent property risks, homeowners have limited capacity to address Firesmart suggestions, a trend which has been seen in other communities in Canada (Asfaw, Christianson, and Watson 2022).

5.4 Emerging Vulnerabilities

Limitations to adaptive capacity are present throughout the Valley and are likely to expand as socioeconomic changes persist. There remains a significant and increasing fuel load and a changing climate, which may lead to increased fire conditions throughout the Valley.

As is true in B.C. and Northern Canada, the Robson Valley is warming faster than average. Using an ensemble mean temperature of 24 Global Circulation Models, the forecast high carbon temperature by 2050 is 4 degrees, while the low carbon scenario suggests a temperature of 3.5 degrees. A respective increase of 3 and 2.5 degrees from the baseline before the 1900s (Prairie Climate Centre 2019). Flannigan et al. (2016) proposed that to offset the increased fire hazard from a single degree of warming, fine fuels such as leaf litter and small branches require a 15% increase in precipitation. The Robson Valley has is projected to see virtually no increase in precipitation based on the GCMs used. This assessment does not account for the expected increasing concentration of rainfall events and increasingly intense heatwaves both forecast for the region and could lead to increases in extreme fire conditions.

The inhabited Robson Valley consists to three key fuel types. These are Interior Cedar Hemlock, Deciduous and Pine Spruce forests. Through the effects of climate change, timber harvesting and changes to land use, these fuel types are under continual pressures and have changed significantly in recent years. The most notable change is the mortality of many Lodgepole pine trees found in the east the study area due to the Mountain Pine Beetle (MPB). The MBP has led to substantial damage in the forests surrounding Tête Jaune Cache and has greatly increased the fuel load of the surrounding forest.

In addition to the MPB, there are other climactic drivers to consider when assessing potential future hazard. These include other pathogens (notably the spruce budworm), changing suitable habitat for tree species and potential mortality, along with the potential for increased tree mortality through drought, heat waves and flooding. All these events may lead to increased tree mortality and as a result, increase the amount of deadfall therefore the wildfire risk.

5.4.1 Emerging Sensitivities

As the Robson Valley shifts towards a tourism-based economy, the region may increase its economic sensitivity to smoke, which could leave the area additionally exposed to fires elsewhere in B.C. or Alberta. Significant smoke events in the Valley have occurred in several recent fire seasons; however, as tourism in the region continues to increase, there may be adverse impacts on the sector during prolonged periods of smoke exposure, which deters visitors from coming to the Robson Valley. In addition, an increased tourist load may increase the risk of accidental ignition from recreational activities.

As the financial capacity of residents is stretched to manage and reduce the risk of wildfire on their property, alongside the continual challenge of land jurisdiction holding up large-scale work, the focus of residents may towards insurance as the one way to ensure that they are financially secure from the risk of a fire, a strategy endorsed by local government and Regional District officials. While insurance is not a replacement for many of the unique elements that make a home, it does provide a baseline financial security for homes at risk of fire and has been shown to decrease post-fire financial hardship (Lee, Ma, and Li 2022).If the risk of fire is to increase in the Robson Valley, there may be challenges insuring at-risk properties, which presents a significant additional vulnerability.

With a high turnover of residents in the Robson Valley in recent years, the underlying community connections, support networks and relationships are constantly changing. Many older residents worry that newcomers to the Valley may not have the same community orientation and inclination that residents of rural and unincorporated communities share. Newer residents may lack the skills to support their community in the event of a significant emergency and may be reliant on others. In addition, newcomers to the Valley have often arrived from larger centres, where there is an expectation for additional services, government supports and less emphasis on self-sufficiency. Through this turnover of residents, there is a

transitioning skillset throughout the Valley, alongside changing community dynamics, which may become increasingly apparent if trends continue in their current trajectory, resulting in reduced adaptive and response capacity throughout the region.

With changes to the regional economy, some residents and communities have reduced economic capacity to mitigate their hazard, withstand a disaster or build back. As the propensity of high-income jobs and single-income families has dropped with the decline of the forest industry, the sensitivity to infrastructure losses has increased, and the ability to build back has decreased. This highlights the essential role that insurance may play for residents to reduce this economic sensitivity in the Valley.

CHAPTER VI: DISCUSSION

6.1 Perceptions of Wildfire Risk

During both individual interviews and community meeting, the understanding of fire risk among participants was limited in scope, and largely focused on the potential for property loss and damage. Upon further prompting, residents did diversify their responses, notably to include power security; however, there was a clear inclination towards highly local and immediate impacts of wildfire when considering fire risk. When considering the likelihood and the chance of a catastrophic wildfire impacting homes and property, there was a clear distinction between interview participants (largely policy makers of forestry professionals) and participants of community meetings. When discussing the chances of a large-scale fire, many interview participants were measured in their responses, identifying regional differences, the potential for spring fires, and recognising the geographical features which reduce the potential of fire spreading to communities. During community meetings, participants did not use the same level of nuance and largely considered a major fire an inevitability and had a high level of concern over wildfire on their property. At the same time, many residents described taking minimal action on their own properties and described a variety of concerns including jurisdiction, cost, and capacity.

There is substantial research on the perception of fire risk and how that translates into actions. Previous research has found that residents in fire prone areas typically have a good understanding of the potential hazard (Toman et al. 2013); however, the finding that people in the Robson Valley struggled to identify the regional variation in fire risk is unsurprising as it requires a level of granularity that was not present in most previous areas researched. The finding that there is disconnect between stated concern about wildfire risk and taking action to address risk is unsurprising and has been seen in previous research throughout North America (Martin et al. 2007, 2009), which has found that other factors including perceived

self-efficacy had a larger impact on whether people worked to reduce their own fire hazard (Martin et al. 2009; McFarlane et al. 2011). There has been previous research on the needs and concerns of local governments in B.C.(Copes-Gerbitz, Dickson-Hoyle, et al. 2022); however, the comparison between the knowledge and concern levels of policy makers and the general public appears to have been used less (Gordon et al. 2010), and is a potential avenue for further research.

6.2 Economic and Demographic Changes

The Robson Valley has undergone significant economic overhaul in the past two decades. Through the loss of multiple mills, a Ministry of Forest office and contractions in the forest industry, the working age population of the community dropped substantially. This is most evident in high school enrolment numbers, which dropped nearly 70% over 16 years between 2006 and 2022 (Province of British Columbia 2023). Alongside this drop in the number of working age people supported by forestry, some in the forest industry spoke of a substantial decline in the number of residents with skills and experience in fire suppression. This is compounded by the fact that residents have not been engaged in fire management in recent years. While this does not have a significant impact on long term fire suppression, it was commonly identified as a barrier for communities without a fire department, who now felt less qualified and able to quickly respond and help when neighbours were facing a significant fire event.

The finding that economic changes alter community sensitivity to wildfire, but also appear to impact adaptive capacity is new in wildfire literature. While the impacts of economic transitions on vulnerability have been described in environmental change literature (Ford and Pearce 2010), there has been little application of this perspective to the topic of wildfire, which has seen assessments focus on economic losses and risks (Chuvieco et al.

2014; Román, Azqueta, and Rodrígues 2013) rather a change in the economy of a community. Considering these economic changes in the context of government centralisation

A key area in the resilience of the Robson Valley is the strong sense of community and self-sufficiency found for many within the region. Communities have developed in isolated regions, which were without road access for decades, and have thrived through hardiness, self-sufficiency, and a strong expectation of sharing and mutual support for the good of neighbours. This is displayed commonly during power outages and road closures. A strong sense of community has been shown to be a major enhancement to adaptive capacity and should be a key area of focus for communities to maintain in ensuring continued resilience to wildfire and other natural hazards. Residents and policy makers spoke of substantial community turnover in recent years. This was a cause of concern for many, who identified the close sense of community as an element of resilience that made their community more resilient to environmental hazards.

The finding that a strong sense of community and mutual support improves resilience to environmental changes and natural disasters is well known in vulnerability literature (Adger 2003; Woolcock and Narayan 2000)however, is less well known in wildfire contexts. There have been abundant examples of communities coming together in the face of disasters and specifically wildfires (Solnit 2010). There appears to be little work exploring how to harness this sense of community in building resilience in advance of a disaster.

6.3 Land Values and Secondary Impacts

A clear theme that emerged through this research was the differing values on the land and resources within the valley. These differences in values included debates over outdoor recreation and forestry, balancing aesthetic values and economic needs, managing differing levels of concern for environmental initiatives and the wide array of cultural and traditional

values of Indigenous communities that still consider the Robson Valley as part of their traditional territory. The differing values on the landscape complicate fire risk reduction initiatives as well as are difficult to incorporate into emergency management prioritisation systems.

The finding that different users of a land base have differing priorities in wildfire resilience is unsurprising and has been addressed in a variety of contexts (Ager, Kline, and Fischer 2015; Venn et al. 2011). In the context of integrating Indigenous values into fire management, this has largely been discussed in the context of Indigenous fire management and cultural burning (Hoffman et al. 2022; Nikolakis et al. 2020). There has been little research on how existing fire management agencies can better incorporate Indigenous values into fire management priorities. This could be a key avenue for further research.

Considering the differing values on the landscape and the impacts of fire are crucial, but this concept can be further expanded to consider the secondary or indirect effects of a wildfire as well. As described previously, there has been significant research on post fire sedimentation (Reneau et al. 2007; Warrick et al. 2012), flooding (Moody and Ebel 2012) and slope instability (Rengers et al. 2020). While these effects are well known, there has been little progress made in incorporating these concepts into larger fire planning and prioritization. Considering these impacts is crucial to improved fire management and considering them in the context of divergent land values will require a fundamental restructuring in the way that fires are managed.

6.4 Governance and Barriers

Adaptive capacity in the Robson Valley is constrained in both the ability to address fire risk and the ability to respond to a fire. In addressing fire risk, residents are constrained by the complex jurisdiction of private and public land in the region and the ways in which

public land is managed, which vastly complicates any potential multi property or large-scale fire mitigation work, as any would require total buy in from surrounding properties. This was often cited as a reason for individuals not taking action to address fire risk on their property. In addition, fire risk mitigation is costly for homeowners, who face barriers to individual action including cost, lack of knowledge and awareness as well as difficulty understanding the purpose and effectiveness of basic fuel treatments. Through the community meetings, residents commonly realised common interests, and often discussed working together. For this to happen was a public event to discuss these challenges. Investing in messaging or facilitation in the form of a volunteer or part time employed community member could be an effective option to address the barriers to community action.

The finding that jurisdictional challenges hamper the ability to address wildfire risk is also unsurprising and has been found commonly in the USA(Muller and Yin 2010; Palsa et al. 2022). This research is unique as there has been little work on understanding the position of Regional Districts as emergency managers without agency to address fire hazard on crown land. Regional district representatives as well as communities reported significant suspicions of government and regional district initiatives. This included a reluctance to allow regional district employees on private property and a reluctance to provide any information or photographs of private property to the RDFFG or other levels of government. Anti-establishment mentalities have been previously researched in Canada (Banack 2021), yet surprisingly, there appears to be little literature focused on working with this ethos and supporting initiatives at the local level. This is a key need for further research in B.C. and in the context of wildfire and a key need for rural governments.

Fire suppression was a contentious issue during much of the community engagement. As the nature of fire suppression has changed and centralised, there has been a high level of resentment and animosity among rural residents who used to play a more active role in fire

suppression. Through many discussions and the personal experience of the researcher, there appears to be a clear disconnect in the in communication between government fire agencies and rural residents. The finding that there are significant communication challenges for fire management agencies is well known. In the B.C. context, this has been highlighted (Copes-Gerbitz, Hagerman, et al. 2022) and identified as a priority nationally (Tymstra et al. 2020). There has been little academic investigation of this relationship and dynamic at the local level, which could be a key avenue for further research.

CHAPTER VII: CONCLUSION

This thesis examined how rural communities are at risk to wildfires through a case study of the Robson Valley, B.C., Canada. The results reveal several themes that are specific to the Robson Valley but might also be relevant to other rural communities elsewhere. First, the impacts of wildfire are multi-faceted and go well beyond the primary impacts to homes, property, and timber supply, to include secondary and tertiary impacts. Secondary impacts of wildfire can include an increased potential for other geohazards including landslide, sedimentation, and flooding, disruption to power, telecommunications, and transportation infrastructure, and loss of timber supply. Tertiary impacts can include job losses due to loss of timber supply, physical and mental health issues caused by the trauma of wildfire, loss of tourism revenue to due to the destruction of natural infrastructure, and strain on community resources in servicing evacuees. Secondary and tertiary impacts of wildfire need to be considered in community wildfire risk assessments.

Second, the Robson Valley is home to a diversity of perspectives and values of the land, and on wildfire risk. As a region with many multi-generational families, changing industries, increasing tourism, many rural properties, and home to cultural and traditional values for local First Nations, there is a mosaic of perspectives on land management. A key example of this was the perceived conflict between forestry and tourism and how that played out in the context of wildfire fuel treatments—foresters want to manage the forest whereas tourism operators defend the natural aesthetic integrity of the forest. Grassroots, community-governed dialogue is needed to bring people with diverse perspectives together to achieve the common goal of wildfire risk reduction and preparedness.

Third, residents and government representatives are aware of the risk of wildfire and understand what needs to be done to manage risk, but face barriers to achieving their goals. Barriers include funding, complex land management jurisdiction, a suspicion of governments among some residents, a lack of support for community level solutions, and the centralisation of government services away from rural areas such as the Robson Valley. Understanding these local difficulties is key to addressing the risk of wildfire. The identification of these barriers is a starting point for developing solutions to alleviate them.

7.1 Policy Recommendations

Throughout the research, there was a clear desire for potential solutions and ideas to address the challenge of wildfire in the Robson Valley. In addressing some of the findings from this research, there are several opportunities to enhance wildfire resilience for communities in the Robson Valley.

1. Implementation of a community wildfire champion position that would be used by the Regional District of Fraser-Fort George to build community level fire prevention initiatives.

The regional district did an effective job at hiring a Firesmart co-ordinator, who was able to present to different communities and conduct Firesmart assessments. While the presentations did attract some residents, there was little uptake on any suggestions beyond basic home and property maintenance. One element which was not covered, and something that was brought up in community meetings was having an identifiable leader in the community who can collaborate with other residents and build interest internally. One method for this would be a community Firesmart leader, who is paid a small amount, and operates on a part time basis to engage with community members on fire risk reduction

initiatives. This has been identified as a key element for the success of fire risk mitigation in previous scenarios (Labossière and McGee 2017).

2. Improved communication as to the rights, responsibilities, and liabilities of suppressing a fire as well as common expectations for prevention of private property.

There also needs to be improved communication as to the right, responsibilities and regulations surrounding residents supporting their communities and neighbours during small fires and new starts. Many residents described confusion as to what they were allowed to, the risks they faced and whether they should take any effort to engage a fire. This will require improved communication from wildfire crews to address.

3. Improved opportunities to meet local firefighters in advance of wildfire events.

Fire suppression was a commonly discussed topic during both interviews and community meetings. Many residents felt a lack of engagement from centrally managed fire agencies and suggested that felt safer previously, when they were reliant on locally situated fire suppression, community members and friends to manage fires. Fire suppression agencies throughout North America and internationally have typically moved away from this model toward a professional service and centralised management. This has come during a time of substantial government centralisation of services away from rural communities in B.C., and in recent years has become a topic of concern in rural areas (Little 2021). To address this concern, there are clear steps that the B.C. Wildfire Service could take at both the local and provincial level. Locally, increased presence and integration with the community were commonly brought up. In many cases residents described fire crews conducting gear checks each spring, and commonly identified that as an effective relationship builder between new crews and community members. This identified the key importance of casual community engagement and could take the form of hosing a public meeting or forum each Spring. This

could be a casual event such a coffee with a firefighter, or pre-fire season information session, but would allow for local engagement and interaction with fire suppression professionals in their community.

4. Improved legislation to engage rural residents in fire suppression activities.

Provincially, the B.C. Wildfire Service should aim to find a way to engage rural residents in the firefighting process that can ensure the safety or residents and improve communication and collaboration between firefighters and public (often defying evacuation orders). One potential example of this could be the Rangeland Fire Protection Association model used in Oregon and Idaho (Davis et al. 2017). This allows for trained volunteers in rural communities to have the legal authority to respond to local fires in advance and alongside professional wildland firefighters. Building this kind of program would allow for substantial community engagement and collaboration; however, may present logistical and safety challenges to implement. Developing this kind of program may allow B.C. Wildfire to provide training to residents, better engaging community in fire suppression and improve response times in rural areas.

7.2 Future Research Directions

This research shows the complexity and challenge of understanding wildfire vulnerabilities in the local context. Wildfire is a complex hazard that affects large portions of B.C. and North America, with the severity and impacts expected to continue to increase in coming years. The research is unique as it focuses on locally specific wildfire challenges and impacts for a region of interdependent communities, many without political representation and in the context of a Regional District governance. There are a few key areas of need for further research which have arisen during this project.

7.2.1 Divergent Values of Lands and Resources

Recognising the diversity of priorities, values, concerns and opinions over the importance, management and use of land and resources is crucial to better understanding the potential consequences and impacts of a wildfire occurring. In some cases (particularly the values of Indigenous communities) these values are not considered in emergency planning, and in some cases, they may impact the way in which communities can plan and prepare for fires. In recent years, the Government of B.C. has started working towards considering a wide array of values in forest planning through the development of Forest Landscape Plans (Ministry of Forests n.d.). These plans are in the early stages of implementation but are slated to shape the next generation of B.C.'s forest policy. There is a clear need for research in this area, both focused on FLPs, but also focused in better understanding, categorising and legitimising a variety of values and considering these in relation to fire and emergency management in B.C.

7.2.2 Governance Challenges and Barriers.

Rural communities in B.C. have seen significant centralisation in services towards major centres in recent years. While this trend is unlikely to change, there is a key research need to better understand how rural communities are responding to this change and to search for better ways to engage residents of these communities. Exploring how this centralisation has impacted wildfire management in the province is an important area of investigation. Copes-Gerbitz, Hagerman, et al. (2022) argued that B.C. has entered a new phase of wildfire management which recognises that fires are beyond the scope of government and requires a comprehensive and collaborative approach involving communities, the forest industry, first nations and other partners to effectively manage and mitigate the risk (Copes-Gerbitz, Hagerman, et al. 2022). *"Incorporating local knowledge… into wildfire planning"* been identified by B.C. Wildfire as a key priority following the 2017 season (Abbott and Chapman

2018). Understanding the role of centralisation at a time where there is an identified need building improved relationships at the community level is a key conflict which requires further investigation.

While previous fire mitigation efforts at the community level have been studied in the past (Labossière and McGee 2017), there is little other work exploring the traits of communities who have been able to take initiative to address wildfire hazard in B.C.. Further research to guid local policy makers and practitioners at the local government and Regional District is a key area of need. Some work has been done through surveys at the overview level (Copes-Gerbitz, Dickson-Hoyle, et al. 2022), but little has focused on specific communities and successes. There is a need to better identify ways for governments to facilitate and support locally sources solutions and ideas to reduce potential fire hazard.

7.2.3 Engaging Indigenous Communities and Integrating Indigenous Fire Stewardship

There is a key need to better understand the broad scale effects of fire on Indigenous communities, who share many of the same vulnerabilities as rural communities, yet an increased interdependence with traditional territories. Indigenous communities are also impacted by wildfire evacuations at a disproportionately high rate and therefore understanding the impacts on Indigenous communities is of key importance (McGee et al. 2021; McGee, Nation, and Christianson 2019).

Many Indigenous communities also have a long history of fire stewardship, which has typically involved the use of fire for cultural purposes along with aiding in community protection and the production of food (Christianson 2015). In recent years, there has been a renewed interest in the restoration of cultural burning in Canada, and it is now seen by many

as a key step to enhancing community and landscape resilience throughout Canada (Hoffman et al. 2022).

There is a key need for better research to better understand both the specific impacts of fire on Indigenous the barriers that currently inhibit the practice of cultural burning in Canada. There is also a need to better understand how to incorporate this approach to fire stewardship into larger fire management in a culturally appropriate way. Work done by Hoffman et al. (2022) argues that the future of wildfire management in Canada requires a shift to the perspective of co-existence with fire and a drastic increase in Indigenous engagement both in wildfire suppression and in the restoration of cultural burning. This is a key area for further investigation.

7.2.4 Indirect and Cascading Impacts

Expanding the scope of understanding surrounding wildfire risk to include factors such as economic vulnerability, availability of essential utilities, and recognition of the effects of economic and demographic changes on the ways in which communities experience wildfire is key to enhancing resilience and adaptive capacity. In addition, the understanding of biophysical wildfire risk is largely incomplete without recognising the ways in which wildfire interacts with other biophysical features including steep slopes, watersheds, and vegetation. Much of this is understood at the overview level, with several reviews identifying the need for a broader vision and community planning pivoting to using a Wildfire Resiliency Plans, that said, it is not common practise at the community level and understanding of hazard is largely generalised and not locally specific.

Many of the cascading impacts of wildfire are well known academically and have been described in previous research. That said, further research is needed in establishing best practises to incorporate the risk of cascading effects into wildfire prioritisation and planning.

Better prioritising and operationalising of planning for indirect effects of wildfire is key to addressing fire risk. fire mitigation and suppression resources to recognise the risk that fire may impact slope stability, water quality and flood potential it key to recognising and preparing for indirect and second order consequences of wildfire.

7.3 Conclusion

Research has shown that the risk of wildfire to human communities is likely to increase in the coming years because of fuel build-up due to wildfire suppression, climate change, and expanded development of the Wildland Urban Interface (Erni et al. 2021). In recent years, managing this increased risk and the resulting fire seasons has become well beyond the capacity of government fire crews. As a result, there must be new approaches to addressing wildfire hazard that cross jurisdictions, engage communities and increase local self-sufficiency and resilience. Along with these new approaches, there also must be a shift in focus to coexisting with wildfire and recognising it as a natural process and environmental need rather than simply managing the consequences of fires when they occur.

REFERENCES

Abatzoglou, John T., and A. Park Williams. 2016. 'Impact of Anthropogenic Climate Change on Wildfire across Western US Forests'. *Proceedings of the National Academy of Sciences* 113(42):11770–75. doi: 10.1073/pnas.1607171113.

Abbott, George, and Maureen Chapman. 2018. *Addressing the New Normal: 21st Century Disaster Management in British Columbia Report and Findings of the BC Flood and Wildfire Review: An Independent Review Examining the 2017 Flood and Wildfire Seasons*. Victoria, BC: Government of British Columbia.

Absher, James D., and Jerry J. Vaske. 2006. 'An Analysis of Homeowner and Agency Wildland Fire Mitigation Strategies'. *In: Peden, John G.; Schuster, Rudy M., Comps., Eds. Proceedings of the 2005 Northeastern Recreation Research Symposium; 2005 April 10-12; Bolton Landing, NY. Gen. Tech. Rep. NE-341. Newtown Square, PA: U.S. Forest Service, Northeastern Research Station: 231-236.*

Adger, W. Neil. 2003. 'Social Aspects of Adaptive Capacity'. Pp. 29–49 in *Climate Change, Adaptive Capacity and Development*. Imperial College Press.

Adger, W. Neil. 2006. 'Vulnerability'. *Global Environmental Change* 16(3):268–81. doi: 10.1016/j.gloenvcha.2006.02.006.

Ager, Alan A., Jeffrey D. Kline, and A. Paige Fischer. 2015. 'Coupling the Biophysical and Social Dimensions of Wildfire Risk to Improve Wildfire Mitigation Planning'. *Risk Analysis* 35(8):1393–1406. doi: 10.1111/risa.12373.

Arnold, Andrea. 2022. 'Power Outage Hits 12,000 Customers North of Kamloops'. *The Rocky Mountain Goat*. Retrieved 8 May 2023 (https://www.therockymountaingoat.com/2022/03/outage-affects-12000-customers-north-of-kamloops/).

Asfaw, Henok Workeye, Amy Cardinal Christianson, and David O. T. Watson. 2022. 'Incentives and Barriers to Homeowners' Uptake of FireSmart® Canada's Recommended Wildfire Mitigation Activities in the City of Fort McMurray, Alberta'. *Fire* 5(3):80. doi: 10.3390/fire5030080.

Banack, Clark. 2021. 'Ethnography and Political Opinion: Identity, Alienation and Anti-Establishmentarianism in Rural Alberta'. *Canadian Journal of Political Science/Revue Canadienne de Science Politique* 54(1):1–22. doi: 10.1017/S0008423920000694.

Bayham, Jude, Jonathan K. Yoder, Patricia A. Champ, and David E. Calkin. 2022. 'The Economics of Wildfire in the United States'. *Annual Review of Resource Economics* 14(1):379–401. doi: 10.1146/annurev-resource-111920-014804.

BC Hydro. 2010. 'BC Hydro Opens Biodiesel Generating Station in McBride'. *BC Hydro*. Retrieved 8 April 2023 (https://www.bchydro.com/news/press_centre/news_releases/2010/mcbride_biodiesel_generating_station.html).

BC Wildfire Service. n.d. 'Wildfire Season Summary - Province of British Columbia'. Retrieved 25 November 2021 (https://www2.gov.bc.ca/gov/content/safety/wildfire-status/about-bcws/wildfire-history/wildfire-season-summary).

Bowker, J. M., Siew Hoon Lim, H. Ken Cordell, Gary T. Green, Sandra Rideout-Hanzak, and Cassandra Y. Johnson. 2008. 'Wildland Fire, Risk, and Recovery: Results of a National Survey with Regional and Racial Perspectives'. *Journal of Forestry* 106(5):268–76. doi: 10.1093/jof/106.5.268.

Brenkert-Smith, Hannah. 2006. 'The Place of Fire'. *Natural Hazards Review* 7(3):105–13. doi: 10.1061/(ASCE)1527-6988(2006)7:3(105).

Brenkert-Smith, Hannah, Patricia A. Champ, and Nicholas Flores. 2012. 'Trying Not to Get Burned: Understanding Homeowners' Wildfire Risk–Mitigation Behaviors'. *Environmental Management* 50(6):1139–51. doi: 10.1007/s00267-012-9949-8.

Bright, Alan D., and Randall T. Burtz. 2006. 'Creating Defensible Space in the Wildland–Urban Interface: The Influence of Values on Perceptions and Behavior'. *Environmental Management* 37(2):170–85. doi: 10.1007/s00267-004-0342-0.

Bright, Alan D., and Peter Newman. 2006. 'How Forest Context Influences the Acceptability of Prescribed Burning and Mechanical Thinning'. Pp. 47–52 in *In: McCaffrey, S.M., ed. The public and wildland fire management: social science findings for managers. Gen. Tech. Rep. NRS-1*. Newtown Square, PA: US Department of Agriculture, Forest Service, Northern Research Station.

Brown, James K. 1983. 'The "Unnatural Fuel Buildup" Issue'. Pp. 127–28 in *Proceedings - Symposium and Workshop on Wilderness Fire*. Missoula, Montana.

Bubeck, P., W. J. W. Botzen, and J. C. J. H. Aerts. 2012. 'A Review of Risk Perceptions and Other Factors That Influence Flood Mitigation Behavior'. *Risk Analysis* 32(9):1481–95. doi: 10.1111/j.1539-6924.2011.01783.x.

Bush, Elizabeth, and Donald Lemmen. 2019. *Canada's Changing Climate Report*. Ottawa, On: Government of Canada.

Calkin, David E., Jack D. Cohen, Mark A. Finney, and Matthew P. Thompson. 2014. 'How Risk Management Can Prevent Future Wildfire Disasters in the Wildland-Urban Interface'. *Proceedings of the National Academy of Sciences* 111(2):746–51. doi: 10.1073/pnas.1315088111.

Cameron, Janny. 2021. 'Focusing on the Focus Group'. Pp. 200--221 in *Qualitative Research Methods in Human Geography*. Don Mills, Ontario: Oxford University Press.

Cameron, Peter A., Biswadev Mitra, Mark Fitzgerald, Carlos D. Scheinkestel, Andrew Stripp, Chris Batey, Louise Niggemeyer, Melinda Truesdale, Paul Holman, Rishi Mehra, Jason Wasiak, and Heather Cleland. 2009. 'Black Saturday: The Immediate Impact of the February 2009 Bushfires in Victoria, Australia'. *Medical Journal of Australia* 191(1):11–16. doi: 10.5694/j.1326-5377.2009.tb02666.x.

Campbell, Elizabeth M., René I. Alfaro, and Brad Hawkes. 2007. 'Spatial Distribution of Mountain Pine Beetle Outbreaks in Relation to Climate and Stand Characteristics: A

Dendroecological Analysis'. *Journal of Integrative Plant Biology* 49(2):168–78. doi: 10.1111/j.1744-7909.2007.00423.x.

Campbell, Elizabeth M., Joseph A. Antos, and Lara vanAkker. 2019. 'Resilience of Southern Yukon Boreal Forests to Spruce Beetle Outbreaks'. *Forest Ecology and Management* 433:52–63. doi: 10.1016/j.foreco.2018.10.037.

Canada, Natural Resources. n.d. 'Canadian Wildland Fire Information System | Canadian National Fire Database (CNFDB)'. Retrieved 12 October 2021 (https://cwfis.cfs.nrcan.gc.ca/ha/nfdb).

Cecco, Leyland. 2021. '"There's Nothing Left in Lytton": The Canadian Village Destroyed by Wildfire – Picture Essay'. *The Guardian*, July 25.

Chapin, F. Stuart, Amy L. Lovecraft, Erika S. Zavaleta, Joanna Nelson, Martin D. Robards, Gary P. Kofinas, Sarah F. Trainor, Garry D. Peterson, Henry P. Huntington, and Rosamond L. Naylor. 2006. 'Policy Strategies to Address Sustainability of Alaskan Boreal Forests in Response to a Directionally Changing Climate'. *Proceedings of the National Academy of Sciences* 103(45):16637–43. doi: 10.1073/pnas.0606955103.

Chapin, F. Stuart, Sarah F. Trainor, Orville Huntington, Amy L. Lovecraft, Erika Zavaleta, David C. Natcher, A. David McGuire, Joanna L. Nelson, Lily Ray, Monika Calef, Nancy Fresco, Henry Huntington, T. Scott Rupp, La'ona DeWilde, and Rosamond L. Naylor. 2008. 'Increasing Wildfire in Alaska's Boreal Forest: Pathways to Potential Solutions of a Wicked Problem'. *BioScience* 58(6):531–40. doi: 10.1641/B580609.

Charnley, Susan, Melissa R. Poe, Alan A. Ager, Thomas A. Spies, Emily K. Platt, and Keith A. Olsen. 2015. 'A Burning Problem: Social Dynamics of Disaster Risk Reduction through Wildfire Mitigation'. *Human Organization* 74(4):329–40. doi: 10.17730/0018-7259-74.4.329.

Christianson. 2011. 'Wildfire Risk Perception and Mitigation at Peavine Métis Settlement'. *ERA*. Retrieved 10 December 2021 (https://era.library.ualberta.ca/items/a1e460ad-5009-456a-ab7f-5ae1f007e66d).

Christianson, Amy Cardinal. 2015. 'Social Science Research on Indigenous Wildfire Management in the 21st Century and Future Research Needs'. *International Journal of Wildland Fire* 24(2):190. doi: 10.1071/WF13048.

Chuvieco, Emilio, Susana Martínez, María Victoria Román, Stijn Hantson, and M. Lucrecia Pettinari. 2014. 'Integration of Ecological and Socio-Economic Factors to Assess Global Vulnerability to Wildfire'. *Global Ecology and Biogeography* 23(2):245–58. doi: 10.1111/geb.12095.

City of Prince George. 2020. *Climate Change Adaptation Strategies for the Community of Prince George*. Prince George.

Collins, Timothy W. 2005. 'Households, Forests, and Fire Hazard Vulnerability in the American West: A Case Study of a California Community'. *Global Environmental Change Part B: Environmental Hazards* 6(1):23–37. doi: 10.1016/j.hazards.2004.12.003.

Collins, Timothy W., and Bob Bolin. 2009. ‘Situating Hazard Vulnerability: People’s Negotiations with Wildfire Environments in the U.S. Southwest’. *Environmental Management* 44(3):441–55. doi: 10.1007/s00267-009-9333-5.

Copes-Gerbitz, Kelsey, Sarah Dickson-Hoyle, Sarah L. Ravensbergen, Shannon M. Hagerman, Lori D. Daniels, and Jemina Coutu. 2022. ‘Community Engagement With Proactive Wildfire Management in British Columbia, Canada: Perceptions, Preferences, and Barriers to Action’. *Frontiers in Forests and Global Change* 5.

Copes-Gerbitz, Kelsey, Shannon M. Hagerman, and Lori D. Daniels. 2022. ‘Transforming Fire Governance in British Columbia, Canada: An Emerging Vision for Coexisting with Fire’. *Regional Environmental Change* 22(2):48. doi: 10.1007/s10113-022-01895-2.

Cutter, Susan L. 1996. ‘Vulnerability to Environmental Hazards’. *Progress in Human Geography* 20(4):529–39. doi: 10.1177/030913259602000407.

Cutter, Susan L. 2003. ‘The Vulnerability of Science and the Science of Vulnerability’. *Annals of the Association of American Geographers* 93(1):1–12. doi: 10.1111/1467-8306.93101.

Cutter, Susan L. 2021. ‘The Changing Nature of Hazard and Disaster Risk in the Anthropocene’. *Annals of the American Association of Geographers* 111(3):819–27. doi: 10.1080/24694452.2020.1744423.

Dadzie, John, Goran Runeson, Grace Ding, and Francis K. Bondinuba. 2018. ‘Barriers to Adoption of Sustainable Technologies for Energy-Efficient Building Upgrade—Semi-Structured Interviews’. *Buildings* 8(4):57. doi: 10.3390/buildings8040057.

Davis, Emily Jane, Jesse Abrams, Katherine Wollstein, Alethea Steingisser, and James E. Meacham. 2017. *Rangeland Fire Protection Associations: An Alternative Model for Wildfire Response*. Eugene, Oregon: University of Oregon.

Dickenson-Hoyle, Sarah, and C. John. 2021. *Elephant Hill: Secwépemc Leadership and Lessons Learned from the Collective Story of Wildfire Recovery*. Vancouver, BC: Secwepemcúlecw Restoration and Stewardship Society.

Dunn, Kevin. 2021. ‘Engaging Interviews’. Pp. 148–85 in *Qualitative Research Methods in Human Geography*. Don Mills, Ontario: Oxford University Press.

Erni, Sandy, Lynn Johnston, Yan Boulanger, Francis Manka, Pierre Bernier, Brian Eddy, Amy Christianson, Tom Swystun, and Sylvie Gauthier. 2021. ‘Exposure of the Canadian Wildland–Human Interface and Population to Wildland Fire, under Current and Future Climate Conditions’. *Canadian Journal of Forest Research* 51(9):1357–67. doi: 10.1139/cjfr-2020-0422.

Expedition Consulting. 2020. *McBride Tourism Master Plan*. McBride, BC.

Faulkner, Hilary, Bonita L. McFarlane, and Tara K. McGee. 2009. ‘Comparison of Homeowner Response to Wildfire Risk among Towns with and without Wildfire Management’. *Environmental Hazards* 8(1):38–51. doi: 10.3763/ehaz.2009.0006.

Fawcett, David, Tristan Pearce, James D. Ford, and Lewis Archer. 2017. 'Operationalizing Longitudinal Approaches to Climate Change Vulnerability Assessment'. *Global Environmental Change* 45:79–88. doi: 10.1016/j.gloenvcha.2017.05.002.

Fernandez, Matias C., Feng Sheng Hu, Daniel G. Gavin, Guillaume de Lafontaine, and Katy D. Heath. 2021. 'A Tale of Two Conifers: Migration across a Dispersal Barrier Outpaced Regional Expansion from Refugia'. *Journal of Biogeography* 48(9):2133–43. doi: 10.1111/jbi.14209.

Finlay, Sarah Elise, Andrew Moffat, Rob Gazzard, David Baker, and Virginia Murray. 2012. 'Health Impacts of Wildfires'. *PLoS Currents* 4:e4f959951cce2c. doi: 10.1371/4f959951cce2c.

Flannigan, M. D., B. M. Wotton, G. A. Marshall, W. J. de Groot, J. Johnston, N. Jurko, and A. S. Cantin. 2016. 'Fuel Moisture Sensitivity to Temperature and Precipitation: Climate Change Implications'. *Climatic Change* 134(1):59–71. doi: 10.1007/s10584-015-1521-0.

Flannigan, Mike, Alan S. Cantin, William J. de Groot, Mike Wotton, Alison Newbery, and Lynn M. Gowman. 2013. 'Global Wildland Fire Season Severity in the 21st Century'. *Forest Ecology and Management* 294:54–61. doi: 10.1016/j.foreco.2012.10.022.

Flannigan, Mike, Brian Stocks, Merritt Turetsky, and Mike Wotton. 2009. 'Impacts of Climate Change on Fire Activity and Fire Management in the Circumboreal Forest'. *Global Change Biology* 15(3):549–60. doi: 10.1111/j.1365-2486.2008.01660.x.

Ford, James D., and Tristan Pearce. 2010. 'What We Know, Do Not Know, and Need to Know about Climate Change Vulnerability in the Western Canadian Arctic: A Systematic Literature Review'. *Environmental Research Letters* 5(1):014008. doi: 10.1088/1748-9326/5/1/014008.

Ford, James D., Tristan Pearce, Graham McDowell, Lea Berrang-Ford, Jesse S. Sayles, and Ella Belfer. 2018. 'Vulnerability and Its Discontents: The Past, Present, and Future of Climate Change Vulnerability Research'. *Climatic Change* 151(2):189–203. doi: 10.1007/s10584-018-2304-1.

Ford, James D., and Barry Smit. 2004. 'A Framework for Assessing the Vulnerability of Communities in the Canadian Arctic to Risks Associated with Climate Change'. *Arctic* 57(4):389–400.

Gallopín, Gilberto C. 2006. 'Linkages between Vulnerability, Resilience, and Adaptive Capacity'. *Global Environmental Change* 16(3):293–303. doi: 10.1016/j.gloenvcha.2006.02.004.

Ghasemi, Benjamin, Gerard T. Kyle, and James D. Absher. 2020. 'An Examination of the Social-Psychological Drivers of Homeowner Wildfire Mitigation'. *Journal of Environmental Psychology* 70:101442. doi: 10.1016/j.jenvp.2020.101442.

Gordon, Jason S., David Matarrita-Cascante, Richard C. Stedman, and A. E. Luloff. 2010. 'Wildfire Perception and Community Change'. *Rural Sociology* 75(3):455–77. doi: 10.1111/j.1549-0831.2010.00021.x.

Government of British Columbia. 2021. *Modernizing Forest Policy in British Columbia; Setting The Intention and Leading the Forest Sector Transition*. Victoria, BC.

Government of Canada, Statistics Canada. 2022. '2021 Canadian Census - Population'. Retrieved 23 March 2022 (https://www12.statcan.gc.ca/census-recensement/index-eng.cfm).

de Groot, William J., Michael D. Flannigan, and Alan S. Cantin. 2013. 'Climate Change Impacts on Future Boreal Fire Regimes'. *Forest Ecology and Management* 294:35–44. doi: 10.1016/j.foreco.2012.09.027.

Haalbloom, Bethany, and David C. Natcher. 2012. 'The Power and Peril of "Vulnerability": Approaching Community Labels with Caution in Climate Change Research'. *Arctic* 65(3):319–27.

Hamilton, Matthew, Alexandra Paige Fischer, and Alan Ager. 2019. 'A Social-Ecological Network Approach for Understanding Wildfire Risk Governance'. *Global Environmental Change* 54:113–23. doi: 10.1016/j.gloenvcha.2018.11.007.

Hergott, Simon. 2021. 'A Valley Destroyed Part 1 - The Story of Monte Lake and Paxton Valley'.

Hewitt, Kenneth. 1997. *Regions of Risk: A Geographical Introduction to Disasters*. London: Routledge.

Hinkel, Jochen. 2011. '"Indicators of Vulnerability and Adaptive Capacity": Towards a Clarification of the Science–Policy Interface'. *Global Environmental Change* 21(1):198–208. doi: 10.1016/j.gloenvcha.2010.08.002.

Hof, Anouschka R., Caren C. Dymond, and David J. Mladenoff. 2017. 'Climate Change Mitigation through Adaptation: The Effectiveness of Forest Diversification by Novel Tree Planting Regimes'. *Ecosphere* 8(11):e01981. doi: 10.1002/ecs2.1981.

Hoffman, Kira M., Amy Cardinal Christianson, Sarah Dickson-Hoyle, Kelsey Copes-Gerbitz, William Nikolakis, David A. Diabo, Robin McLeod, Herman J. Michell, Abdullah Al Mamun, Alex Zahara, Nicholas Mauro, Joe Gilchrist, Russell Myers Ross, and Lori D. Daniels. 2022. 'The Right to Burn: Barriers and Opportunities for Indigenous-Led Fire Stewardship in Canada'. *FACETS* 7:464–81. doi: 10.1139/facets-2021-0062.

Hope, Emily S., Daniel W. McKenney, John H. Pedlar, Brian J. Stocks, and Sylvie Gauthier. 2016. 'Wildfire Suppression Costs for Canada under a Changing Climate'. *PLOS ONE* 11(8):e0157425. doi: 10.1371/journal.pone.0157425.

IPCC. 2021. *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.

IPCC WG2. 2014. *AR5 2014: Impacts, Adaptation, and Vulnerability.* Assessment Report 5. Cambridge.

Ishtiaque, Asif, Ronald C. Estoque, Hallie Eakin, Jagadish Parajuli, and Yasin Wahid Rabby. 2022. 'IPCC's Current Conceptualization of "Vulnerability" Needs More

Clarification for Climate Change Vulnerability Assessments'. *Journal of Environmental Management* 303:114246. doi: 10.1016/j.jenvman.2021.114246.

Jakes, Pamela J., Victoria Sturtevant, Pamela J. Jakes, and Victoria Sturtevant. 2013. 'Trial by Fire: Community Wildfire Protection Plans Put to the Test'. *International Journal of Wildland Fire* 22(8):1134–43. doi: 10.1071/WF12156.

Johnson, E. A., K. Miyanishi, and S. R. J. Bridge. 2001. 'Wildfire Regime in the Boreal Forest and the Idea of Suppression and Fuel Buildup'. *Conservation Biology* 15(6):1554–57.

Johnston, Lynn M., Xianli Wang, Sandy Erni, Stephen W. Taylor, Colin B. McFayden, Jacqueline A. Oliver, Chris Stockdale, Amy Christianson, Yan Boulanger, Sylvie Gauthier, Dominique Arseneault, B. Mike Wotton, Marc-André Parisien, and Mike D. Flannigan. 2020. 'Wildland Fire Risk Research in Canada'. *Environmental Reviews* 28(2):164–86. doi: 10.1139/er-2019-0046.

Keil, Laura. 2021. 'Prolonged Power Outage Offset by Robson Valley IPPs'. *The Rocky Mountain Goat*, April 11.

Kemter, M., M. Fischer, L. V. Luna, E. Schönfeldt, J. Vogel, A. Banerjee, O. Korup, and K. Thonicke. 2021. 'Cascading Hazards in the Aftermath of Australia's 2019/2020 Black Summer Wildfires'. *Earth's Future* 9(3):e2020EF001884. doi: 10.1029/2020EF001884.

Kharuk, Viacheslav I., Evgenii I. Ponomarev, Galina A. Ivanova, Maria L. Dvinskaya, Sean C. P. Coogan, and Mike D. Flannigan. 2021. 'Wildfires in the Siberian Taiga'. *Ambio* 50(11):1953–74. doi: 10.1007/s13280-020-01490-x.

Kirchmeier-Young, M. C., N. P. Gillett, F. W. Zwiers, A. J. Cannon, and F. S. Anslow. 2019. 'Attribution of the Influence of Human-Induced Climate Change on an Extreme Fire Season'. *Earth's Future* 7(1):2–10. doi: 10.1029/2018EF001050.

Kochi, Ikuho, Geoffrey H. Donovan, Patricia A. Champ, and John B. Loomis. 2010. 'The Economic Cost of Adverse Health Effects from Wildfire-Smoke Exposure: A Review'. *International Journal of Wildland Fire* 19(7):803–17. doi: 10.1071/WF09077.

Kramer, Heather Anu, Miranda H. Mockrin, Patricia M. Alexandre, Volker C. Radeloff, Heather Anu Kramer, Miranda H. Mockrin, Patricia M. Alexandre, and Volker C. Radeloff. 2019. 'High Wildfire Damage in Interface Communities in California'. *International Journal of Wildland Fire* 28(9):641–50. doi: 10.1071/WF18108.

Krawchuk, Meg A., Steve G. Cumming, and Mike D. Flannigan. 2009. 'Predicted Changes in Fire Weather Suggest Increases in Lightning Fire Initiation and Future Area Burned in the Mixedwood Boreal Forest'. *Climatic Change* 92(1):83–97. doi: 10.1007/s10584-008-9460-7.

Labossière, Léanne M. M., and Tara K. McGee. 2017. 'Innovative Wildfire Mitigation by Municipal Governments: Two Case Studies in Western Canada'. *International Journal of Disaster Risk Reduction* 22:204–10. doi: 10.1016/j.ijdrr.2017.03.009.

Lee, Ji Yun, Fangjiao Ma, and Yue Li. 2022. 'Understanding Homeowner Proactive Actions for Managing Wildfire Risks'. *Natural Hazards* 114(2):1525–47. doi: 10.1007/s11069-022-05436-2.

Lewis, Michael, Amy Christianson, and Marsha Spinks. 2018. 'Return to Flame: Reasons for Burning in Lytton First Nation, British Columbia'. *Journal of Forestry* 116(2):143–50. doi: 10.1093/jofore/fvx007.

Lindner, Marcus, Michael Maroschek, Sigrid Netherer, Antoine Kremer, Anna Barbati, Jordi Garcia-Gonzalo, Rupert Seidl, Sylvain Delzon, Piermaria Corona, Marja Kolström, Manfred J. Lexer, and Marco Marchetti. 2010. 'Climate Change Impacts, Adaptive Capacity, and Vulnerability of European Forest Ecosystems'. *Forest Ecology and Management* 259(4):698–709. doi: 10.1016/j.foreco.2009.09.023.

Little, Simon. 2021. '"We'Re Doing It All on Our Own": Monte Lake Residents Feel Abandoned over White Rock Lake Fire | Globalnews.Ca'. *Global News*, August 7.

Liu, Zhongwei, Jonathan M. Eden, Bastien Dieppois, and Matthew Blackett. 2022. 'A Global View of Observed Changes in Fire Weather Extremes: Uncertainties and Attribution to Climate Change'. *Climatic Change* 173(1):14. doi: 10.1007/s10584-022-03409-9.

Lozano, Olga M., Michele Salis, Alan A. Ager, Bachisio Arca, Fermin J. Alcasena, Antonio T. Monteiro, Mark A. Finney, Liliana Del Giudice, Enrico Scoccimarro, and Donatella Spano. 2017. 'Assessing Climate Change Impacts on Wildfire Exposure in Mediterranean Areas'. *Risk Analysis* 37(10):1898–1916. doi: 10.1111/risa.12739.

Mahoney, Aaron. 1998. 'Fire Update'. *The Valley Sentinel*, August 12, Vol 13, Issue 32, 1.

Martin, Ingrid M., Holly Bender, and Carol Raish. 2007. 'What Motivates Individuals to Protect Themselves from Risks: The Case of Wildland Fires'. *Risk Analysis* 27(4):887–900. doi: 10.1111/j.1539-6924.2007.00930.x.

Martin, Wade E., Ingrid M. Martin, and Brian Kent. 2009. 'The Role of Risk Perceptions in the Risk Mitigation Process: The Case of Wildfire in High Risk Communities'. *Journal of Environmental Management* 91(2):489–98. doi: 10.1016/j.jenvman.2009.09.007.

Matthews, Evan. 2017. 'Robson Valley Aids Forest Fire Evacuees'. *The Rocky Mountain Goat*, July 15.

Matthews, Evan. 2022. 'Valemount Air Quality among Worst in B.C.' *Rocky Mountain Goat*, February 5.

McBride Community Forest. n.d. 'McBride Community Forest'. Retrieved 25 March 2022 (https://mcfc.ca/).

McCaffrey, Sarah. 2004. 'Thinking of Wildfire as a Natural Hazard'. *Society & Natural Resources* 17(6):509–16. doi: 10.1080/08941920490452445.

McCracken, Audru. 2003. 'Fresh Batteries and a Plan for Rural Phone Service'. *The Robson Valley Times*, August 19, Volume 2, Issue 32, 1.

McCracken, Audru. 2021. ‘Valemount Council: Clean Air Task Force, Housing Project, CF Agreement, Bad Stoves Ban’. *Rocky Mountain Goat*, December 1.

McFarlane, Bonita L., Tara K. McGee, Hilary Faulkner, Bonita L. McFarlane, Tara K. McGee, and Hilary Faulkner. 2011. ‘Complexity of Homeowner Wildfire Risk Mitigation: An Integration of Hazard Theories’. *International Journal of Wildland Fire* 20(8):921–31. doi: 10.1071/WF10096.

McGee, T. K., M. O. Nation, and A. C. Christianson. 2019. ‘Residents’ Wildfire Evacuation Actions in Mishkeegogamang Ojibway Nation, Ontario, Canada’. 33:266–74. doi: 10.1016/j.ijdrr.2018.10.012.

McGee, Tara K., Amy Cardinal Christianson, and First Nations Wildfire Evacuation Partnership. 2021. *First Nations Wildfire Evacuations: A Guide for Communities and External Agencies*. Purich Books.

McGee, Tara K., Bonita L. McFarlane, and Jeji Varghese. 2009. ‘An Examination of the Influence of Hazard Experience on Wildfire Risk Perceptions and Adoption of Mitigation Measures’. *Society & Natural Resources* 22(4):308–23. doi: 10.1080/08941920801910765.

Mercier, Stephanie. 2016. ‘New Valemount, B.C. Ski Resort One Step Closer to Reality | CBC News’. *CBC*. Retrieved 25 March 2022 (https://www.cbc.ca/news/canada/british-columbia/valemount-glacier-ski-resort-plan-gets-provincial-approval-1.3725221).

Meyer, Gesa, T. Andrew Black, Rachhpal S. Jassal, Zoran Nesic, Nicholas C. Coops, Andreas Christen, Arthur L. Fredeen, David L. Spittlehouse, Nicholas J. Grant, Vanessa N. Foord, and Rebecca Bowler. 2018. ‘Simulation of Net Ecosystem Productivity of a Lodgepole Pine Forest after Mountain Pine Beetle Attack Using a Modified Version of 3-PG’. *Forest Ecology and Management* 412:41–52. doi: 10.1016/j.foreco.2018.01.034.

Miller, Susan J. 2021. ‘Community Voices as Agents of Change: 2018 Wildfire Experiences in the Southside’.

Ministry of Forests. n.d. ‘Forest Landscape Plans - Province of British Columbia’. *Province of British Columbia*. Retrieved 4 April 2023 (https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-landscape-plans).

Montz, Burrell E., and Graham A. Tobin. 2011. ‘Natural Hazards: An Evolving Tradition in Applied Geography’. *Applied Geography* 31(1):1–4. doi: 10.1016/j.apgeog.2010.06.005.

Moody, John A., and Brian A. Ebel. 2012. ‘Hyper-Dry Conditions Provide New Insights into the Cause of Extreme Floods after Wildfire’. *CATENA* 93:58–63. doi: 10.1016/j.catena.2012.01.006.

Morioka, Sandra Naomi, and Marly M. Carvalho. 2016. ‘Measuring Sustainability in Practice: Exploring the Inclusion of Sustainability into Corporate Performance

Systems in Brazilian Case Studies'. *Journal of Cleaner Production* 136:123–33. doi: 10.1016/j.jclepro.2016.01.103.

Moritz, Max A., Enric Batllori, Ross A. Bradstock, A. Malcolm Gill, John Handmer, Paul F. Hessburg, Justin Leonard, Sarah McCaffrey, Dennis C. Odion, Tania Schoennagel, and Alexandra D. Syphard. 2014. 'Learning to Coexist with Wildfire'. *Nature* 515(7525):58–66. doi: 10.1038/nature13946.

Muller, Brian H., and Li Yin. 2010. 'Regional Governance and Hazard Information: The Role of Co-Ordinated Risk Assessment and Regional Spatial Accounting in Wildfire Hazard Mitigation'. *Journal of Environmental Planning and Management* 53(1):1–21. doi: 10.1080/09640560903414639.

Narayan, Rashmi. 2003a. 'Forest Fire Leaves Valley in Darkness'. *Robson Valley Times*, August 5.

Narayan, Rashmi. 2003b. 'Mills to Get Power This Week'. *Robson Valley Times*, August 12.

Naylor, Angus, James Ford, Tristan Pearce, and James Van Alstine. 2020. 'Conceptualizing Climate Vulnerability in Complex Adaptive Systems'. *One Earth* 2(5):444–54. doi: 10.1016/j.oneear.2020.04.011.

Nelson, Kristen C., Martha C. Monroe, Jayne Fingerman Johnson, Alison Bowers, Kristen C. Nelson, Martha C. Monroe, Jayne Fingerman Johnson, and Alison Bowers. 2004. 'Living with Fire: Homeowner Assessment of Landscape Values and Defensible Space in Minnesota and Florida, USA'. *International Journal of Wildland Fire* 13(4):413–25. doi: 10.1071/WF03067.

Nikolakis, William, Emma Roberts, Ngaio Hotte, Russell Myers Ross, William Nikolakis, Emma Roberts, Ngaio Hotte, and Russell Myers Ross. 2020. 'Goal Setting and Indigenous Fire Management: A Holistic Perspective'. *International Journal of Wildland Fire* 29(11):974–82. doi: 10.1071/WF20007.

Northeast Climate Resilience Network. 2019a. *Northeast Climate Change Vulnerability Assessments - Dawson Creek*. Surrey, British Columbia: Northeast Climate Resilience Network (NCRN).

Northeast Climate Resilience Network. 2019b. *Northeast Climate Change Vulnerability Assessments - Fort St John*. Surrey, British Columbia: Northeast Climate Resilience Network (NCRN).

Northeast Climate Resilience Network. 2019c. *Northeast Climate Change Vulnerability Assessments - Northern Rockies Regional Municipality*. Surrey, British Columbia: Northeast Climate Resilience Network (NCRN).

Northeast Climate Resilience Network. 2019d. *Northeast Climate Change Vulnerability Assessments - Tumbler Ridge*. Surrey, British Columbia: Northeast Climate Resilience Network (NCRN).

Oetelaar, Gerald A., and D. Joy Oetelaar. 2007. 'The New Ecology and Landscape Archaeology: Incorporating the Anthropogenic Factor in Models of Settlement

Systems in the Canadian Prairie Ecozone'. *Canadian Journal of Archaeology / Journal Canadien d'Archéologie* 31(3):65–92.

Ogden, A. E., and J. L. Innes. 2008. 'Climate Change Adaptation and Regional Forest Planning in Southern Yukon, Canada'. *Mitigation and Adaptation Strategies for Global Change* 13(8):833–61. doi: 10.1007/s11027-008-9144-7.

Ogden, A. E., and J. L. Innes. 2009. 'Adapting to Climate Change in the Southwest Yukon: Locally Identified Research and Monitoring Needs to Support Decision Making on Sustainable Forest Management'. *Arctic* 62(2):159–74.

Otero, Iago, and Jonas Ø. Nielsen. 2017. 'Coexisting with Wildfire? Achievements and Challenges for a Radical Social-Ecological Transformation in Catalonia (Spain)'. *Geoforum* 85:234–46. doi: 10.1016/j.geoforum.2017.07.020.

Palsa, Emily, Matt Bauer, Cody Evers, Matt Hamilton, and Max Nielsen-Pincus. 2022. 'Engagement in Local and Collaborative Wildfire Risk Mitigation Planning across the Western U.S.—Evaluating Participation and Diversity in Community Wildfire Protection Plans'. *PLOS ONE* 17(2):e0263757. doi: 10.1371/journal.pone.0263757.

Parisien, Marc-André, Quinn E. Barber, Kelvin G. Hirsch, Christopher A. Stockdale, Sandy Erni, Xianli Wang, Dominique Arseneault, and Sean A. Parks. 2020. 'Fire Deficit Increases Wildfire Risk for Many Communities in the Canadian Boreal Forest'. *Nature Communications* 11(1):2121. doi: 10.1038/s41467-020-15961-y.

Pearce, Tristan D., James D. Ford, Gita J. Laidler, Barry Smit, Frank Duerden, Mishak Allarut, Mark Andrachuk, Steven Baryluk, Andrew Dialla, Pootoogoo Elee, Annie Goose, Theo Ikummaq, Eric Joamie, Fred Kataoyak, Eric Loring, Stephanie Meakin, Scott Nickels, Kip Shappa, Jamal Shirley, and Johanna Wandel. 2009. 'Community Collaboration and Climate Change Research in the Canadian Arctic'. *Polar Research* 28(1):10–27. doi: 10.1111/j.1751-8369.2008.00094.x.

Pearce, Tristan, Barry Smit, Frank Duerden, James D. Ford, Annie Goose, and Fred Kataoyak. 2010. 'Inuit Vulnerability and Adaptive Capacity to Climate Change in Ulukhaktok, Northwest Territories, Canada'. *Polar Record* 46(2):157–77. doi: 10.1017/S0032247409008602.

Ponomarev, Evgenii I., Viacheslav I. Kharuk, and Kenneth J. Ranson. 2016. 'Wildfires Dynamics in Siberian Larch Forests'. *Forests* 7(6):125. doi: 10.3390/f7060125.

Prairie Climate Centre. 2019. 'Climate Atlas of Canada - Version 2'. *Climate Atlas of Canada*. Retrieved 7 May 2023 (https://climateatlas.ca/find-local-data).

Province of British Columbia. 2023. 'BC Schools - Student Enrolment and FTE by Grade'.

Pyne, Stephen J. 2008. *Awful Splendour: A Fire History of Canada*. University of British Columbia Press.

Raffa, Kenneth F., Brian H. Aukema, Barbara J. Bentz, Allan L. Carroll, Jeffrey A. Hicke, Monica G. Turner, and William H. Romme. 2008. 'Cross-Scale Drivers of Natural Disturbances Prone to Anthropogenic Amplification: The Dynamics of Bark Beetle Eruptions'. *BioScience* 58(6):501–17. doi: 10.1641/B580607.

Regional District of Fraser-Fort George. n.d. 'Robson Valley - Canoe'. *Regional District of Fraser Fort George*. Retrieved 23 March 2022 (https://www.rdffg.bc.ca/government/board-of-directors/member-areas/robson-valley-canoe).

Reid, Colleen E., Michael Brauer, Fay H. Johnston, Michael Jerrett, John R. Balmes, and Catherine T. Elliott. 2016. 'Critical Review of Health Impacts of Wildfire Smoke Exposure'. *Environmental Health Perspectives* 124(9):1334–43. doi: 10.1289/ehp.1409277.

Reneau, Steven L., Danny Katzman, Gregory A. Kuyumjian, Alexis Lavine, and Daniel V. Malmon. 2007. 'Sediment Delivery after a Wildfire'. *Geology* 35(2):151–54. doi: 10.1130/G23288A.1.

Rengers, Francis K., Luke A. McGuire, Nina S. Oakley, Jason W. Kean, Dennis M. Staley, and Hui Tang. 2020. 'Landslides after Wildfire: Initiation, Magnitude, and Mobility'. *Landslides* 17(11):2631–41. doi: 10.1007/s10346-020-01506-3.

Román, María Victoria, Diego Azqueta, and Marcos Rodrígues. 2013. 'Methodological Approach to Assess the Socio-Economic Vulnerability to Wildfires in Spain'. *Forest Ecology and Management* 294:158–65. doi: 10.1016/j.foreco.2012.07.001.

RV Courier. 1971. 'Forest Fire Destroys Part of Crescent Supur'. *Robson Valley Courrier*, May 19, Volume 4, Ed 20, 1.

Scheffer, Marten, Steve Carpenter, Jonathan A. Foley, Carl Folke, and Brian Walker. 2001. 'Catastrophic Shifts in Ecosystems'. *Nature* 413(6856):591–96. doi: 10.1038/35098000.

Seidl, Rupert, Dominik Thom, Markus Kautz, Dario Martin-Benito, Mikko Peltoniemi, Giorgio Vacchiano, Jan Wild, Davide Ascoli, Michal Petr, Juha Honkaniemi, Manfred J. Lexer, Volodymyr Trotsiuk, Paola Mairota, Miroslav Svoboda, Marek Fabrika, Thomas A. Nagel, and Christopher P. O. Reyer. 2017. 'Forest Disturbances under Climate Change'. *Nature Climate Change* 7(6):395–402. doi: 10.1038/nclimate3303.

Sidle, Roy C., William H. Benson, John F. Carriger, and Toshitaka Kamai. 2013. 'Broader Perspective on Ecosystem Sustainability: Consequences for Decision Making'. *Proceedings of the National Academy of Sciences of the United States of America* 110(23):9201–8. doi: 10.1073/pnas.1302328110.

Smit, Barry, and Olga Pilifosova. 2003. 'From Adaptation to Adaptive Capacity and Vulnerability Reduction'. Pp. 9–28 in *Climate Change, Adaptive Capacity and Development*. Imperial College Press.

Smit, Barry, and Johanna Wandel. 2006. 'Adaptation, Adaptive Capacity and Vulnerability'. *Global Environmental Change* 16(3):282–92. doi: 10.1016/j.gloenvcha.2006.03.008.

Solnit, Rebecca. 2010. *A Paradise Built in Hell: The Extraordinary Communities That Arise in Disaster*. Reprint edition. New York: Penguin Books.

Steel, Zachary L., Hugh D. Safford, and Joshua H. Viers. 2015. 'The Fire Frequency-Severity Relationship and the Legacy of Fire Suppression in California Forests'. *Ecosphere* 6(1):art8. doi: 10.1890/ES14-00224.1.

Steelman, Toddi. 2016. 'U.S. Wildfire Governance as Social-Ecological Problem'. *Ecology and Society* 21(4).

Stutz, Birgit, and Lawrence Scanlan. 2010. *The Rescue Of Belle And Sundance*. HarperCollins Publishers Ltd.

Taylor, Stephen W., Lori D. Daniels, Kelsey Copes-Gerbitz, and Keldi Forbes. 2022. *'Wildfires' Resilience Pathways Report | Insights for Disaster and Climate Risk Management*. Geological Survey of Canada.

Toman, Eric, Melanie Stidham, Sarah McCaffrey, and Bruce Shindler. 2013. 'Social Science at the Wildland-Urban Interface: A Compendium of Research Results to Create Fire-Adapted Communities'. doi: 10.2737/NRS-GTR-111.

Toman, Eric, Melanie Stidham, Bruce Shindler, Sarah McCaffrey, Eric Toman, Melanie Stidham, Bruce Shindler, and Sarah McCaffrey. 2011. 'Reducing Fuels in the Wildland–Urban Interface: Community Perceptions of Agency Fuels Treatments'. *International Journal of Wildland Fire* 20(3):340–49. doi: 10.1071/WF10042.

Turner, B. L., Roger E. Kasperson, Pamela A. Matson, James J. McCarthy, Robert W. Corell, Lindsey Christensen, Noelle Eckley, Jeanne X. Kasperson, Amy Luers, Marybeth L. Martello, Colin Polsky, Alexander Pulsipher, and Andrew Schiller. 2003. 'A Framework for Vulnerability Analysis in Sustainability Science'. *Proceedings of the National Academy of Sciences* 100(14):8074–79. doi: 10.1073/pnas.1231335100.

Tymstra, Cordy, Brian J. Stocks, Xinli Cai, and Mike D. Flannigan. 2020. 'Wildfire Management in Canada: Review, Challenges and Opportunities'. *Progress in Disaster Science* 5:100045. doi: 10.1016/j.pdisas.2019.100045.

Valemount Community Forest. n.d. 'Valemount Community Forest – Valemount, B.C.' Retrieved 25 March 2022 (https://valemountcommunityforest.ca/).

Valemount Glacier Destination. n.d. 'Project Approved'. Retrieved 23 March 2022 (https://valemountglaciers.com/project-approved/).

VARDA. n.d. 'Valemount & Area Recreation Development Association'. *Home*. Retrieved 23 March 2022 (https://ridevalemount.com/).

Venn, Tyron J., David E. Calkin, Tyron J. Venn, and David E. Calkin. 2011. 'Accommodating Non-Market Values in Evaluation of Wildfire Management in the United States: Challenges and Opportunities'. *International Journal of Wildland Fire* 20(3):327–39. doi: 10.1071/WF09095.

Viswanathan, M., A. Ammerman, E. Eng, G. Garlehner, K. N. Lohr, D. Griffith, S. Rhodes, C. Samuel-Hodge, S. Maty, L. Lux, L. Webb, S. F. Sutton, T. Swinson, A. Jackman, and L. Whitener. 2004. *Community-Based Participatory Research: Assessing the Evidence: Summary*. Agency for Healthcare Research and Quality (US).

Wachinger, Gisela, Ortwin Renn, Chloe Begg, and Christian Kuhlicke. 2013. 'The Risk Perception Paradox—Implications for Governance and Communication of Natural Hazards'. *Risk Analysis* 33(6):1049–65. doi: 10.1111/j.1539-6924.2012.01942.x.

Wall, Ellen, and Katia Marzall. 2006. 'Adaptive Capacity for Climate Change in Canadian Rural Communities'. *Local Environment* 11(4):373–97. doi: 10.1080/13549830600785506.

Wang, Xianli, Dan K. Thompson, Ginny A. Marshall, Cordy Tymstra, Richard Carr, and Mike D. Flannigan. 2015. 'Increasing Frequency of Extreme Fire Weather in Canada with Climate Change'. *Climatic Change* 130(4):573–86. doi: 10.1007/s10584-015-1375-5.

Warrick, J. A., J. A. Hatten, G. B. Pasternack, A. B. Gray, M. A. Goni, and R. A. Wheatcroft. 2012. 'The Effects of Wildfire on the Sediment Yield of a Coastal California Watershed'. *GSA Bulletin* 124(7–8):1130–46. doi: 10.1130/B30451.1.

Wheeler, Marilyn. 2008. *The Robson Valley Story: A Century of Dreams*. 2nd ed. McBride: Sternwheeler Press.

Williams, A. Park, John T. Abatzoglou, Alexander Gershunov, Janin Guzman-Morales, Daniel A. Bishop, Jennifer K. Balch, and Dennis P. Lettenmaier. 2019. 'Observed Impacts of Anthropogenic Climate Change on Wildfire in California'. *Earth's Future* 7(8):892–910. doi: 10.1029/2019EF001210.

Woods, Alex J., K. David Coates, Martin Watts, Vanessa Foord, and Erin I. Holtzman. 2017. 'Warning Signals of Adverse Interactions between Climate Change and Native Stressors in British Columbia Forests'. *Forests* 8(8):280. doi: 10.3390/f8080280.

Woolcock, Michael, and Deepa Narayan. 2000. 'Social Capital: Implications for Development Theory, Research, and Policy'. *The World Bank Research Observer* 15(2):225–49. doi: 10.1093/wbro/15.2.225.

Wotton, B. M., M. D. Flannigan, and G. A. Marshall. 2017. 'Potential Climate Change Impacts on Fire Intensity and Key Wildfire Suppression Thresholds in Canada'. *Environmental Research Letters* 12(9):095003. doi: 10.1088/1748-9326/aa7e6e.

Wotton, B. M., C. A. Nock, and M. D. Flannigan. 2010. 'Forest Fire Occurrence and Climate Change in Canada'. *International Journal of Wildland Fire* 19(3):253–71. doi: 10.1071/WF09002.

Wotton, Mike, Martin Alexander, and S. W. Taylor. 2009. *Updates and Revisions to the 1992 Canadian Forest Fire Behavior Prediction System. Sault Ste.*

Appendix 1: Interview Guide

Date:

Interview by:

Attachment #1: Socio-demographic Interview

1.	Interview # Name for recording purposes	
2.	Gender	
3.	Age	
4.	Length of time in McBride	
5.	Highest level of schooling	
6.	Occupation	
7.	Current professional involvement with wildfire	
8.	Household characteristics (who lives in the house? How many children? Are all in the village? If not, where, doing what?	

Notes: *[describe the setting, time of day, place, and context for discussion]*

Interview Guide (continued)

Attachment #2: Semi-Structured Interview Guide

The following is a set of questions about perceptions and assessments of wildfire risk. Because it is a semi-structured interview, the responses are expected to be open-ended, and additional but related questions may be asked as part of probing or following up on what the participants may say. The interview should take between 30 minutes to an hour and be complimented with follow-up conversations and participant observation.

General Questions

1. Can you list the types of changes you have observed in your time in the Robson Valley with the most noticeable as number one? (Environmental and social) When did they happen?
2. Which of these changes has been most significant?
3. What future environmental changes are you most concerned about?

Livelihood activities and current stresses affecting livelihood activities

1. What is your employment/livelihood?
2. How long have you been doing this?
3. Is preparation for natural hazards a significant part of your work?

Freelisting Activity

1. List the impacts that a significant wildfire could have on your community (2 minutes)
    a. Slow prompting
        i. Environmental
        ii. Economic
        iii. Social
2. Which of these impacts would be most significant to you and your community? (3 minutes)
    a. How so?

Perceptions of Vulnerability and Adaptive Capacity

1. How vulnerable is the community to the impacts of a fire (both direct and indirect)?
2. What might make your community less vulnerable to the impacts of fire?
3. If you had an unlimited budget, what would you do to enhance the resilience of the Robson Valley?
4. What is your biggest concern in the event of a significant fire near the community?

Roles and Responsibility

1. Whose responsibility is it to manage and prepare for the risk of a fire?
2. Has your organisation done well to address this risk?
3. What could you do better?
4. What more should the Robson Valley be doing to address fire risk?

Who else should I talk to?

Appendix 2: Coding Themes

Below is a list of themes used to code interviews during data analysis. Primary themes are underlined and bolded, while secondary codes are below.

Current Exposure Sensitivity	**Current Adaptive Capacity**	**Concern for wildfire**
Changing Weather/Climate	Brushing and Logging	Cascading Effects
Economic Changes	Bush awareness/knowledge of fire	Causes of Fire
Lack of Awareness	Community Relationships	Changing Weather
Forest Composition	Public Education	Likelihood of Fire
Home and Community Exposure	Fire risk reduction	**Centralization of government services**
Jurisdictional Challenges	Financial Capacity to Act	Changes to Fire Suppression
Lack of Agency to Act	Other Adaptive Capacity	Closure of McBride Forestry Office
Impacts of the Forest Industry		Centralisation General
Smoke		
Railway		
Transportation Corridors		
Traditional Territory/Indigenous Fire Stewardship		