Assessing Private Land Fuel Management Treatments in the Wildland Urban Interface of British Columbia's Southern Interior

by

COLIN EDWARD SWAN

BNRSc, Thompson Rivers University, 2008

A THESIS SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE
in Environmental Science

THOMPSON RIVERS UNIVERSITY

This thesis has been accepted as conforming to the required standards by:

Dr. Wendy Gardner (Ph.D.), Thesis Supervisor, Department of Natural Resource Sciences, Thompson Rivers University

Dr. John Karakatsoulis (Ph.D.), Supervisory Committee Member, Department of Natural Resource Sciences, Thompson Rivers University

Dr. Terry Kading (Ph.D.), Supervisory Committee Member, Department of Philosophy, History and Politics, Thompson Rivers University

Robert Gray, External Examiner, Fire Ecologist

Dated this March 17, 2019, in Kamloops, British Columbia, Canada

© Colin Swan, 2019

Thesis Supervisor: Professor Dr. Wendy Gardner

ABSTRACT

The problems of fire in areas where forest and infrastructure meet (the wildland urban interface) are becoming better understood as a mounting body of research grows against the backdrop of climate change, forest fuel build-up and the expansion of human settlement into rural areas. The Province of British Columbia has a history of catastrophic wildland fires. Following the events of the 2003 fire season, fuel management emerged as a key recommendation to mitigate the risk of wildland fire in rural areas. Although the overall effectiveness of the Provincial fuel management strategy will continue to be the subject of debate, there is consensus that at-risk private landowners need to take responsibility for their safety. Fuel management on Crown land can provide a model for landowners to implement mitigation strategies on their own properties, but are homeowners using that model? This study investigated if homeowners in wildland urban interface areas within the Kamloops Fire Zone of British Columbia are using adjacent Crown land fuel management treatments as a template for conducting mitigation work on their own property. This was accomplished using a two-part study. The first part of the study involved an *in situ* measurement of Crown and private land parcels using hazard assessment criteria modified from FireSmart Canada. Hazard assessment scores of fuel-managed public lands and adjacent private lands were similar, suggesting that private land owners were reproducing mitigation measures on their own properties. Fuel management reduced the hazard assessment scores of crown and private lands in the areas studied and there was variability in fuel management treatments. The second component of the study involved a mail-out survey to wildland urban interface residents to support the findings of part one and gain a better understanding of the human dimension of fuel management treatments by clarifying the motives, trends and obstacles that may be in place. Residents of the wildland urban interface were aware of the risk of wildland fire impacting their communities. Most residents were familiar with the FireSmart program. Education continues to be an important component of any forest fuel mitigation effort and residents in fuel managed areas generally felt a greater sense of community than those residing in untreated areas.

Keywords: Fuel Management, Treatment, Influence, Public Land, Private Land, British Columbia

DEDICATION

I dedicate this thesis to the 239 homeowners of Upper Mission, who in 2003 had their lives irrevocably changed. May the lessons we can learn from never become lessons observed.

ACKNOWLEDGEMENTS

This has truly been one of the greatest challenges in my life. It came with its share of cuts, bruises and sprains along the way. In the end it was worth it. Because it helped me to re-establish that man that I want to be. The values I wish to espouse. The kind of man that lives by the words of the legendary Vince Lombardi "It's not whether you get knocked down, it's whether you get up."

I've had help along the way. Thank you, Tom Lacey and Greg Garrish. You both taught me a lot. Especially about passion for your work.

Thank you, Gerald Smith. You've been a quiet inspiration along the way.

Kristen, Amy, Cheryl, Dan, Aaron, Heather, Erika, Jo, Sarah-my mates in the trenches.

Roman Chapman. You're a good dude. Thanks for giving someone to handover the keys and someone to rock my socks off in statistics.

Rick Erland. Nothing ever turns out the way you think it will. True. Sometimes it's better.

My committee members John K. and Terry Kading. You guys make TRU a better place.

Dr. Wendy Gardner. You've always treated me like a colleague when sometimes I needed to be treated like a child. Thank you for always believing in me.

My home fire crew, H51B Maya Swan and H51C Chloe "Charlie" Swan. You've made my life a happier place. I hope I have taught both of you to never give up.

And finally, my wife Michaela, "you stay the course, you hold the line Keep it all together. You're the one true thing I know I can believe in" (McLachlan 2003). Thank you, my love. I owe you so much. It will take the rest of my life to try and pay you back.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1-INTRODUCTION

Wildland Fire and the Natural World

Wildland fires, those unplanned fires burning in natural areas such as forests, shrublands, grasslands or prairie, have always been a natural part of the earth, driving the evolutionary components of species composition and community assembly within terrestrial landscapes and making essential contributions to the vitality and renewal of its ecosystems (Bond and Keely 2005). Fire ecology is the study of these fire as it affects and relates to the natural environment and its interrelationships with flora and fauna (CIFFC 2003). These interrelationships are complex and highly variable, depending on factors including location, intensity and size of the fire, the season, the weather and more recently in earth's history, the type and amount of human influence on the land base (Anderson 2001, Greswell 1999, Martin and Sapsis 1992).

These factors make fire somewhat of a shapeshifter, taking several different forms and resulting in a wide range of ecological effects in space and time (Beck et al. 2005). These forms are classified as ground, surface or crown fires. Ground fires are those that burn slowly, slowly consuming the combustible material in the organic soil layer. Oxygen is in short supply and the flames tend to be absent or small. Surface fires burn the combustible material above the litter layer between the ground and the ladder fuels, those fuels that allow fire to climb to the canopy layer of the forest. These fires consume branches, twigs, herbs, shrubs and small trees and flame lengths can very between 30 cm and several metres in height (CIFFC 2003). Crown fires are propagated through the canopy fuel layer and may spread in union with a coincident surface fire; this is referred to as an intermittent crown fire. Crown fires are the most impressive of all wildland fires and may travel as quickly as 200 meters per minute and have a flame length up to 200 metres (CIFFC 2003). Crown fires also readily spread by ember cast. This "spotting" involves the production of firebrands that are lofted into the air and travel great distances, igniting spot fires in receptive fuels well ahead of the main fire (Partners in Protection 2003).

Fire Regimes

Fire regimes are the patterns, frequency, size and intensity of wildland fires that prevail in a given ecosystem over extended periods of time (Pyne et al. 1996) and are the result of complex and dynamic processes generated by the interactions and feedback among fire, climate, vegetation attributes, landscape characteristics, land use and ignition patterns (Barros and Pereira 2014). The variability of fire regimes can be characterized as a spectrum, with some ecosystems experiencing rare or minimal natural fires, to surface fires of varying frequency and intensity to crown fires of varying frequency (Beck et al. 2005). Understanding fire regimes is important to evaluating the effects of fire and predict how fire patterns will change in response to human and environmental drivers (Archibald et al. 2013). It is equally important to natural resource mangers in planning fire risk mitigation strategies (Chen et al. 2017).

Fire regimes have been extensively investigated at different spatial and temporal scales, covering various topics from how plant species adapt to wildfire (Fernandes and Rigolot 2007) to how landscapes interact with fire (Moreira et al. 2011) to how fire regimes are categorized over decades (Malamud et al. 2005) to over millennia (Gill et al. 2009). The influence of climate change and the effect of human activity in altering the past, current and future fire regimes have become a dominant topic in recent fire regime studies (Bowman et al. 2009; Gillett et al. 2004; Guyette et al. 2002; Marlon et al. 2008).

Mankind as the Keeper of the Flame

Fire history studies have determined that most of our forests and grasslands have been influenced by wildland fire for thousands, if not millions, of years; evidence exists as fossil charcoal, charcoal layers in aquatic sediments and soil horizons (Beck et al. 2005). As soon as plants colonized land, they burned, and they have been burning ever since (Pyne 2016). They burned in a way that was patchy, because nature in the form of lightning was the sole source of its ignition. That changed with the arrival of man, the one creature that could wrest control of ignition away from lightning and fire at will. When this occurred, the global history of human civilization became inextricably bound to wildland fire with humanity remaining as the greatest source of its ignition, its introduction into new lands, its removal from old ones, and the greatest modifier of its environment (Pyne et al. 1996). Wildland fire was featured prominently in North American First Nations culture prior to European settlement (Agee 1993). First Nations people used fire extensively to manipulate landscapes for purposes of war, agriculture and hunting creating "a mosaic of anthropogenic fire regimes as complex as the historical geography of the cultures themselves" (Pyne 1982). Fire was also used to reduce fuel loading around habitations. Burning required special knowledge of fire behaviour and vegetation response and was done at specific times of year under specific weather conditions (Beck et al. 2005). At least 18 species of plants have been consistently identified by First Nations people in British Columbia as being purposely encouraged by their traditional burning practices (Beck et al. 2005).

Generally speaking, First Nations people in North America were well adept at utilizing wildland fire as a tool and companion on a local and fine-scale level. Conversely, the arrival of non-natives from Europe and their use of wildland fire created an impact that was much greater, more abrupt and widespread (Beck et al. 2005). As societies evolved from nomadic and agrarian roots to industrialization, the paradigm of wildland fire also evolved as valued resources and infrastructure were repeatedly and indiscriminately altered by fire. This has been seen throughout the world during the last century, as many human settlements in Asia (China, Indonesia, Japan, Israel and South Korea), Australia, Europe (Germany, Greece, Italy, France, Poland, Portugal, Russia and Spain), North America and South America have all been negatively impacted by large wildland fires (Blackwell 2014). The same has been seen in British Columbia, as settlement in the late 1800s was accompanied by exploration, industrial activity and land clearing that resulted in many accidental and serious wildfires (Beck et al. 2005).

The Shifting Paradigm

The natural paradigm of wildland fire first made a shift during this period, a shift that cast them collectively as destructive and dangerous to the environment and human well-being (Dyck et al. 2003; Parminter 1978). The concept of firefighting developed, and fire suppression became a well-accepted practice (Dyck et al. 2003), achieving a level of success measured in the decade preceding 2003 by containment of 93% of all wildfires to less than four hectares in size (BC 2003 Firestorm Provincial Review 2004). The campaign to prevent wildland fires also took root during this period, as fire prevention messages that stressed the negative effects of fire appeared on signposts and mileage markers on roads and trails, as educational material in schools and public movie theatres, and as notices in churches, hotels, post offices, campsites and industrial camps (Parminter 1978 and references within). Traditional burning by First Nations was permitted to continue, but on a drastically reduced scale (Parminter 1995). Generations were taught to believe that fire was a catastrophe of nature (Kaufmann 2004).

Combatting the ecological insurgency of wildland fire with fire suppression has come at a significant cost to the residents of British Columbia. On an average year, approximately $140 million is spent on suppression (Gray 2013). During the extreme fire seasons experienced in 2003 and 2009, fire suppression cost the Province approximately $500 million and more than $400 million, respectively (Government of BC 2010). The true cost of wildland fire, measured in terms of impacts to watersheds, ecosystems, infrastructure, business, individuals and to the local and national economies can extend into the distant future. It is also thought to be anywhere from 2 to 30 times the cost of suppression (WFLC 2010). This was the case in 2003, when damage to timber, forest productivity, homes and infrastructure was significantly greater than the suppression costs and calculated to be more than one billion dollars (Grant Thorton 2004).

Far greater than any material costs are those resulting from injury and fatalities. In British Columbia from 1941 to 1990, there were 61 wildland fire fighter fatalities, the highest of any province. From 1990 to 2010, there were another 33 across the country (Alexander 2010).

These costs, both monetary and lives lost, are forecast to further increase with the steadily increasing risk and damage associated with wildland fire. This increase has been attributed to three synergistic causes: climate change, fuel accumulation and the development of fire prone areas (Brenkert-Smith et al. 2012).

The climate of British Columbia is expected to change and be warmer, regardless of the models or carbon emission scenarios used (Haughian et al. 2012). Extreme fire weather, characterized by hot, dry and windy conditions, remains the dominant factor in fire severity and the amount of area burned (McKenzie et al. 2003). With a warming climate, fire seasons are expected to lengthen. Wotton and Flannigan (1993) have estimated a 22% increase or 30 day, increase in fire season length in Canada using global circulation models. Subsequent research has forecast that most Canadian provinces will experience significant increases in the total amount of area burned and fire suppression costs by the second half of this century due to climate change (Hope et al. 2016)

The unnatural accumulation of forest fuels, the live and dead vegetation in a forest environment that can potentially contribute to combustion (Brown and Smith 2000), can be attributed in part to the disruption of historical fire regimes through years of fire exclusion (Gayton 2001); this exclusion has in turn increased the risk of wildland fire within dry forest ecosystems, creating a powder keg within the forest that waits only for a credible ignition source to develop into a potentially severe wildfire. Mountain pine beetle infestation has also contributed to this build up by significantly increasing the amount of forest fuels available for combustion; it was estimated that by 2010, 17.5 million hectares of BC would be affected by the Mountain Pine Beetle (Westfall and Ebata 2011) and by 2017, it is estimated that there will be 787.8 million cubic metres of pine killed in the province by the beetle (Walton 2012). This buildup of combustible fuels in the forests of British Columbia has been recognized in several publications by government and professional associations (BC 2003 Firestorm Provincial review 2004; FBP 2006; ABCFP 2005).

Significant infrastructure development has also occurred in fire prone areas. As the population of British Columbia continues to expand, communities are spreading (Peter et al. 2006). Community expansion in both rural areas and in urban centres is frequently into former wildland areas for their natural scenic beauty and more relaxed lifestyle (Partners in Protection 2003, Peter et al. 2006). Such areas, where structures such as homes or business are built among the trees and other forest fuels, are known as the wildland urban interface or the WUI. (Partners in Protection 2003). The WUI may occur at the “interface” where development and forest fuels meet at a well-defined boundary, or in areas of “intermix”, where urban development and forest fuels intermingle with no clear boundary (Partners in Protection 2003). Development in the wildland urban interface is problematic from a wildfire management perspective and providing effective fire protection for communities in the WUI is one of the greatest challenges currently facing fire officials today (Partners in Protection 2003).

The impacts of escalating wildfire in many regions necessitates a more sustainable existence with wildfire with emerging strategies for managing ecosystems and mitigating risks to human communities providing some hope (Moritz et al. 2014). Wildfire behaviour is dependent on three general factors: forest fuels, daily weather conditions and the topographic features of the landscape (Hirsch and Pengelly 1997). Among these factors, very little can be done to alter either daily weather conditions or topography. Therefore, the only feasible option to influence fire behavior potential is to modify the build-up of forest fuels (Partners in Protection 2003). The 2003 Firestorm Provincial Review, known commonly as the Filmon Report in recognition of the review committee's lead, the former Premier of Manitoba, the Honourable Gary Filmon, recognized this and recommended improvements be made in fire prevention in areas of wildland urban interface by primarily by reducing the forest fuel build up using the process of fuel management (BC 2003 Firestorm Provincial Review 2004). Fuel management can be defined as the planned manipulation of forest vegetation to decrease the intensity and rate of spread of a wildfire (Merrill and Alexander 1987). This manipulation can be accomplished by using one or a combination of three distinct methods: fuel reduction, fuel conversion and fuel isolation (Pyne et al. 1996). Fuel reduction refers to the actions and processes that decrease the total amount of fuel in a given area. This often includes the removal of dead and down woody surface material, removal of coniferous understory trees, pruning branches and stems and by over story thinning (Hirsch and Pengelly 1997). These activities decrease the total amount of fuel available for consumption by a wildfire and alter the vertical arrangement of the remaining fuel. In turn, this makes it more unlikely that a high intensity crown fire may develop (Hirsch and Pengelly 1997). Fuel conversion is the process of replacing flammable coniferous tree species, such as Douglas-fir or lodgepole pine (*Pinus contorta var. latifolia*) with less volatile deciduous species such as aspen (*Populus spp.*) or birch (*Betula spp.*). Fuel conversion decreases fire behavior potential in two ways, by restricting the period during which a forest stand can sustain wildfire spread (Forestry Canada Fire Danger Group 1992) and by creating a significant barrier to wildfire spread in its full leaf state (Hirsch and Pengelly 1997). Fuel isolation involves fragmenting large areas of continuous forests to curtail the horizontal spread of wildfire. Mechanically created fuel breaks and prescribed fire have been used to create such discontinuity in large areas of continuous forests (Hirsch and Pengelly 1997).

Wildfire threat reduction using fuel management in British Columbia has been occurring on a provincial scale since the introduction of the Strategic Wildfire Prevention Initiative in 2004. This initiative stemming from the Filmon report (BC 2003 Firestorm Provincial review 2004) was created to assist communities in the development of plans and operational projects that would assist in improving fire prevention and community safety in interface areas by reducing the risk of wildfire (UBCM 2015). Since 2004, $62 million has been allocated to this initiative by the federal and provincial government (MFLNRO 2015) with an additional contribution of $5 million announced in March 2015 (UBCM 2015).

Although an estimated 43,000 hectares of provincial Crown and municipal lands have been treated to date under the Strategic Wildfire Prevention Initiative (WMB 2012), there is no current estimate of treatment that has occurred on privately owned properties. This represents a substantial knowledge gap, as research focusing on wildfire management in the interface not only supports the requirement of home owners to complete wildfire risk mitigation on their own properties to aid in overall effectiveness of hazard reduction programs (Cortner et al. 1990; Monroe et al. 2003; Field and Jensen 2005) but further suggests the treatment of fuels in immediate proximity to residences is far more important in determining the survivability of homes than the treatment of fuels in adjacent areas (Reinhardt et al. 2008). Considerable research has been conducted on the factors that influence homeowner participation in wildfire risk mitigation activities (Beringer 2000; McGee and Russel 2003; McCaffrey 2004; Nelson et al. 2005; Brenkert-Smith et al. 2006) but few studies have examined the relationship between fuel management undertaken by government agencies within or near towns and fuel management conducted by the homeowner.

Thesis Research Objectives

This study looks to address the questions of whether there is a relationship between fuel management undertaken by government agencies on Crown lands and that conducted by homeowners on private property and why or why not this relationship is occurring. To address these questions, I have conducted a two-part study involving a field assessment (Chapter 2) and mail response survey (Chapter 3) component. The objective of the field assessment is to determine if fuel management conducted on public lands influences homeowners on adjacent private lands to conduct fuel management activities on their properties. The objective of the mail response survey is to better understand the motivations and rationale of private landowners when deciding whether to fuel manage their property and to what extent they will engage in these activities. The results of this thesis will be valuable in determining future fuel management policy and strategy and ideally create communities that are more resilient in the wake of wildland fire.

Literature Cited

Agee, J.K. 1993. Fire ecology of Pacific Northwest forests. Island Press, Washington, D.C. 492 pp.

Anderson, L. 2001. Terrestrial wildlife and habitat. National Wildfire Coordinating Group, Fire Use Working Team, ed. Fire effects guide, chapter VII. NFES 2394. Boise, ID: National Interagency Fire Centre: 141-165. http://www.nwcg.gov/pms/RxFire/FEG.pdf (August 16, 2015).

Alexander, M.E. 2010. Wildland fire suppression related fatalities in Canada, 1941-2010.

[ABCFP] Association of British Columbia Forest Professionals. 2005. Forest fires in British Columbia: How policies and practices lead to increased risk. Association of British Columbia Forest Professionals. Position paper. Vancouver, BC. 19 pp.

Archibald, S., Lehmann, C. E., Gomez-Dans, J. L., Bradstock, R. A. 2013. Defining pyromes and global syndromes of fire regimes. Proceedings of the National Academy of Sciences of the United States of America, 110(16), 6442-6447.

Barros, A. M., Pereira, J. M. 2014. Wildfire selectivity for land cover type: Does size matter? PloS One, 9(1).

Beck, J., Parminter, J., Alexander, M., MacDermid, E., Van Nest, T., Beaver, A., Grimaldi, S. 2005. Fire Ecology and Management. In: Watts, S.B., Tolland, L., editors. Forestry Handbook for British Columbia, part 2. 5th edition. The Forestry Undergraduate Society, University of British Columbia. P. 490-525.

Beringer, J. 2000. Community fire safety at the urban/rural interface: the bushfire risk. Fire Safety Journal, 35: 1–23.

Blackwell, B.A. and Associates. 2014. Firesmart planning and practices assessment. North Vancouver (BC).

Bond, W.J., Keeley, J.E. (2005) Fire as a global ‘herbivore’: the ecology and evolution of flammable ecosystems. Trends in Ecology & Evolution 20:387–394.

Bowman, D. M., Balch, J. K., Artaxo, P., Bond, W. J., Carlson, J. M., Cochrane, M. A. 2009. Fire in the earth system. Science (New York, N.Y.), 324(5926), 481-484.

Brenkert-Smith, H, Champ, P.A., Flores, N. 2012. Trying not to get burned: Understanding homeowners’ wildfire risk-mitigation behaviours. Environmental Management. 50: 1139-1151.

British Columbia 2003 Firestorm Provincial Review. 2004. Firestorm 2003 Provincial Review. Vancouver, BC. 100 pp.

Brown, J.K. and Smith, J.K. 2000. Wildland fire in ecosystems: Effects of fire on flora (Gen. Tech. Rep. RMRS-GTR-42-vol2). Ogden, UT: US Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Chen, D., Pereira, J. M. C., Masiero, A., Pirotti, F. 2017. Mapping fire regimes in China using MODIS active fire and burned area data. Applied Geography, 85, 14–26.

CIFFC. 2003. Glossary of forest fire management terms. Canadian Interagency Forest Fire Centre, Winnipeg, MB. 61pp.

Cortner H.J., Gardner, P.D. and Taylor, J.G., 1990. Fire hazards at the urban–wildland interface: What the public expects. Environmental Management 14(1): 57–62.

Dyck, B.W., Gawalko, L., Rollins, R.B. 2003. Public perceptions of fire management practices in BC provincial parks. Forest Practices Code of BC Act. Forest Fire Prevention and Suppression Regulation.

Field, D.R., Jensen, D.A. 2005. Humans, fire, and forests: expanding the domain of wildfire research. Society and Natural Resources 18: 355–362.

[FBP] Forest Practices Board. 2006. Managing Forest Fuels. Forest Practices Board. Special Report 29. Victoria, BC. 20 pp.

Forestry Canada Fire Danger Group. 1992. Development and structure of the Canadian Forest Fire Behaviour Prediction System. Forestry Canada, Science and Sustainable Development Directorate, Ottawa, Ontario, Information Report ST-X-3.

Fernandes, P. M., & Rigolot, E. (2007). The fire ecology and management of maritime pine (Pinus pinaster Ait.). Forest Ecology and Management, 241(1-3), 1-13.

Gayton, D.V. 2001. Ground work: basic concepts of ecological restoration in British Columbia. Southern Interior Forest Extension and Research Partnership, Kamloops, B.C. SIFERP Series 3

Gill, J. L., Williams, J. W., Jackson, S. T., Lininger, K. B., Robinson, G. S. 2009. Pleistocene megafaunal collapse, novel plant communities, and enhanced fire regimes in north America. Science, 326(5956), 1100-1103.

Gillett, N., Weaver, A., Zwiers, F., Flannigan, M. 2004. Detecting the effect of climate change on Canadian forest fires. Geophysical Research Letters, 31, 1-4.

Government of British Columbia, Ministry of Forests. 2010. Wildland Fire Management Strategy. Canada

Grant Thorton LLP. 2004. Incremental economic/financial impacts of the 2003 forest fires in B.C. Prepared for the Government of B.C.

Gray, R.W. [Internet]. 2013. B.C.’s fire-reduction strategy misses mark. Vancouver Sun; [cited April 17, 2015]. Available from: http://www.vancouversun.com/business/fire+reduction+strategy+misses+mark/8733516/story.html

Greswell, R.E. 1999. Fire and aquatic ecosystems in forested biomes of North America. Transactions of the American Fisheries Society. 128: 193-221.

Guyette, R. P., Muzika, R. M., Dey, D. C. 2002. Dynamics of an anthropogenic fire regime. Ecosystems, 5, 472-486.

Haughian, S., Burton, P., Taylor, S., Curry, C. 2012 Expected effects of climate change on forest disturbance regimes in British Columbia. BC Journal of Ecosystems and Management 13(1): 1-24.

Hessburg, P.F., Reynolds, K.M., Keane, R.E., James, K.M., Salter, R.B. 2007.Evaluating wildland fire danger and prioritizing vegetation and fuels treatments. Forest Ecology and Management. 247:1-17.

Hirsch, K., Pengelly, I. 1997. Forest fuels management in theory and practice. In Proceedings of Symposium on Stand Density Management: Planning and Implementation, Alberta Environmental Protection, Edmonton, Alberta, 6 and 7 November 1997. Edited by C.R. Bamsey. Clear Lake Ltd., Edmonton, Alberta, Canada. ISBN 0-9695385-4-5: 112–116.

Hope, E. S., McKenney, D. W., Pedlar, J. H., Stocks, B. J., Gauthier, S. 2016. Wildfire suppression costs for Canada under a changing climate. *PLoS ONE*, *11*(8), 1–18.

Kauffman, J.B. 2004. Death Rides the Forest: Perceptions of Fire, Land Use, and Ecological Restoration of Western Forests. Conservation Biology. Volume 18, No. 4: Pages 878-882.

Malamud, B. D., Millington, J. D. A., & Perry, G. L. W. 2005. Characterizing wildfire regimes in the United States. Proceedings of the National Academy of Sciences, 102(13), 4694-4699.

Guyette, R. P., Muzika, R. M., Dey, D. C. 2002. Dynamics of an anthropogenic fire regime. Ecosystems, 5, 472-486.

Martin, R.E., Sapsis, D.B. 1992. Fires as agents of biodiversity: pyrodiversity promotes biodiversity. In: Harris, R.R., Erman, D.E. and H.M. Kerner. Tech cords. Proceedings of the symposium on biodiversity of northwestern California. Wildland Resources Center Report No. 29. Berkeley, University of California: 150-157

McCaffrey, S.M. 2004. Thinking of wildfire as a natural hazard. Society and Natural Resources 17: 509–516.

McGee, T.K. and Russell, S. 2003. ‘It’s just a natural way of life. . .’ An investigation of wildfire preparedness in rural Australia. Environmental Hazards 5: 1–12.

McKenzie, D., Gedalof, Z., Peterson, D.L., Mote, P. 2003. Climatic change, wildfire and conservation. Conservation Biology 18 (4): 890-902

Merrill, D.F., Alexander, M.E. 1987. Glossary of forest fire management terms (4th edition). Canadian Committee on Forest Fire Management, National Research Council of Canada, Ottawa, Ontario.

[MFLNRO] Ministry of Forests, Lands and Natural Resource Operations .2015. Fuel Management 2pp. [online]. Available: http://bcwildfire.ca/fuelmanagement/ [January 7, 2015].

Monroe, M.C., Long, A.J., Marynowski, S. 2003.Wildland fire in the southeast: Negotiating guidelines for defensible space. Journal of Forestry 101(3): 14–19.

Moreira, F., Viedma, O., Arianoutsou, M., Curt, T., Koutsias, N., Rigolot, E. 2011. Landscape-wildfire interactions in southern Europe: Implications for landscape management. Journal of Environmental Management, 92(10), 2389-2402.

Moritz, M. A., Syphard, A. D., Batllori, E, Bradstock, R.A., Gill, A.M., Handmer, J., Hessburg, P.F., McCaffrey, S., Leonard, J., Odion, D.C., Schoennagel, T. 2014. Learning to coexist with wildfire. Nature. 515(7525):58-66.

Nelson, K.C., Monroe, M.C., Johnson, J.F. 2005. The look of the land: homeowner landscape management and wildfire preparedness in Minnesota and Florida. Society and Natural Resources 18: 321–336.

Parminter, J. 1978. A historical review of forest fire management in British Columbia (thesis). Vancouver, BC: University of British Columbia; November 1978. 105 pp.

Parminter, J. 1995. Human Influence on Landscape Pattern in the Pacific Region: Impacts of Burning by First Nations and Early European Settlers. Landscape Ecology Symposium, 76th Annual Meeting of the Pacific Division, American Association for the Advancement of Science. June 20, 1995. Vancouver, BC.

Partners in Protection. 2003. FireSmart: Protecting your community from wildfire. Partners in Protection, Edmonton, Alberta. pp 2-5.

Peter, B., Wang, S., Mogus, T., Wilson, B. 2006. Fire risk and population trends in Canada's wildland–urban interface. Canadian wildland fire strategy: Background syntheses, analyses, and perspectives, Hirsch, K.G., Fuglem P. (Tech.Coordinators). Canadian Council of Forest Ministers, Natural Resources Canada, Canadian Forest Service, Northern Forestry Centre, Edmonton, AB.

Pyne, S.J. 1982 Fire in America: A Cultural History of Wildland and Rural Fire (Seattle: University of Washington Press, 1982), 78.

Pyne, S.J., Andrews, P.L., Laven, R.D. 1996. Introduction to wildland fire, 2nd edition. John Wiley and Sons, New York, NY. PP 213-233, 405-419 769 pp.

Pyne, S.J. 2016. How fire shapes everything [internet]. YouTube.com; [cited 2019 Jan 25]. Available from: https://www.youtube.com/watch?v=LPC7UQyQQhQ.

Reinhardt, E.D., Keane, R.E., Calkin, D.E., Cohen, J.D. 2008. Objectives and considerations for wildland fuel treatment in forested ecosystems of the interior United States. Forest Ecology and Management 256: 1997-2006.

Walton, A. 2012. Provincial level projection of the current mountain pine beetle outbreak: Update of infestation projection based on the provincial aerial overview surveys of forest health conducted from 1999 to 2011 and the BCMPB (year 9). Ministry of Forests, Lands and Natural Resource Operations. Province of British Columbia.

Westfall, J., Ebata, T. 2011. Summary of forest health conditions in British Columbia (2010). Pest Management Report No. 15, Ministry of Forests, Mines and Lands, Victoria, BC.

[WFLC] Western Forestry Leadership Coalition. 2010. The true cost of wildfire in the western U.S. [WWW Document]. URL http://wflccenter.org/inf-materials/reports

[WMB] Wildfire Management Branch. 2012. Proactive wildfire threat reduction. Discussion paper. 1-4.

Wotton, B.M., Flannigan, M.D. 1993. Length of the fire season in a changing climate. Forestry Chronicle 69: 187–192.

[UBCM] Union of British Columbia Municipalities Strategic Wildfire Prevention [Internet]. 2015. Union of British Columbia Municipalities; [updated April 14, 2015; cited April 17, 2015]. Available from: http://www.ubcm.ca/EN/main/funding/lgps/current-lgps-programs/strategic-wildfire-prevention.html

CHAPTER 2 – QUANTITATIVE ASSESSMENT OF FUEL MANAGEMENT TREATMENTS ON PRIVATE LAND IN BRITISH COLUMBIA'S SOUTHERN INTERIOR

INTRODUCTION

Wildland urban interface (WUI) areas – those areas in which structures are built among trees and other combustible vegetation - are attractive places in which to live because of affordability and ready access to natural surroundings and recreation (Abrams et al. 2012). Within the Pacific Northwestern United States of Washington, Oregon and California, the wildland- urban interface saw a substantial growth of 11% or 5218 km^2 during the 1990s and a higher growth of 15% was seen in the number of houses that were WUI in both 1990 and 2000 (Hammer et al. 2007). Canadian population trends including urban expansion into rural areas, demand for recreational property and high rates of growth in some isolated communities are all impacting the WUI of the nation (Peter et al. 2006). In Alberta, population growth generally means an increase in the number of homes and an expansion of the interface between wildland and homes (MNP 2016). Although there have been no recent studies that chart the growth of the WUI in the Province of British Columbia, over 5.5 million hectares (55 000 km^2) of land are considered wildland-urban interface, containing homes, seasonal homes, public buildings and commercial structures (Johnston and Flannigan 2017). This total represents 5.1% of the overall land base, a percentage that could be much greater if industrial structures such as oil and gas facilities and infrastructure such as roads, railways or powerlines were included in the traditional WUI definition (Johnston and Flannigan 2017).

Wildland fires in these areas where vegetation and houses meet or intermingle are especially problematic due to the proximity of flammable vegetation to houses, the density of structures, and the propensity of people to ignite fires here by accident or on purpose (Radeloff et al. 2018). Fire can originate in one of the natural or man-made fuel sources of these areas and quickly and easily spread to the other. Management, and suppression, are further complicated by limited firefighting resource and access challenges (Partners in

Protection 2003; Mell et al. 2010). Wildland fire presents further challenges for mangers from the mechanism of heat transfer; fire can ignite and propagate through fuels by direct flame contact or radiant heat and by producing firebrands that are lofted in the air and can travel a great distance before finding a suitable spot to ignite. The reality of fire-brand ignitions indicates that homes and structures some distance from the interface of communities and wildlands are at risk (Partners in Protection 2003).

The impacts of wildland-urban interface fires are often catastrophic resulting in tremendous damage, large economic losses and severe social impacts (Partners in Protection 2003). These impacts have been well documented throughout the world in Australia, Europe (Blackwell 2014), the United States (Mell et al. 2010; Hammer et al. 2007; Pyne 1997) and Canada (BC 2003 Firestorm Provincial review 2004; MNP 2016).

Faced with such catastrophic impacts, researchers and government agencies alike have seen fuel management as a major part of the solution to reducing structural and natural resource losses from fire in the WUI. From their review of the Cascade fire complex of central Idaho in 2007, Graham et al. (2008) determined that the survival of most structures located within the Warm Lake Basin could be directly attributed to fuel management treatments. During that summer, 202,342 hectares of tinder dry forests burned, driven by strong winds over challenging terrain. These fires burned through and over 3,237 hectares of fuel management treatment designed to offer fire protection to over 70 summer homes and other buildings located near Warm Lake (Graham et al. 2008). It was also determined that the presence of these treatments influenced the development of the appropriate management response, fire suppression strategies and the location of the Incident Command Post during the response to the complex (Bull et al. 2007). Fuel composition, moisture content, and structure are major determinants of fire behavior and are easily modified by fuel treatments (Agee 1993). As such, this review also directly compared forest structure and composition of fuel treated areas to areas where fuels were not treated in the Monumental and North Fork Fires of the complex and determined that treatments modified the behavior of the fires when compared to areas where the fuels were not treated (Graham et al. 2008). This modified behavior was measured as reduced burn severity, allowing vegetation to stay intact, preservation of wildlife habitat, retention of scenery, maintenance of “sense of place” and protection of soil and water (Graham et al. 2008).

Identification of wildland urban interface areas is an important step in prioritizing fire prevention and preparedness projects, as limited resources create the need for planners to set priorities by choosing the treatment and location of fuel management projects to maximize the expected reduction of damage to people, homes and natural resources (Haight et al. 2004) but doing so is not without challenges. In Canada, identification has only been done recently on a national scale by overlapping geographic structural and fuel data sets and applying a variable-width buffer to determine areas of WUI (Johnston and Flannigan 2017). Within British Columbia, identification and delineation of WUI areas was made on a Provincial scale in 2004 as an externality of the BC government's high-level Provincial Strategic Threat Analysis. The analysis was in the form of a map identifying forest fuels with the potential to exacerbate fire behavior and spot wildfire back in wildland urban interface areas and specifically looked at interface areas, fire risk, fire behavior potential, combined risk/fire behavior and spotting potential into the WUI (MoFLNRO 2015). However, this analysis and its subsequent editions in 2011, 2015 and 2017, provides coarse resolution and is not intended to represent site specific values or geographic certainties (Government of BC 2017).

Despite its limitations, the Provincial Strategic Threat Analysis does provide a starting point of a community's wildfire risk assessment, the development of a Community Wildfire Protection Plan and the quantitative evidence required to access a funding for fuel management prescriptions and treatments on public land through the Strategic Wildfire Prevention Initiative (MoFLNRO 2015). However, on its own it does not aid significantly to a prioritization strategy for treatment of areas within communities nor among communities at a provincial level given the millions of hectares of forested land that potentially pose a threat to the WUI.

During the period of 2004 to 2011, local governments were left to develop their own priorities that were then adjudicated by the Province. Community Wildfire Protection Plans were developed, using staff of the local government or contracted Forest Professionals when technical expertise was not present, and vast tracts of land were identified for prescription development and operational treatment using the Provincial Strategic Threat Analysis as a starting point. Subsequent site- specific assessment of these public lands to be managed came primarily from utilization of the "Wildfire Hazard Assessment System" of the FireSmart manual (Morrow et al. 2013). The FireSmart manual was developed by the Alberta consortium of Partners in Protection to provide practical tools and information for use by WUI residents, municipal officials, land use planners, structural and wildland firefighters and industries that operate in the WUI to quantitatively assess structural and vegetation hazards (Partners in Protection 2003). Under this system, sixteen factors are assessed as structural and site hazards or as area hazards. Each is given a point rating for the degree of interface fire hazard contributed by that factor. Individual point rating scores are then tallied to determine the hazard level for the site and area, expressed as low, moderate high or extreme (Partners in Protection 2003). The drawback of using this assessment tool was its intrinsic failure to address all the components of the system, particularly the rating of forest fuels (Morrow et al. 2013). As a result, modifications were often made to the Firesmart system by its practitioners to broaden its scope. An unintended negative consequence of these modifications was the decrease in the uniformity of assessments (Morrow et al. 2013). As a result, this made direct comparison, and therefore province wide prioritization, of treatment areas unnecessarily subjective. This problem was exacerbated by the increasing numbers of assessments being completed by the increasing numbers of professionals. To alleviate this problem, a new wildfire threat assessment system was developed in 2008 by a team led by Bruce Morrow. This system differed from Firesmart in that it focused on fuels, weather and topography, the three elements of the fire triangle. It was scientifically justifiable, with proven wildland fire behavior principles tied to the Canadian Forest Fire Danger Rating System (CFFDRS) and it focused on assessment from the structure outwards (Morrow et al. 2013), meaning the forest fuel hazard immediately adjacent to structures and extending into the wildland. This method has been recognized as the standard method of wildland urban interface threat assessment of public lands in BC.

Despite the identification of WUI areas and the development of a recognized suite of metrics that guide prioritization of fuel management projects, the amount of work completed since the release of the 2003 Firestorm Provincial review until 2014 has been considered expensive and of limited value with an estimated 4 percent of critically important work having been completed (Hansard 2014). This underwhelming estimate of the work completed on publicly owned land suggests that to reduce the loss of homes during incidents of wildland fire in the WUI, private land strategies are becoming more important to complement the current fuel management strategy on public lands (Brenkert-Smith et al.

2006; Mell et al. 2010; Penman et al. 2015; Reilly 2015). To successfully control fires in the WUI, the private land owner must work with government and emergency response agencies to manage fuels and provide fuel modified areas around their structures (Partners in Protection 2003).

Faulkner et al. (2009) have recently examined wildfire risk mitigation activities of homeowners' in Alberta in response to the activities of government and have determined that homeowners living in communities having undergone fuel management work had higher levels of perceived risk and greater awareness of wildfire and mitigation but had completed no additional mitigation on their properties from their counterparts in communities in which no fuel management had occurred. In this study, I will look at wildfire risk mitigation activities of homeowners in response to government activity on public lands in British Columbia's southern interior by conducting a field study to quantitatively evaluate parcels of private land adjacent to Provincial Crown lands that have undergone forest fuel management treatments and parcels of private land adjacent to Provincial Crown lands that have not undergone fuel management treatments to determine if treatment has an influence on land owners to mitigate wildfire hazards on their own properties.

MATERIALS AND METHODS

Geographic Area of Study – Kamloops Fire Zone

The Kamloops Fire Zone in British Columbia's south-central interior was selected as the geographic area of this study because of the historical number of wildfires it experiences annually, the prevalence of wildland urban interface areas throughout the zone and the number of documented fuel management treatments on public lands. This fire zone is one of seven administrative areas within the Kamloops Fire Centre. The zone boundary extends in an approximate radius of 100 km from the City of Kamloops, British Columbia, Canada north to the community of Little Fort, east to the Village of Chase, south to the District of

Logan Lake and approximately 30 km west of the Village of Cache Creek and covers approximately 1.3 million hectares. (Figure 2.1).

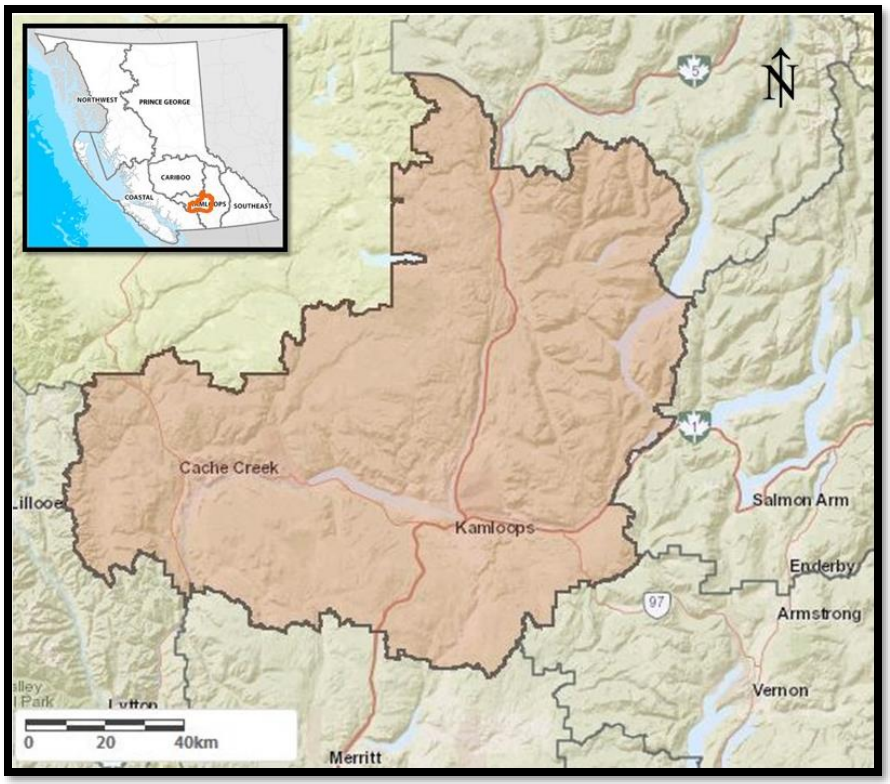

Figure 2.1. The administrative boundary of the Kamloops Fire Zone inset within the map British Columbia.

The pronounced rain shadow cast by the Coast Mountains to the west, coupled with the hot temperatures of the interior plateau during the growing season allows vegetation of the Bunchgrass, Ponderosa Pine and Interior Douglas-Fir biogeoclimatic zones to dominate within the zone (Hope et al. 1991a). These biogeoclimatic zones are characterized by frequent and stand maintaining wildland fires (MoF 1995).

Although at present there is no quantitative assessment of the number of hectares of wildland urban interface area within the Kamloops Fire Zone, anecdotal evidence confirms that not one community within its boundaries- including the Village of Ashcroft, the District of Barriere, the Village of Cache Creek, the Village of Chase, the City of Kamloops, the District of Logan Lake and Sun Peaks Mountain Resort Municipality-is without an area or multiple areas in which homes or other structures meet with or are dispersed within wildland vegetation and are thus at risk from fire in the wildland urban interface.

This fire zone has also been on the forefront of implementing fuel management recommendations set out in the 2003 Firestorm Provincial Review. From the period of 2006 to 2013 inclusive, 37 fuel management projects on Provincial Crown land were developed and carried out in conjunction with three local governments- the City of Kamloops, the District of Logan Lake and the Thompson Nicola Regional District (Table 2.1).

Field Assessment

To evaluate the effect of public land management on the private landowner's decision to apply fuel management treatments on his or her own property, in situ measurement was carried out. Field sites were placed in one of two categories: fuel treated (those that had undergone a prescribed fuel management treatment on the public land base) versus control or untreated (those public lands that remain in a natural or untreated state). In total 5 fuel treated replicates and 5 untreated (control) replicates were located across the Kamloops Fire Zone. At each site replicate data was collected from a minimum of 5 private land areas and 5 adjacent Crown land areas. Details on the full study design to follow.

Determination of Fuel Treated Replicates

Fuel treated replicates were defined as the parcels of Provincial Crown land associated with the fuel management projects identified during the review of the fire zone's fuel management project inventory (Table 2.1). Each replicate has undergone some form of fuel management treatment and was geographically adjacent to privately owned properties or separated by easements including roadways, utility line rights-of-way and hiking trails. Each replicate was assigned a unique numerical identifier and five were selected for field study using a random number generator written in Microsoft excel (Table 2.2, Figure 2.2).

Table 2.1. Inventory of fuel management projects within the Kamloops Fire Zone 2006-2013.

LOCAL GOVERNMENT	FUEL MANAGEMENT PROJECT	NUMERICAL IDENTIFIER
CITY OF KAMLOOPS	Barnhartvale Block 3	1
	Barnhartvale Horse Trails	2
	Blackwell Block 1	3
	Blackwell Block 3	4
	Pineview Block 7 (005)	5
	Pineview Block 7 (019)	6
	Pineview Block 7 (063)	7
	Pratt Road Block 2 (040)	8
	Pratt Road Block 2 (050)	9
	Rose Hill East	10
	Uplands	11
LOGAN LAKE	Block 0	12
	Block 1	13
	Block 1A	14
	Block 1B	15
	Block 3	16
	Block 4	17
	Block 5	18
	Block 6	19
	Block 08-1, 08-2, 08-3	20
	Block The Duck Pond	21
	Block The Island Municipal	22
	Block The Island Provincial	23
	Block The Pocket	24
	Block The Shovel	25
	Block West Duck Pond	26
THOMPSON NICOLA REGIONAL DISTRICT	Evergreen	27
	Heffley Lake 1	28
	Heffley Lake 2	29
	Heffley Lake 3	30
	Lac Le Jeune	31
	Maple Mission	32
	Paska Lake (072) P1	33
	Paska Lake (072) P2	34
	Paska Lake (072) P3	35
	Paska Lake (072) P4	36
	Paska Lake (072) P5	37
	Watson Larson	38

Table 2.2. Fuel treated replicates from the Kamloops Fire Zone Project Inventory randomly selected for quantitative assessment.

LOCAL GOVERNMENT	FUEL MANAGEMENT PROJECT
CITY OF KAMLOOPS	Pratt Road Block 2 (050)
LOGAN LAKE	Block 5
THOMPSON NICOLA REGIONAL DISTRICT	Evergreen Lac Le Jeune Watson Larson

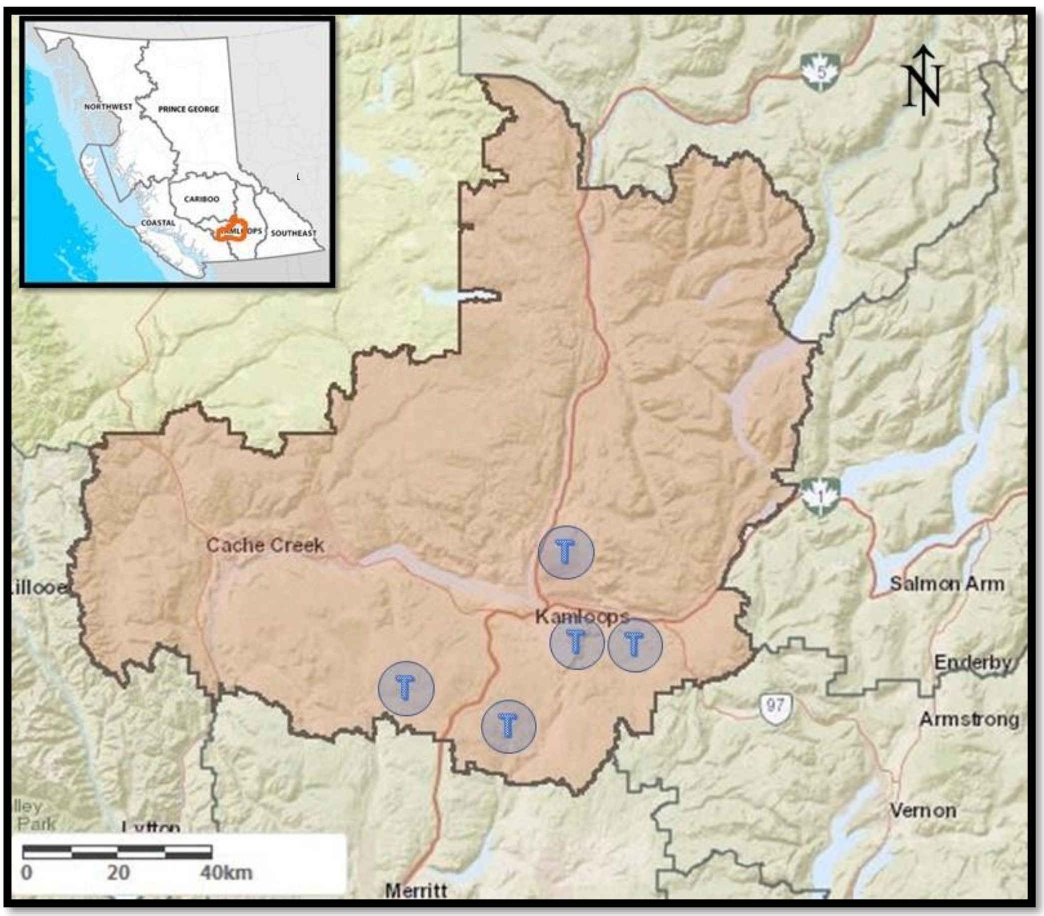

Figure 2.2. Relative location of the five randomly selected treatment areas marked by an encircled "T", relative to the City of Kamloops (from west to east Logan Lake Block 5, Lac Le Jeune, Evergreen, Pratt Road Block 2, Watson Larson).

Determination of Untreated (Control) Replicates

The untreated, or control, replicates were determined using a trisection of three overlapping geographical data sets. The online mapping platform iMapBC was used to identify private properties within WUI communities of the Kamloops Fire Zone that are adjacent to Crown land parcels that have no documented fuel management treatment and are within two-kilometer spotting distance areas, as defined in the 2007 Provincial Strategic Threat Analysis Kamloops Fire Centre WUI Spotting Potential Map (Figure 2.3). Only five communities, all under the governance of the Thompson Nicola Regional District, were identified that met each of the three criteria (Table 2.3, Figure 2.4).

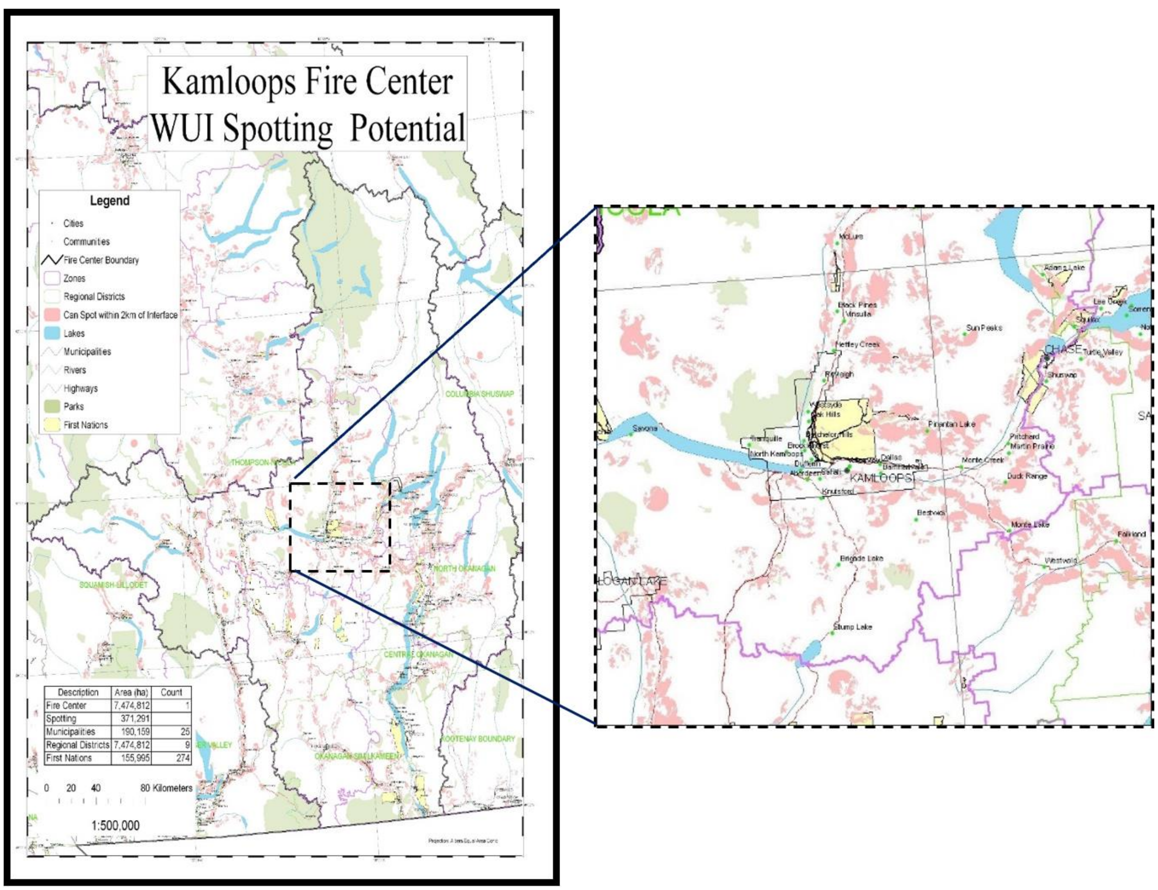

Figure 2.3. 2007 Provincial Strategic Threat Analysis Map of Kamloops Fire Centre WUI Spotting Potential. Excerpt on the right displays area of central interior around the City of Kamloops. Polygons colored in light pink are areas within 2 km spotting distance of interface areas.

Table 2.3. Untreated replicates determined from communities identified within the Kamloops Fire Zone as being within the WUI, adjacent to untreated Crown land and within 2-kilometre distance spotting areas as defined by the 2007 Provincial Strategic Threat Analysis Kamloops Fire Centre WUI Spotting Map.

LOCAL GOVERNMENT	COMMUNITY
THOMSPON NICOLA REGIONAL DISTRICT	Walloper Lake Pinitan Lake Fir Road East Barriere Lake South East Barriere Lake North

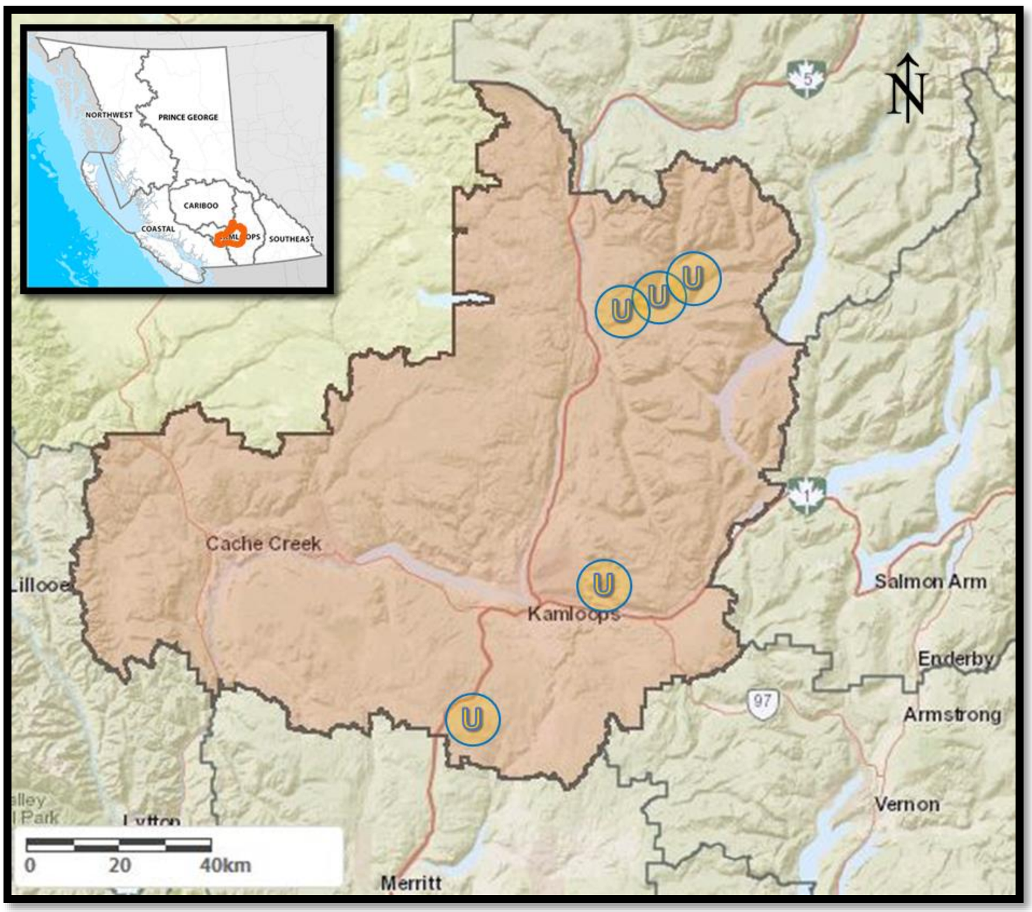

Figure 2.4. Relative location of the five untreated areas marked by an encircled “U”, relative to the City of Kamloops (from west to east Walloper Lake, Pinitan Lake, Fir Road, East Barriere Lake South, East Barriere Lake North).

Sampling within Replicates

Within each replicate, all adjacent private land parcels were identified (Figure 2.5, Figure 2.6). Those parcels measuring 0.10 hectares (0.25 acres) and smaller were excluded from further assessment as previous research has demonstrated statistically significant differences in mitigation levels in relation to lot sizes (Brenkert-Smith et al. 2012). Hazard assessment was conducted on location and access to sampling sites was made through Crown land. Sites were established at the approximate mid-point of the boundary between each of the private land parcels and Crown land treatment area (Figure 2.5 and 2.6). For each fuel treatment replicate, a minimum of 5 sampling sites were established.

The centre of the sampling site was the location from which hazard assessment of public and private land occurred. All data was recorded with the aid of a Private/Public Interface Hazard Assessment Form (Appendix A). Each sampling site was given a unique identifier based on the replicate name and the number of the sample. The physical location was then determined using a Garmin HCX hand-held GPS; coordinates were recorded in degrees and minutes notation along with the associated accuracy error. Elevation of the site was recorded in metres. Defining the sampling area for hazard assessment was then carried out by projecting a circle with a 30-metre radius from the centre of the sampling site with the aid of a Nikon 550 Forestry laser range finder. Half of each circle extended into the private land parcel while the other half extended into the treated Crown parcel (Figure 2.5 and 2.6).

Evaluating the wildfire hazard for each half of the sampling sites was then completed using an adaptation of the wildfire hazard assessment system described in FireSmart Protecting Your Community from Wildfire (Figure 2.7) (Partners in Protection 2003). This adaptation of the area hazard assessment form was focussed on the forest vegetation, surface vegetation and ladder fuel components of the assessment exclusively as direct comparison of vegetation can easily be made between the public and private lands. Slope and setback from slope are important contributory factors assessed in regular hazard assessment but are unable to be altered and were therefore not considered in this study. Likewise, assessment of structural characteristics and location of combustibles are also important elements of a regular wildfire hazard assessment but were beyond the scope of this study and were not assessed.

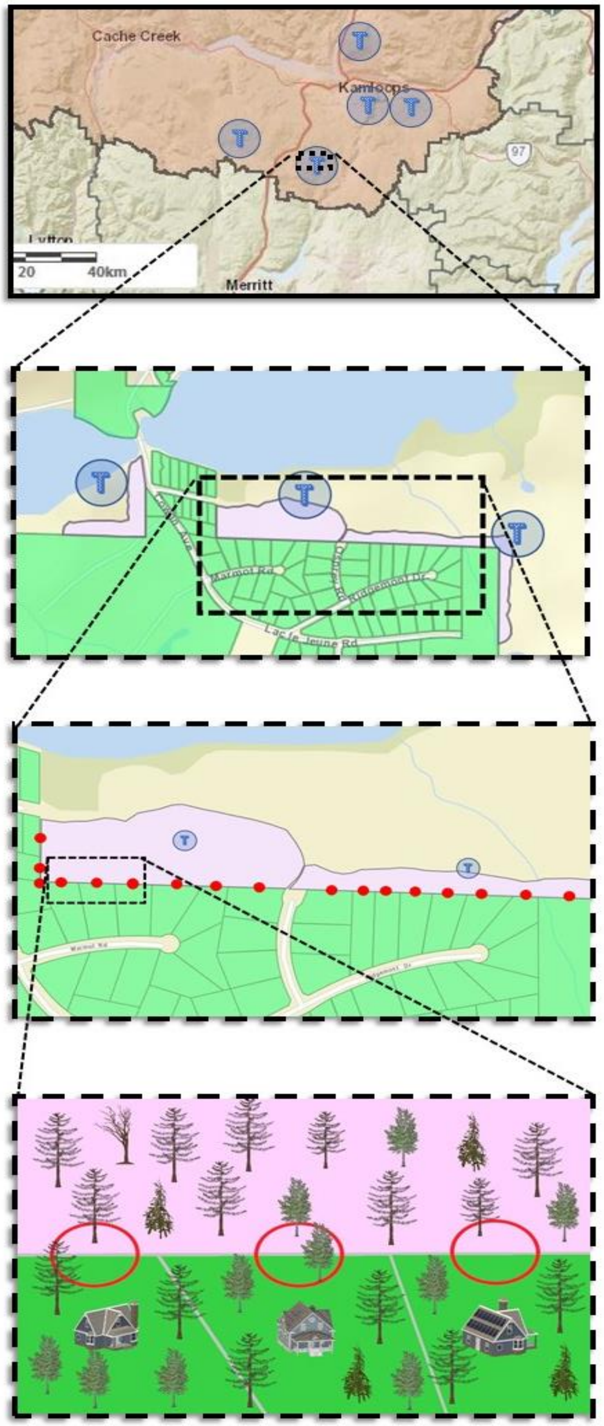

Figure 2.5. Sampling within treated replicates. All private land parcels (green) adjacent to treated Crown land parcels (pink) were identified. Those measuring 0.10 hectares or less were excluded. A sampling site was established at the approximate mid-point of the boundary between the private land parcel and the Crown land parcel. Hazard assessment for the private and Crown land halves was then conducted in a 30-metre radius from the sampling site.

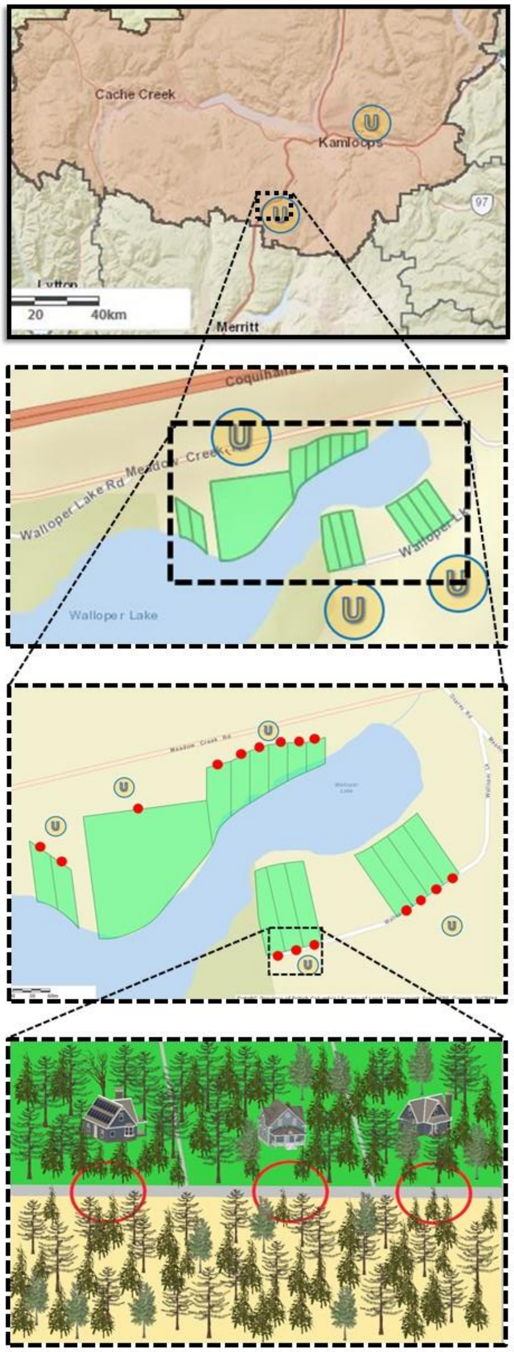

Figure 2.6. Sampling within untreated replicates. All private land parcels (green) adjacent to untreated Crown land parcels (yellow) were identified. Those measuring 0.10 hectares or less were excluded. A sampling site was established at the approximate mid-point of the boundary between the private land parcel and the Crown land parcel. Hazard assessment for the private and Crown land halves was then conducted in a 30-metre radius from the sampling site.

Criteria	Characteristics and Point Rating				Score
Forest Vegetation (overstory)	Deciduous	Mixed Wood	Coniferous		
			Separated	Contiuous	
	0	15	15	30	
Surface Vegetation	Lawn or non-comubistible	Wild grass or shrubs	Dead and down woody material		
			Scattered	Abundant	
	0	5	5	15	
Ladder Fuels	Absent	Scattered	Continuous		
	0	5	10		
				Total Score for Criteria	
				Hazard Level	

Hazard Level   Low < 13   Moderate 13-21 High 22-27   Extreme >27

Figure 2.7. Adaptation of Area Hazard Assessment Form with modified hazard level ranges (Partners in Protection 2003).

Point ratings were recorded for forest vegetation, surface vegetation and ladder fuels. Forest vegetation, or over story, was categorized as deciduous if greater than 90 percent of the assessed stand was deciduous. Mixed wood describes those stands greater than 50 percent deciduous and less than 50 percent coniferous. Coniferous stands are greater than 50 percent coniferous; separated coniferous stands have a low stand density where trees are widely- spaced and Crowns do not touch or overlap. Continuous coniferous stands are those with a high stand density where trees are tightly-spaced and Crowns frequently touch or overlap.

Surface vegetation could consist of lawn or non–combustible material or wild grass or shrubs. It may have also been dead and down woody material. These are considered scattered if groups of logs, branches and twigs are widely spaced, separated by 3-5 metres or more. They are considered abundant if groups of logs, branches and twigs are continuous or nearly continuous.

Ladder fuels are shrubs, immature trees and branches extending to the ground. Trees with branches extending within 2 metres of the ground have ladder fuels. Ladder fuels are considered absent if fewer than 25 percent of trees on site have ladder fuels, scattered if 25-75 percent of the trees on site have them and abundant if more than 75 percent of trees have ladder fuels.

Total scores were recorded, and a photograph of the private land half and the Crown land half of the sampling site was taken using a Panasonic Lumix point and shoot digital camera.

Eliminating the criteria of slope and position of slope in the adaptation of the area hazard assessment form required a corresponding adjustment of the previously established ranges for each hazard level. As the maximum contribution made by slope and slope setback to the overall area hazard score is 15 and the minimum contribution is 0, the average of 8 (rounded up from 7.5) was the total by which each hazard level and threshold was reduced for this study. Hazard assessment scores were considered low if less than 13, moderate from 13 to 21, high from 22 to 27 and Extreme if greater than 27. Areas are not considered FireSmart unless they obtain low or moderate assessment scores (Partners in Protection 2003).

Statistical Analysis

Mean hazard scores were determined for public and private land for each fuel treated and untreated (control) replicate (Table 2.4). This data set was then analyzed using a two-way ANOVA in the statistical package R to compare the mean differences between the two independent variables land type (public, private) and treatment on public or Crown land (treated, untreated) and to understand if there is an interaction between the two independent variables on the dependent variable (mean hazard score).

Table 2.4. Mean hazard scores for public land and private land portions of for fuel treated and untreated replicates.

Fuel Treated			Untreated (Control)		
Replicate	**Public Land Mean Hazard Score**	**Private Land Mean Hazard Score**	**Replicate**	**Public Land Mean Hazard Score**	**Private Land Mean Hazard Score**
Pratt Road Block 2	21	34	Walloper Lake	38	41
Logan Lake Block 5	16	19	Pinitan Lake	36	29
Evergreen	16	21	Fir Road	40	40
Lac Le Jeune	40	28	East Barriere Lake South	42	42
Watson Larson	19	8	East Barriere Lake North	43	39

RESULTS

Statistical analysis using R determined that treatment on the land base (treated or untreated) had a significant effect. Treated public and private property hazard scores were not significantly different from each other (Figure 2.8), nor were those of untreated public and private properties. Sites that had been treated had a significantly lower hazard score than those that had not been treated (p = 0.0015). The land type, public or private did not have a significant effect as hazard scores were not different by land type (p = 0.74). In addition, the land type by treatment did not have a significant effect (p = 0.84).

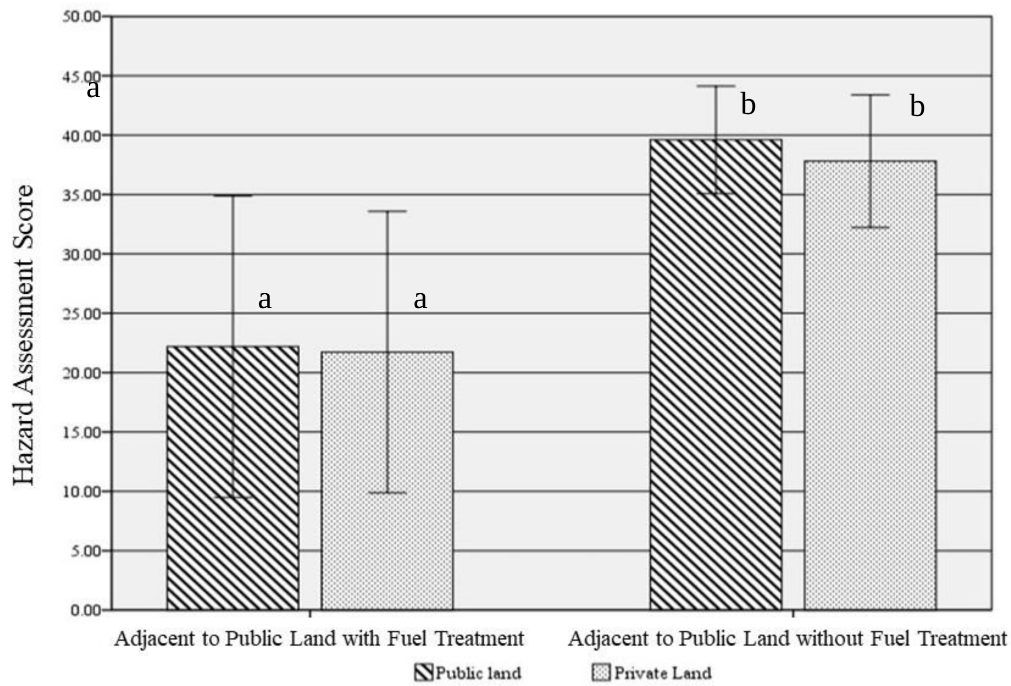

Figure 2.8. Mean hazard assessment scores by land type. Different letters on bars indicate a significant treatment effect. Sites that have been treated have a significantly lower hazard assessment score than those that have not been treated (p = 0.0015). Different letters indicate a significant effect.

DISCUSSION

The aim of fuel management in the wildland urban interface is to influence fire behavior potential by modifying the build-up of forest fuels and is part of the solution to reducing structural losses (BC 2003 Firestorm Provincial Review 2004; Partners in Protection 2003). During this study, hazard assessment scores were determined on public and private lands as a quantitative measure of the relative risk of fire impacts to that land. To reduce the loss of homes during incidents of wildland fire in the WUI, private land strategies are becoming more important to complement the current fuel management strategy on public lands (Brenkert-Smith et al. 2006; Mell et al. 2010; Penman et al. 2015; Reilly 2015).

Historical data confirms that fuel management has been undertaken on public lands within the Kamloops Fire Zone. However, there is currently no record maintained of individual homeowner participation in the FireSmart Canada program and by extension no record of the location or amount of private land treated (FBP 2015). Analysis of the data collected *in situ* for this study suggests that a treatment effect has occurred with the public land treatment. Treated public and private land showed no significant difference in hazard assessment scores, suggesting that the actions taken on public land were replicated by the adjacent private land owners. Private land owners appear to be copying what they see with respect to treatments. This finding contrasts the findings of Flanagan (2008) that found that community level wildfire management does not influence the intentions to adopt or adoption of wildfire mitigation measures by property owners. This difference may be attributed to the broader recipient group of the Flanagan study that targeted unspecific members of communities in which community level wildfire mitigation strategies were applied rather than treatment adjacent members of the community. They may also be attributed to the lack of any on site assessment of fuel management that had been occurring in the community by Flanagan.

This treatment effect is also seen in the untreated replicates. Untreated public and private lands showed no significant difference in hazard assessment scores, suggesting that the actions taken, or lack thereof, on public land were replicated by the adjacent private land owners. Private land owners see no mitigation occurring on public lands and copy what they are seeing.

The data also suggests that fuel management is lowering the hazard assessment scores of both public and private lands. Untreated public and private lands on average scored without exception in the extreme hazard range; in comparison those public and private lands in the treated category on average scored in the low, medium, high and extreme hazard range.

Notwithstanding the replication occurring, the variance of the scores and hazard ratings among the treated areas suggests that fuel management is not being carried out to the same standard in all locations. This can be attributed to several factors. Forests are dynamic systems in which growth from the onset of treatment to the time of assessment can change the overall fuel load and the corresponding hazard rating from low or moderate hazard to high or extreme. The biogeoclimatic zones of each site can influence the overall fuel load in addition to growth rates of the site’s plant communities (Meidinger and Pojar 1991). The fuel management prescription-the plan by which forests are manipulated and altered to achieve objectives- are also variable due to competing interests on the land base and the variability of the authors themselves. Inadequate treatment can be problematic, as it may not accomplish the objective to reduce fire behaviour to lower levels it was established to do. Likewise, the model it creates for the homeowner would be insufficient for any corresponding vegetation management on private land to enough to protect the home. It could mislead homeowners to falsely believe their homes are more protected than they are. The inadequacy of treatment is an issue that has been correlated to a general lack of guidance on what constitutes an effective treatment by the Forest Practices Board of British Columbia (FBP 2015).

Compounding the issues of inadequacies there have been opportunities lost. Under the Strategic Wildfire Prevention Initiative process there was a section for recording lessons learned that was made available to prescribing foresters or local governments (FBP 2015). Such lessons are crucial for improving best practices and avoiding unnecessary costs and the negative impacts of treatments. There is also no assessment criteria and no program currently in place to assess treatment effectiveness after a wildfire burns through a treated area (FBP 2015). Future research in post-fire assessment is critical to determine treatment adequacy.

CONCLUSION

In summary, this study has presented evidence that suggests private land owners are using the visual reference of adjacent Crown land treatments to guide their own fuel management practices. In addition, the degree to which these treatments are being conducted may not always be enough to lower hazard assessment scores to a low or medium hazard and be considered FireSmart.

These findings will be discussed further in the research conclusions, management implications and future research section of this thesis.

LITERATURE CITED

Abrams, J.B., Gosnell, H., Gill, N.J., Klepeis, P.J. 2012. Re-creating the rural, re-constructing nature: An international literature review of the environmental implications of amenity migration. Conservation and Society. 10: 270-284.

Agee, J.K. 1993. Fire ecology of Pacific Northwest forests. Island Press, Washington, D.C. 492 pp.

Blackwell, B.A. and Associates. 2014. Firesmart planning and practices assessment. North Vancouver (BC).

Brenkert-Smith H., Champ, P.A., Flores, N. 2006. Insights into wildfire mitigation decisions among wildland–urban residents. Society and Natural Resources. (19): 759–768.

Brenkert-Smith, H, Champ, P.A., Flores, N. 2012. Trying not to get burned: Understanding homeowners' wildfire risk-mitigation behaviours. Environmental Management. 50: 1139-1151.

British Columbia 2003 Firestorm Provincial Review. 2004. Firestorm 2003 Provincial Review. Vancouver, BC. 100 pp.

Bull, D., Moore T., Dougherty, M., Dawson, C., Gales, S., Payne, J., Putnam, T., Becker, S. 2007. Cascade Complex: Three days on the Boise, August 12-14, 2007. Accident Analysis. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Region. 119 p.

Faulkner H., McFarlane, B.L., McGee, T.K., 2009. Comparison of homeowner response to wildfire risk among towns with and without wildfire management. Environmental Hazards 8(1): 38-51.

[FBP] Forest Practices Board. 2015. Fuel management in the wildland urban interface-update. Forest Practices Board. Special Investigation Report 43. Victoria, BC. 34 pp.

Flanagan, H.M. 2008. Residential wildfire mitigation and management preferences in Alberta [thesis]. [Edmonton (AB)]: University of Alberta.

Government of British Columbia. 2017. Provincial strategic threat analysis: 2017 update. 51pp [online]. Available: ftp://ftp.for.gov.bc.ca/HPR/external/!publish/PSTA/Documents/Provincial%20Strategic%20Threat%20Analysis_2017%20Update.pdf [January 18, 2019]

Graham, R.T., Jain, T.B., Loseke, M. 2009. Fuel treatments, fire suppression, and their interaction with wildfire and its effects: The Warm Lake experience during the Cascade Complex of wildfires in central Idaho, 2007. Gen. Tech. Rep. RMRS-GTR-229. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 36 p. online: www.treesearch/pubs/33178

Haight, R.G., Cleland, D.T., Hammer, R.B., Radeloff, V.B., Rupp, T.S. 2004. Assessing fire risk in the wildland-urban interface. Journal of Forestry. 102(7), 41-48

Hammer, R., Radeloff, V., Fried, J., Stewart, S. 2007. Wildland–urban interface housing growth during the 1990 in California, Oregon, and Washington. International Journal of Wildland Fire. 16. 255-265. 10.1071/WF05077.

[Hansard] British Columbia Legislative Assembly. 2014. May 6 debate – morning sitting. Volume 12: 1. p. 3517.

Hope, G.D., D.A. Lloyd, W.R. Mitchell, W.R. Erickson, W.L. Harper and B.M Wikeem.

1991a. Ponderosa pine zone. In: Meidinger, D. and J. Pojar (eds). Special report series 6 ecosystems of British Columbia. Research Branch Ministry of Forests. Victoria, BC. pp. 139-151.

Johnston, L.M., Flannigan, M.D. 2017. Mapping Canadian wildland fire interface areas. International Journal of Wildland Fire 27, 1-14. Meidinger, D. V. and Pojar, J. 1991. Ecosystems of British Columbia. Research Branch, Ministry of Forests (Special report series (British Columbia. Ministry of Forests): no. 6).

Meidinger, D. V. and Pojar, J. (1991) Ecosystems of British Columbia. Research Branch, Ministry of Forests (Special report series (British Columbia. Ministry of Forests): no. 6).

Mell, W., Manzello, S., Maranghides, A., Butry, D., Rehm, R. 2010. The wildland-urban interface problem – current approaches and research needs. International Journal of Wildland Fire. 19. 10.1071/WF07131

MNP LLP. 2016. Review of Alberta agriculture and forestry's wildfire management program and the 2015 fire season volume 2: Detailed report. Edmonton, AB.

[MoF] Ministry of Forests. 1995. Biodiversity Guidebook. 1pp. [online]. Available: http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/biodiv/biotoc.htm [October 26, 2018].

[MoFLNRO] Ministry of Forests, Lands and Natural Resource Operations. 2015. Provincial Strategic Threat Analysis. 1pp. [online]. Available: https://ground.hpr.for.gov.bc.ca/provincialstrategicthreatanalysis.htm [January 7, 2015]. Cited in text as MoFLNRO 2015.

Morrow, B., Johnston, K. and Davies, J. 2013. Wildland Urban Interface Wildfire Threat Assessment in BC. Ministry of Forests, Lands and Natural Resource Operations

Partners in Protection. 2003. FireSmart: Protecting your community from wildfire. Partners in Protection, Edmonton, Alberta. pp 2-5.

Penman, T.D., Nicholson, A.E., Bradstock, R.A., Collins, L., Penman, S.H., Price, O.F. 2015. Reducing the risk of house loss due to wildfires. Environmental Modelling and Software. 67. pp 12-25.

Peter, B., Wang, S., Mogus, T., Wilson, B. 2006. Fire risk and population trends in Canada's wildland–urban interface. Pages 33–44 in K.G. Hirsch and P. Fuglem, Technical Coordinators. Canadian Wildland Fire Strategy: background syntheses, analyses, and perspectives. Canadian Council for Ministry of Natural Resources Canada, Canadian Forest Service, Northern Forest Centre, Edmonton, AB.

Pyne, S. J. (1997). Fire in America: A cultural history of wildland and rural fire. Seattle, WA: University of Washington Press

Radeloff, V., Helmers, D., Kramer, H., Mockrin, M., Alexandre, P., Bar-Masada, A., Bustic, V., Hawbaker, T., Martinuzzi, S., Syphard, A., Stewart, S. 2018. Rapid growth of the US wildland-urban interface raisers wildfire risk. Proceedings of the National Academy of Sciences. 115. 201718850. 10.1073/pnA.1718850115.

Reilly, B. 2015. Free riders on the firestorm: How shifting the costs of wildfire management to residents of the wildland-urban interface will benefit our public forests. Boston College Environmental Affairs Law Review. 42. pp 541- 576.

CHAPTER 3 – QUALITATIVE ASSESSMENT OF FUEL MANAGEMENT TREATMENTS ON PRIVATE LAND IN BRITISH COLUMBIA'S SOUTHERN INTERIOR

INTRODUCTION

A vast body of research suggests that fire activity is expected to increase in wildland urban interface areas of western North America over the next century (Abatzoglou et al. 2016; Moritz et al. 2013; Yue et al. 2013). This anticipated ramp-up is attributed to climatic change (Schoennagel et al. 2017; Haughian et al. 2012), the build-up of combustible forest fuels due to deterioration and degradation of forest stands and policies of fire exclusion (Gayton 2001; Kaufmann 2004; BC 2003 Firestorm Provincial Review 2004) and the continued expansion of communities into wildland areas in both rural areas and urban centres (Partners in Protection 2003). These three factors in concert have resulted in wildfires that have become costly to manage and more destructive (Stocks 2013). Fire in the WUI can also have severe negative impact on communities where daily life is being disrupted by smoke and/or the need to evacuate (Bowman 2012; Sullivan 2008).

During the period of 1970 to 2013, the average number of fires in the Province of British Columbia has declined, but the average number of hectares burned has steadily increased; to that five of the eight years that had the most hectares burned have occurred since 2003 (B.J. Stocks 2013). Over the same period, there has been a substantial loss of homes and structures. Seven homes were destroyed during the Swiss Wildfire near Houston, BC in 1983. In 1994, the Garnet Fire in Penticton, BC led to the evacuation of 3,500 people and destroyed 18 structures; the Fly Hills wildfire in 1998 caused the evacuation of approximately 7,000 people in the Salmon Arm, BC area and destroyed 40 buildings. In 2003, the McLure Wildfire forced the evacuation of 3,800 people from the communities of Louis Creek, McLure and Barriere and destroyed or damaged 72 homes and 9 businesses. Also, during the summer of 2003 the Okanagan Mountain Park Fire became the most significant interface wildfire event in British Columbia history at the time, causing over

33,000 people to evacuate and destroying or damaging 238 homes. The Kelly Creek Fire, southwest of Clinton, BC, led to the destruction of 2 homes in 2009 (BC Wildfire 2019).

The steady upward trend of hectares burned and structural losses in BC suggests that the current strategy of minimizing the growing threat of wildland fire in interface areas by managing forest fuels may not be effective, and the risk to rural communities is virtually the same as it was in 2003 (Gray 2013). Research on the application of fuel management in the western United States further supports this assertion of fuel management limitations on a broad scale. Mechanical fuel treatments on U.S. Federal lands during the period of 2001-2015 totalled almost 7 million hectares, but the annual area burned continued to set records (Schoennagel et al. 2017). Regionally, areas burned were influenced very little by areas that were treated, rather they were influenced by patterns of drought and warming (Westerling et al. 2006; Dennison et al. 2014; Abatzoglou and Williams 2016). Forested areas greatly exceed the number of areas treated, so it is relatively rare that treated areas experience wildfire (Boer et al. 2015). During the period of 2005 to 2014, on average a mere 1% of areas that received fuel management treatments by the United States Forest Service experienced wildfire (Shoennagel et al. 2017). The effectiveness of fuel management treatments may last between 10 and 20 years, depending on the fuel type, further suggesting they may have little influence on wildland fire (Kalies and Kent 2016). Implementing fuel management treatments has also been challenging and costly (Association 2015; Calkin et al. 2015; North et al. 2015; Hessburg et al. 2016). From the period of 2006 to 2015, funding allocated to the U.S.F.S for fuel management treatment totalled 3.2 billion dollars. In addition, since 1984, only 40% of areas burned have been forested, the majority being grasslands and shrublands.

In consideration of the limitations of broad-based fuel management practices, fuel management treatments on private land are key to the success of any hazard mitigation strategy (Reinhardt et al. 2008; Partners in Protection 2003). Treating fuels in areas adjacent to homes may not be necessary or effective to suppress fires before they reach homes, instead it is the treatment of fuels immediately proximate to residences and the degree to which residential structures themselves can ignite that determine their vulnerability to wildland fire (Reinhardt et al. 2008). Embers cast during combustion as far as two kilometres away are more likely responsible for one half to two-thirds of home ignitions on large interface fires (Cohen

2000; Cohen and Stratton 2003; Maranghides and Mell 2009; Mercer and Zipperer 2012) despite the generalized belief that flame fronts along with radiant heat are responsible for home ignitions. Home ignition occurs when embers then come into contact with flammable materials outside of a structure, or with the home itself (Westhaver 2015).

The development of FireSmart: Protecting Your Community from Wildfire by Partners in Protection, the multidisciplinary association established in Alberta in the 1990's, was done with this objective in mind, to provide individual home owners and communities across Canada with the information and tools required to engage in mitigation work on their own properties, within 30 metres of their homes (Partners in Protection 2003). Fire organizations in Canada, Australia and New Zealand have all adopted the standards provided in the FireSmart manual as strategies to mitigate wildfire risk in the WUI (Walkinshaw et al. 2012).

Notwithstanding the national and international adoption of FireSmart standards, individuals and communities have not been quick to adopt such practices (Ergibi 2018). In one recent study of national FireSmart adoption, most respondents had never heard of FireSmart, although these individuals were categorized as predominantly urban, not threatened by fire and living east of the Province of Manitoba (Ergibi 2018). Within British Columbia, the results of this study were somewhat ambiguous, with only 38% of the 272 respondents overall having familiarity with FireSmart (Ergibi 2018). In another recent study, despite the recognized risk of wildland fire in the WUI and the overwhelming acknowledgment that individuals should being doing to mitigate the risks, there is no indication of FireSmart adoption at the individual level (Daniels et al. 2018).

It has been demonstrated that public acceptability of fuel reduction programs such as prescribed fire and thinning can be enhanced through formal, such as education and public outreach, or informal channels, such as personal experience or word of mouth (Brunson and Shindler 2004). In this study I will build on the results of chapter 2 which has suggested that home owners are more inclined to engage in fuel management treatments on their own properties if they experience them first hand on adjacent Crown lands by filling in knowledge gaps on FireSmart uptake and additional motivations behind treating their properties. This study will also help identify potential obstacles to fuel mitigation work, identify trends, determine the influence of demographic factors and examine risk perception as it applies to public action. Does the perception match the reality of what we are seeing?

METHOD AND MATERIALS

Sample Selection and Survey Delivery

A mail out survey was chosen as the most suitable method of qualitatively assessing underlying trends in the attitudes, motivations and actions of landowners when choosing to engage, or not to engage, in fuel hazard reduction on their own properties. Although face-to-face interviews would likely have allowed for more in-depth discussion of the survey questions and for immediate clarification, time and resource constraints would have considerably limited the sample size.

The total sample size of 118 private residences was determined entirely by the five fuel-treated and five untreated replicates selected at random in the field study. Each of the private properties adjacent to the replicate areas, regardless of size and including those that had undergone an on-site wildfire hazard assessment during the field study, were targeted to receive a survey. Surveys and cover letters were mailed out in envelopes containing a postage-paid return envelope stamped with a postage stamp to the 118 private residences in June 2016. Mailworks, a third-party mailing service was employed to work with the residential addresses and to add codes to the surveys to maintain confidentiality and provide linkage to the specific fuel-treated or untreated replicate from which the survey was returned. Confidentiality was assured to respondents so that they would feel comfortable expressing their opinions concerning neighbours or government organizations. The linkage to the specific treatment area enables better statistical analysis of regional differences in responses. Full disclosure regarding coding was made clear to survey recipients on both the cover letter and the surveys (Appendix B).

A reminder postcard was sent 14 days after the initial mailing (Appendix C). The postcard and cover letter also contained direct contact information (name, email address, phone number) of the researcher. Prize rewards as incentive to complete the survey and increase response rates among were considered but ultimately decided against to preserve confidentiality of the responses.

Survey Design

The survey design was reproduced and adapted from similar research that had been conducted into residential wildfire mitigation and management preferences in the Province of Alberta (Flanagan 2008). Its purpose was to aid in understanding the attitudes, perceptions and motivations of private land owners within fuel treated and non-treated areas of the wildland urban interface using guidelines recommended by literature in the field of survey methodology (Rea and Parker 2005).

Questions were grouped into six sections (wildfire risk, wildfire awareness, your property and wildfires, how wildfires should be managed, you and wildfires, and you and your community) with response options remaining consistent throughout the survey.
The final version of the survey was comprised of these six sections. Questions in the first section focussed on how at-risk respondents felt from wildfires and other hazards to themselves, their property and to their community. The second section focussed on respondent's general knowledge about wildfire. The next section asked about activities that could be used to prepare homes and properties for wildfire. The fourth section focussed on respondent's opinions of management approaches that may be used to reduce the potential impacts of wildfire. Section five of the survey asked about personal experiences with wildfire and wildfire management. The sixth and final section looked at determining if there are connections between people's characteristics and their opinions (Appendix B).

Human Ethics Approval

Permission from the Thompson Rivers University Human Ethics Committee was required prior to contacting any potential survey respondents. Information that could be used to identify potential respondents was maintained in a secure manner and be accessible only to those directly involved with this project (Certificate of Approval #101-195).

Survey Rate of Return

From the total of 118 surveys delivered to private residences, a total of 26 were filled out and returned, representing an overall rate of return of 22%. Returns were equal from the properties adjacent to treated and to untreated public land areas at 13 each, or 11%.

RESULTS

Perceived Risk from Natural Hazards including Wildfire

Wildfires and other hazards can affect people and communities in British Columbia. When asked how much of a risk was posed by these hazards in the next 5 years, respondents in treated and untreated areas answered quite comparably. They both acknowledged that wildfires represent a significant risk to themselves and their property, their community and the natural environment and that the risk was greater than average.

Surveyed property owners were then asked to assess how controllable wildfires are in terms of people's ability to control their impacts to their properties, their communities and the natural environment. In both the treated and untreated areas, respondent opinions on the ability to control wildfire impacts were not different with respect to their property and their communities but suggested a greater perception of an inability to control wildfires in the natural environment. Both groups strongly indicated that wildfire impacts were not acceptable on their properties or in their communities. This feeling did not carry through to the natural environment, as respondents in the treated area were more far more willing to accept the impacts of wildfire than those that resided adjacent to the untreated areas. As well both respondent groups felt higher than average negative emotion, including anger and fear, when asked to think about wildfires and their impacts on themselves, their families and their properties. Both groups also believed that the likelihood of a wildfire occurring near their communities in the next year was greater than average, with those adjacent to the treatment areas feeling the likelihood was greater than those who resided adjacent to non-treatment areas.

Wildfire Awareness

To assess the respondent's general awareness around wildfires, property owners were asked how often they thought and talked about wildfires, their knowledge about the characteristics of fire and its interaction with the physical world and where further information concerning wildfire has been sourced from.

Wildfires are both thought of and talked about more frequently than a few times a year by respondents, and in both the treated and untreated areas people were relatively knowledgeable about fire, correctly responding to a series of questions relating to fire behaviour and impacts (Figure 3.1).

Respondents in both the treated and untreated areas had also sought out information about wildfires, their impact and preparing homes and properties (Figure 3.2). The internet was the dominant source of information for both groups. The Provincial forestry department was a significant source information for those residents in treated areas, whereas friends and relatives played a significant role of providing information in untreated areas. By contrast, no resident in the treated areas identified friends and relatives as a source of information about wildfire.

Knowledge of the term FireSmart differed between the two groups (Figure 3.3). Nearly 85% of those adjacent to treated areas were familiar with the term, whereas only 50% of homeowners in untreated areas were. How people were made aware of that term also differed between the two groups. Those homeowners in treated areas reported hearing about FireSmart primarily through radio and pamphlets or brochures whereas those residing in untreated areas were more likely to have heard about FireSmart in the newspaper or through television.

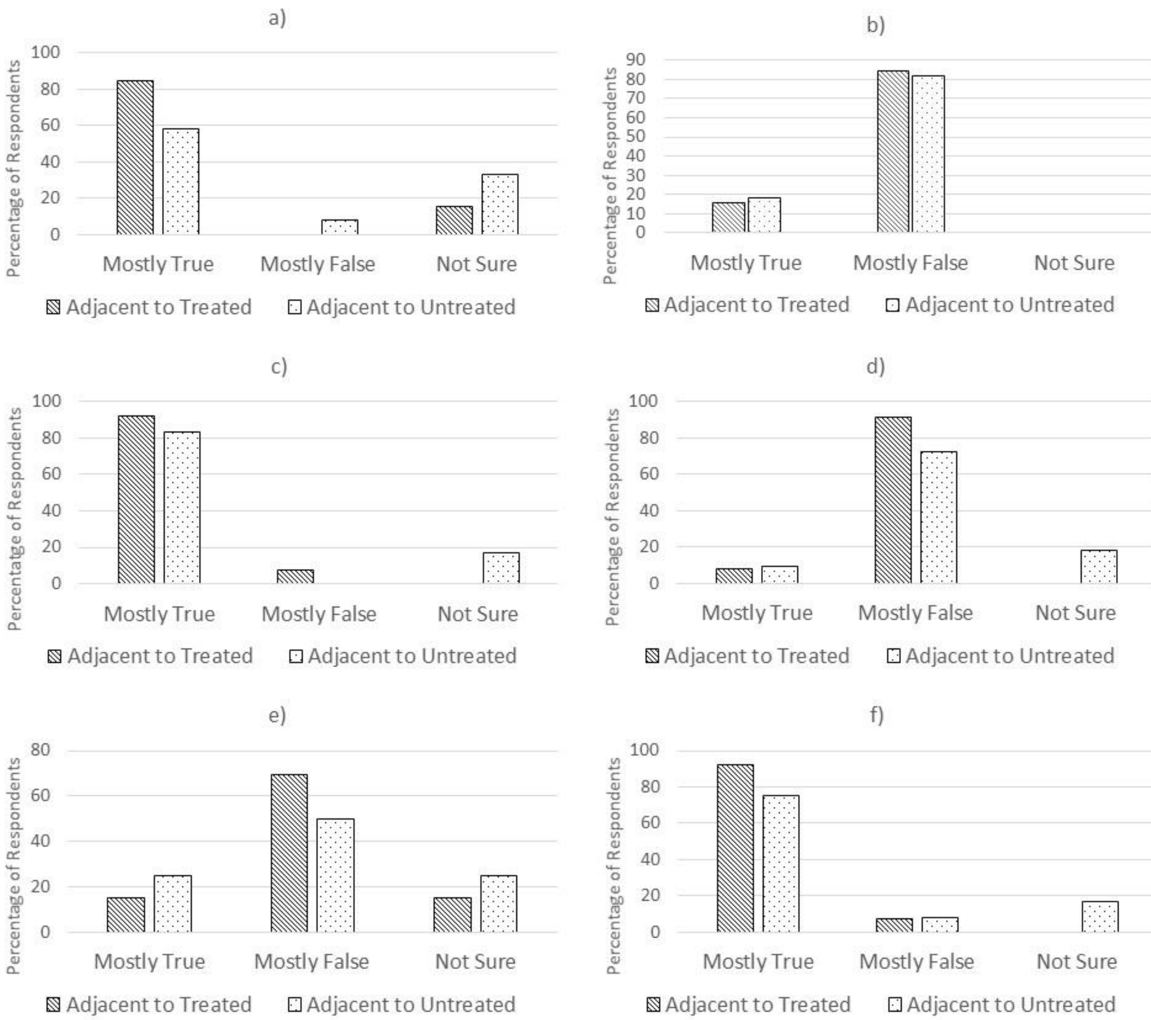

Figure 3.1. General wildfire awareness of respondents from fuel treated and untreated replicates: a) wildfires burn faster going uphill, b) houses only burn when flames from a wildfire reach the house, c) wildfires are important in controlling outbreaks, d) it takes decades for plants to grow in a fire damaged forest, e) wildfires usually result in the death of most animals in a burnt area and f) wildfire helps recycle minerals and nutrients.

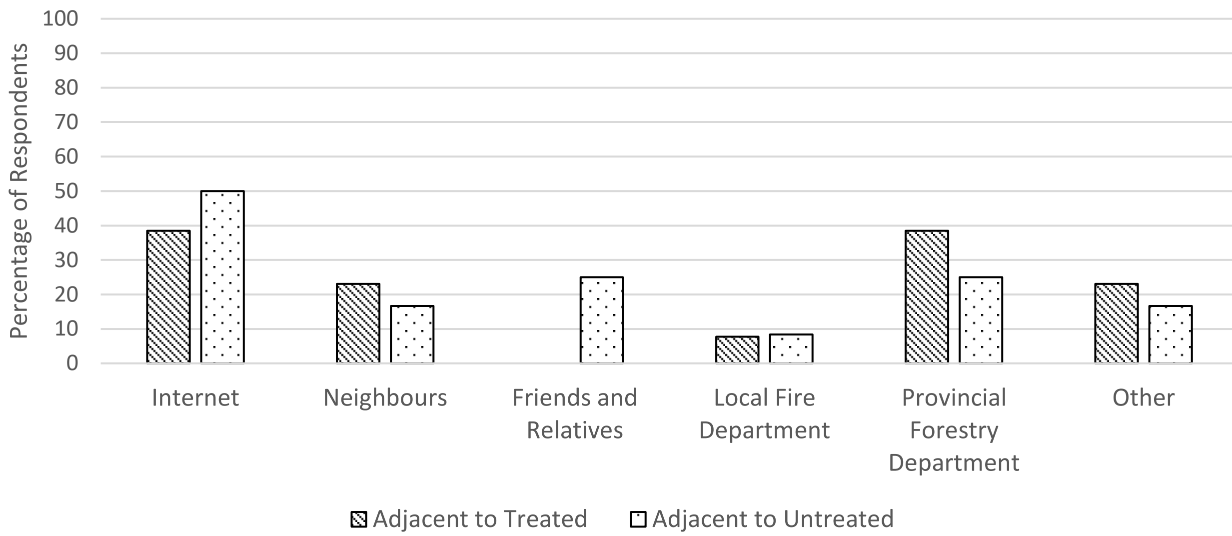

Figure 3.2. Information sources that landowners from fuel treated and untreated replicates have consulted for information about wildfires, their impact and preparing homes and properties.

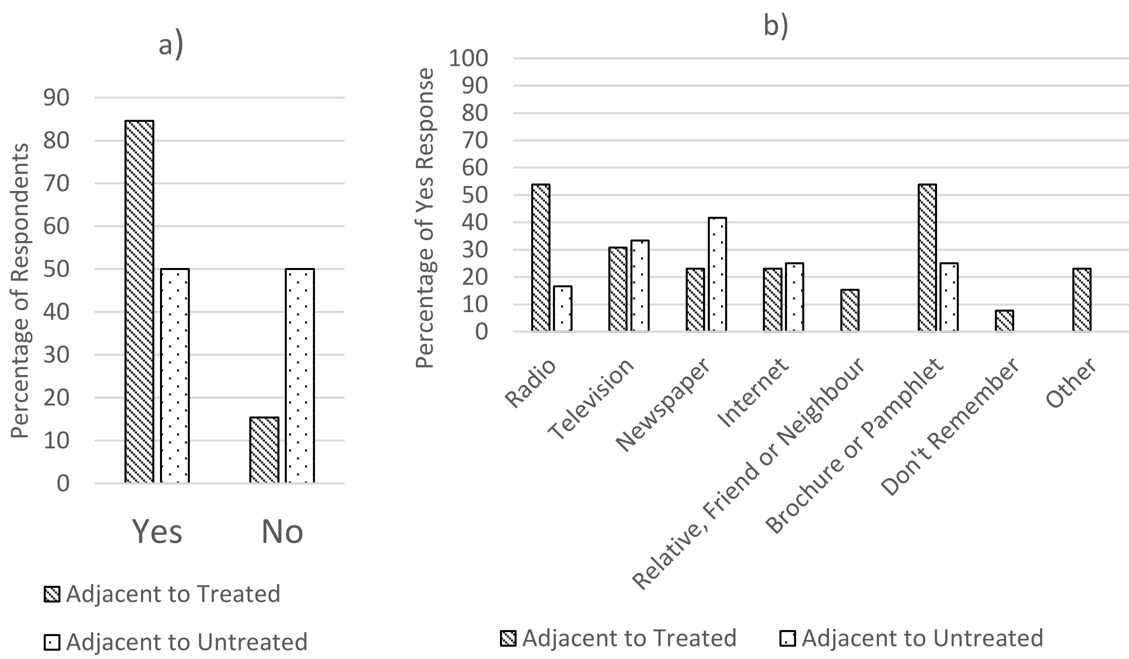

Figure 3.3. Familiarity from respondents from fuel treated and untreated replicates with a) the term FireSmart and b) information sources on FireSmart.

Preparing Homes and Properties for Wildfires

Residents were asked about Firesmart landscape and structural risk reduction activities that can be completed on and around residential properties to better prepare them for wildfires (Partners in Protection 2003). The adoption of these strategies and the intention to adopt them were measured for the respondents adjacent to treated areas and those adjacent to untreated areas. In both areas, the majority of property owners indicated they had either completed or were planning to complete within the next five years each of the queried Firesmart risk reduction activities with the exception of two: screening or enclosing the undersides of decks and porches, and installing stucco, metal, brick or other fire-resistant exterior siding on their homes was either not planned for or was determined to be not applicable by either group.

With respect to completing or planning to complete the FireSmart activities, there were noticeable differences in the levels of agreement between the two groups of respondents when asked about their motivations for doing so (Figure 3.4). Those homeowners adjacent to untreated areas felt they needed more information to complete FireSmart activities, whereas those adjacent to fuel treated areas did not. Those in the treatment areas also felt the activities were a priority for them, that friends and neighbours would also appreciate the completed work, and that completion of the FireSmart activities significantly reduces the damage to their house in the event of a wildfire to a greater degree than those home owners adjacent to untreated areas.

A similar difference in the level of agreement between the two groups was found when they were asked about possible obstacles to completing Firesmart treatments (Figure 3.5). Those adjacent to treated areas were more likely to disagree with the statements that they did not have the skills required to complete FireSmart activities, that when these activities were completed, they would feel less connected with nature and that wildfires were too destructive to bother preparing for than those respondents adjacent to the untreated areas.

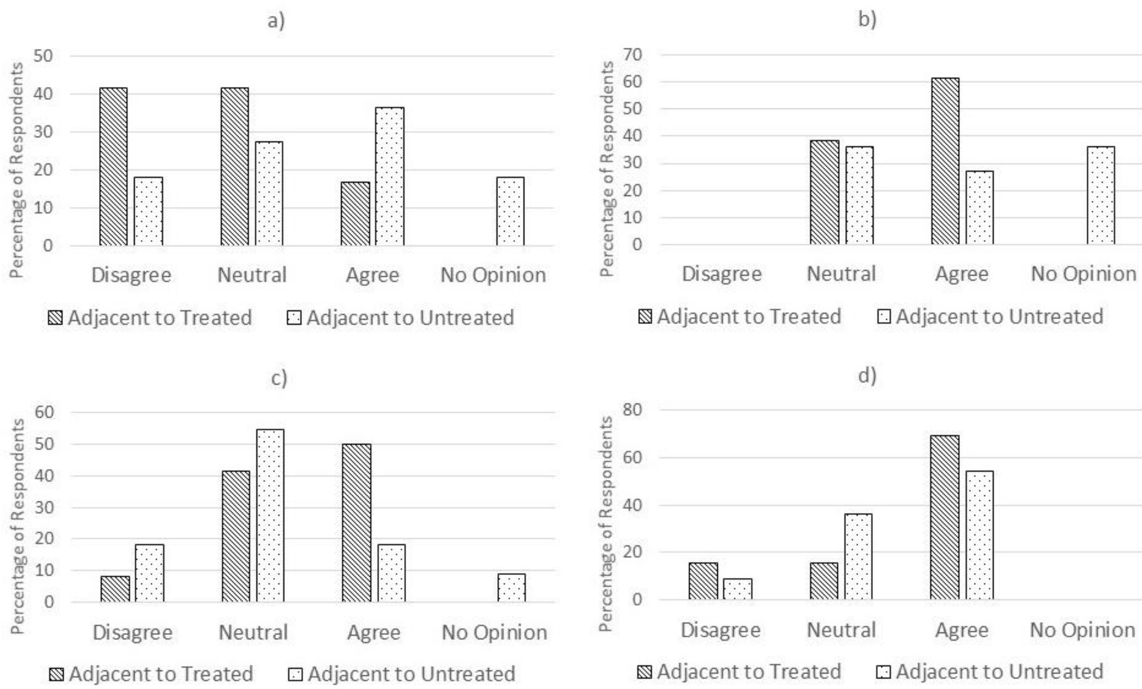

Figure 3.4. Motivations to complete FireSmart activities for the treated and non-treated groups a) need more information before I can complete some of these activities, b) If I made some or all of the suggested changes, my family and neighbours would like it, c) implementing these activities is a priority for me, and d) preparing for wildfires will significantly reduce damage to my house should wildfire occur.

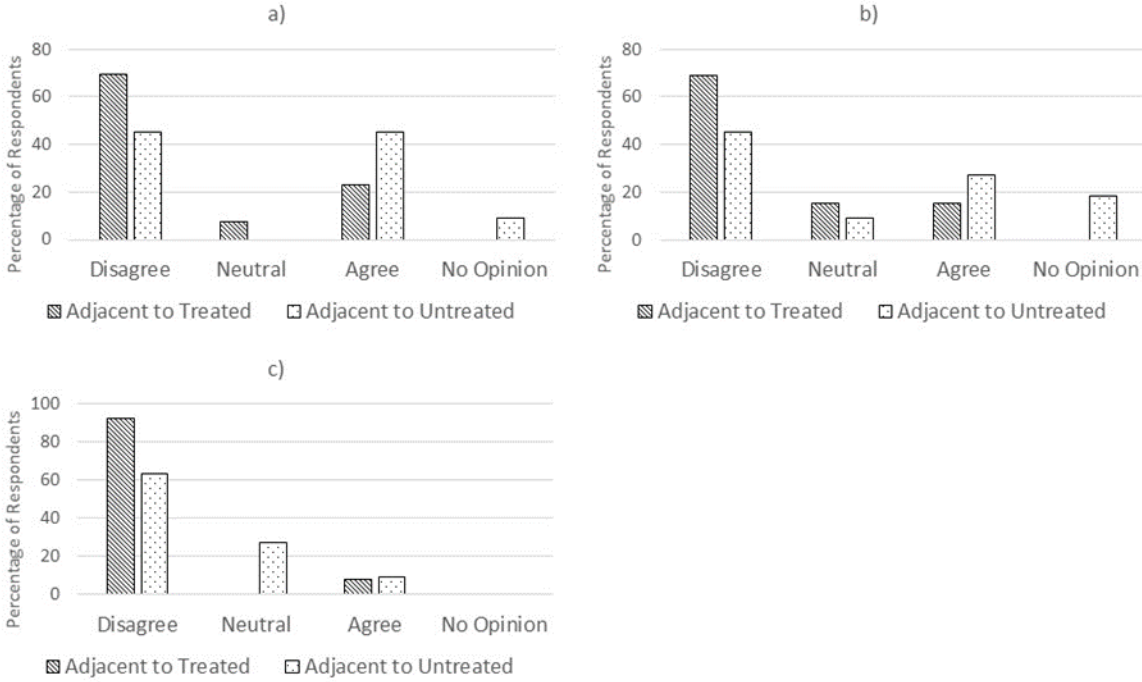

Figure 3.5. Obstacles to complete FireSmart activities for the treated and non-treated groups a) I do not have the skills to complete some of the recommended activities, b) If I made changes I would not feel as connected to nature, and c) wildfires are too destructive to bother preparing for.

The question of who owns the responsibility of reducing wildfire risks to their homes and property, well before a wildfire occurs, was asked of both groups. Responses were similar in both the treated and untreated areas and suggested the homeowners themselves and the Provincial Government share the bulk of responsibility, with the local and Federal governments and the local Fire Departments also having a responsibility, albeit to a lesser extent (Figure 3.6).

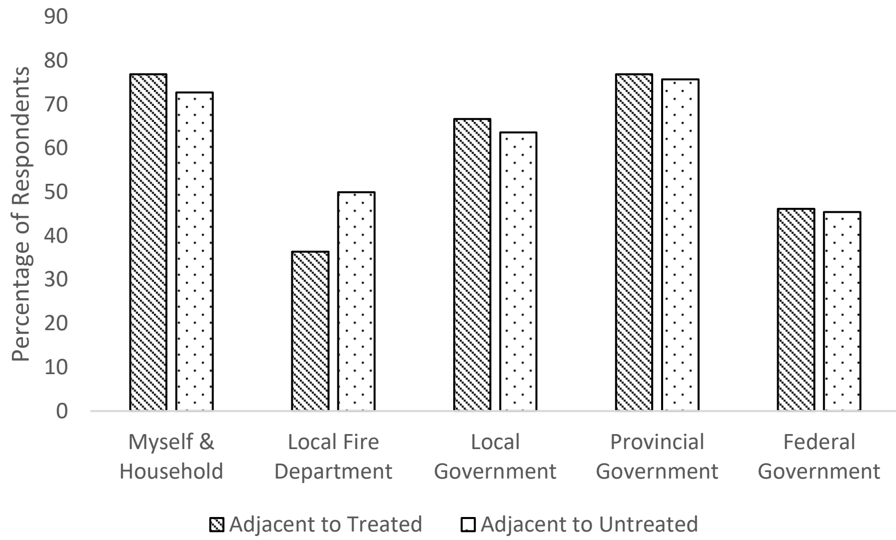

Figure 3.6. Perception of responsibility of reduction of wildfire risk in advance of wildfire occurrence from by homeowners adjacent to treated and non-treated areas of Crown land.

If homes were directly threatened by a wildfire, the likelihood that firefighters could protect them was thought of quite differently by the two groups. Most respondents adjacent to untreated areas believed that firefighters were unlikely to protect their homes, while those respondents adjacent to treated areas did not have a strong opinion either way.

When homeowners were asked if their property had a wildfire hazard home and site assessment done, all responded no, except for one living adjacent to an untreated area. This respondent indicated that the suggestions made by the assessment were completed.

Several ways to reduce the risk of wildfire to the community were cited in the survey. Both groups were asked about the extent to which they favoured or opposed these risk reduction tactics. All property owners were in favour of education about reducing wildfire risks on their property. The majority of those living adjacent to untreated areas were in favour of having bylaws in place requiring homeowners to remove shrubs, trees and dead branches close to their homes while most of the other group were opposed to these bylaws. Over 80% of both groups were in favour of reduced insurance premiums if the recommended activities are done. A strong majority (85%) of respondents adjacent to treated areas were in favour of neighbourhood work bees to help people prepare homes and properties for wildfires; conversely the minority of homeowners adjacent to untreated areas were in favour of this strategy. The option to have free wildfire hazard assessments for residential properties was in favour of nearly everyone in both groups, with a very small minority of respondents adjacent to untreated areas being somewhat opposed. An equal number of respondents (76.92%) from both groups were in favour of bylaws requiring new homes to be built with fire retardant building materials. Most respondents from homes adjacent to treated areas were opposed to restricting houses from being constructed in high risk areas, while the feeling amongst residents adjacent to non-treated areas was more impartial with only 38.46% being opposed to this strategy.

How should wildfires be managed?

Residents were asked to share their opinions on three different management approaches that may be used prior to ignition to reduce the potential impacts of wildfires: fireguards, areas of vegetation around communities that are cleared of combustible materials; thinning, the removal of selected trees in a forested area to reduce the continuity of combustible fuels and open the canopy to increase the effectiveness of aerial fire suppression tactics; and prescribed burning, the intentional burning of forest vegetation under controlled conditions such as firefighters on site to monitor burning conditions and conducting only during favourable weather conditions. Homeowners in treated areas were not only in greater favour of each of these tactics than their counterparts in untreated areas but they also believed in their effectiveness to a much greater extent (Figure 3.7).

When homeowners were asked if fireguards, thinning or prescribed burning was being done in and around their community, the majority of those in the treated areas responded yes, whereas the majority of those in the untreated areas answered no or were uncertain (Figure 3.8).

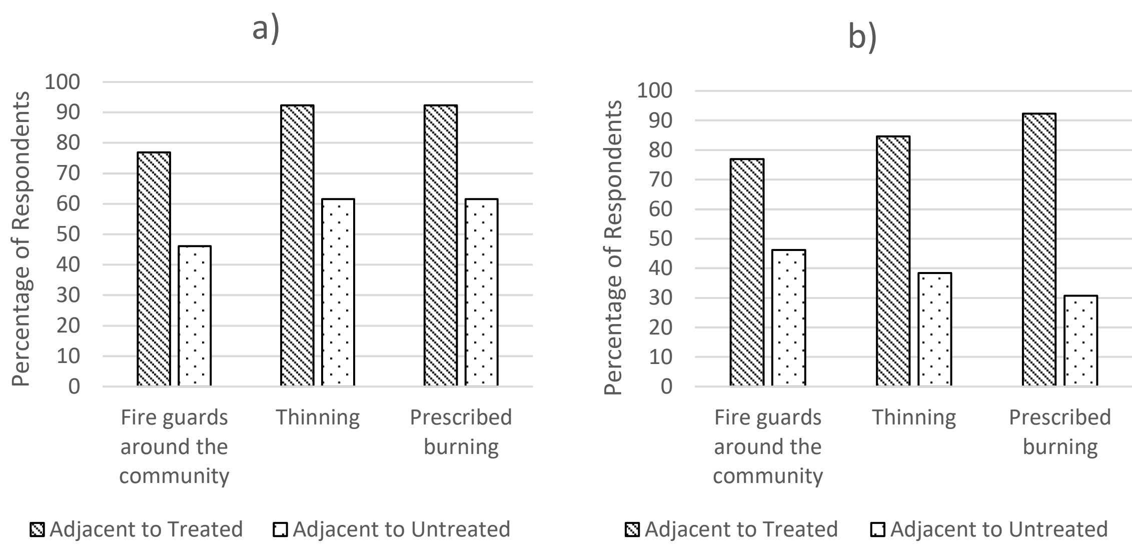

Figure 3.7. Response from people in fuel treated versus untreated areas regarding how wildland fires should be managed a) agreement with the tactics of fireguards around the community, thinning and prescribed burning, and b) belief in the effectiveness of fireguards around the community, thinning and prescribed burning.

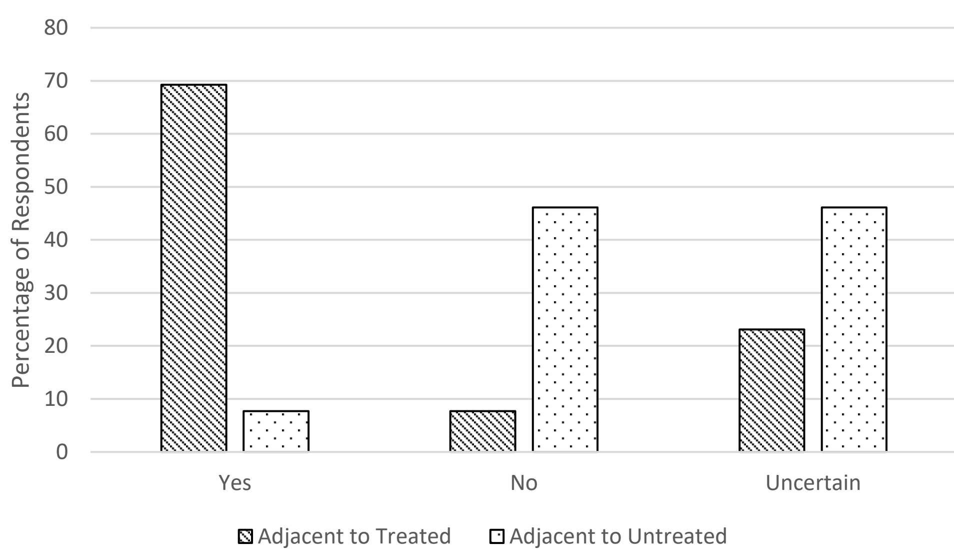

Figure 3.8. Awareness of fire management practices from respondents in fuel treated versus untreated areas in and around the community.

Wildfire management can also involve employing several different strategies once a fire begins. Wildfires can be allowed to burn themselves out, provided that human safety and public and private structures are not in danger. Wildfires can only be fought if the fire is likely to be intense and spread very quickly. Wildfires can only be fought if the fire is likely to burn large areas of land. Wildfire can also be fought as soon as they start, no matter what the cost.

Respondents were asked the extent to which they favoured each of these four selected strategies (Figure 3.9). The greatest disparity between the two groups stemmed from the strategies of allowing fire to burn itself out and fighting wildfire as soon as it starts, no matter the cost. Those homeowners in the treated areas were much more in favour of allowing fire to burn itself out if there was no danger to life or property and less in favour of immediate extinguishment of all fires. In contrast, homeowners in untreated areas were not in favour of allowing fire to run its course and burn itself out, opting to suppress fires as soon as they start, no matter the cost.

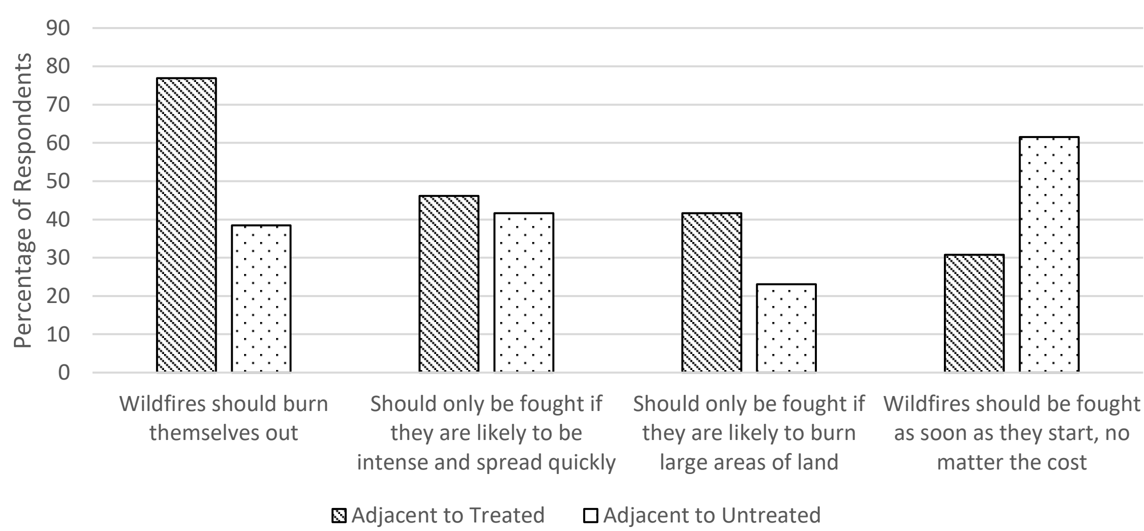

Figure 3.9. Favour of wildfire management tactics used post wildfire ignition from respondents from fuel treated versus untreated replicates.

You and Wildfires

To assess the personal of experiences of respondents with wildfires and wildfire management, survey recipients were presented with a list of wildfire experiences and asked which applied to them (Figure 3.10). Direct experiences with wildfire include feeling fear or anxiety, feeling physical discomfort of health problems, being placed on evacuation alert, being evacuated, experience or training in fire management, losing a house or other structure(s) on the property due to fire, seeing smoke or flames from a wildfire and indicating that a wildfire has come close to one's community. Indirect experience includes reading about or watching wildfire coverage in the media and knowing someone close losing a home due to wildfire. Over 90% of respondents from both groups indicated they had indirect experience with wildfire through media coverage. No respondents had lost a home due to wildfire, and only a small number of each group indicated that someone close to them had lost a home. Feeling anxiety and fear due to wildfire was directly experienced by 3 out of 4 members of both groups and both experienced the discomfort of health problems equally at almost 40%. Those respondents adjacent to untreated areas had more experience being on evacuation alert and being evacuated (62%, 54%) then did those respondents adjacent to treated areas (38%, 15%). Conversely, respondents adjacent to treated areas had more experience personally seeing smoke or flames from a wildfire near their community (77%) and having a wildfire coming close to their community (77%) than did those adjacent to untreated areas at 54% and 70% respectively. Although very few respondents had experience or training in wildfire management or as a firefighter (<15% in both groups), only a small percentage (15%) of respondents in each group claimed to have no experience with wildfire.

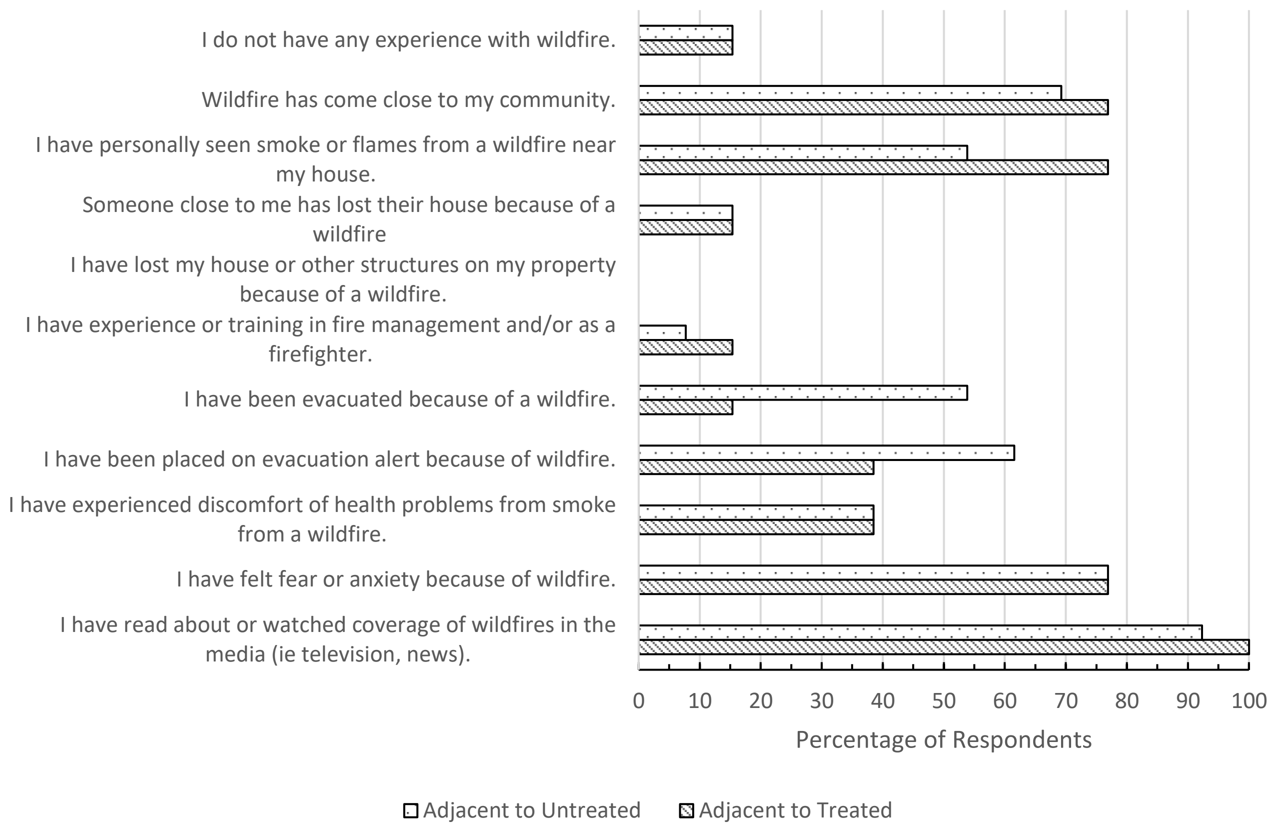

Figure 3.10. Percentage of respondents from fuel treated and untreated areas answering yes when asked about personal experiences with wildfire and wildfire management.

You and Your Community

In the final section, survey recipients were asked questions to determine if there are connections between characteristics of their personalities and their previously expressed opinions. Respondents were questioned about their general mindset and approach to managing daily issues and problems in life and asked to indicate their level of agreement with five related statements: I have considerable control over what happens in my life; I can solve most of my problems by myself; I sometimes feel helpless when dealing with problems; I try to come up with a strategy about what to do and; I think about how I might best handle the problem (Figure 3.11).

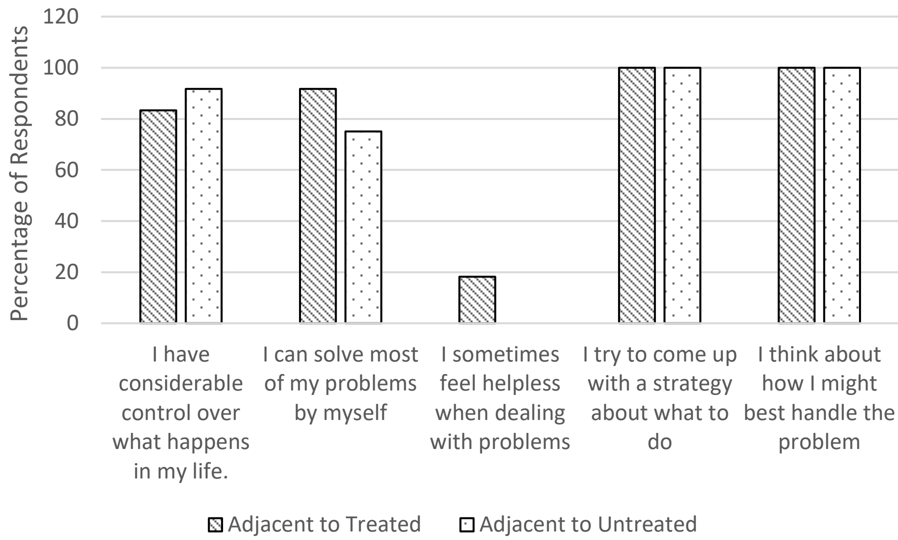

Figure 3.11. Percentage of respondents in areas with fuel treatment and areas without regarding agreeing to statements regarding general mindset and approach to managing daily issues and problems in life.

Homeowners in both treated and untreated areas were very similar in their responses, displaying a clear belief of considerable control over what happens in their lives, the confidence to solve problems on their own, the willingness to come up with a strategy to solve problems and the confidence to do so.

Respondents were also asked about their sense of community. Each homeowner was asked to indicate their level of agreement with statements that they often interact with other members of my community, they feel like I belong to this town and if they would move out of the community if given the opportunity (Figure 3.12). Those respondents in the treated areas displayed a higher level of agreement than those residing in the untreated areas, suggesting they interact more with members of the community, they feel as though they belong, and they would remain in the community if given the opportunity to move.

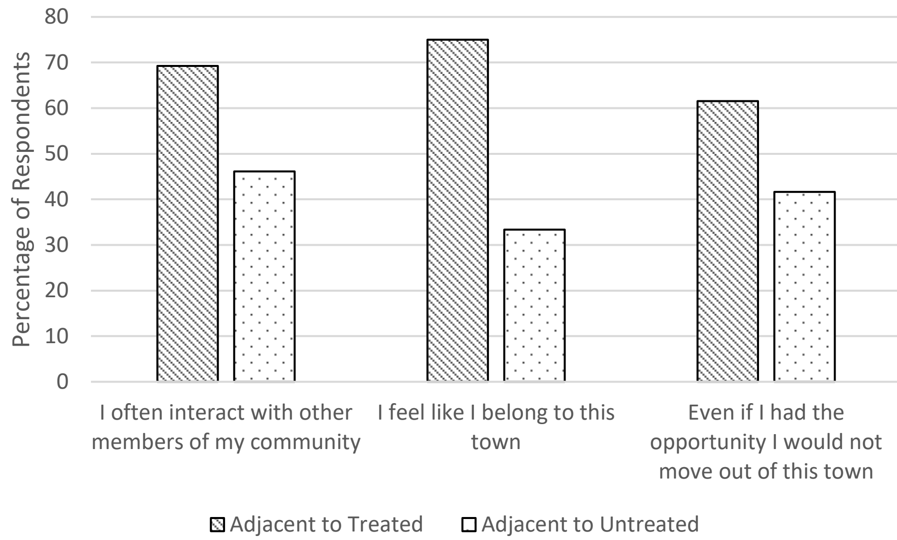

Figure 3.12. Percentage of respondents from fuel treated versus untreated replicates in agreement with statements indicating their sense of community.

DISCUSSION

Survey Use

At the research proposal stage of this experiment, ten replicates (5 treated and 5 untreated) were identified. Each replicate was estimated to have 20 to 50 adjacent private properties resulting in 200 to 500 surveys to be delivered. From the surveys delivered, I prepared for a minimum rate of return of 25% or 50 to 125 surveys and was optimistic of a more reasonable rate of return of 50%, or 100 to 250 surveys. The overall number of private properties was overestimated; from the 10 replicates 118 properties were identified. From that total of homes, 26 surveys were filled out and returned, representing an overall rate of return of 22%. At 22% the number of completed surveys was much greater than the 3.9% completion rate associated with a recent national awareness and adoption of FireSmart study by Ergibi (2018) but less than the 34% obtained by Flanagan (2008) in her study on residential wildfire mitigation and management preferences in Alberta.

Determining the appropriate addresses for homes in unincorporated areas was an obstacle that ultimately may have impacted the survey rate of return. Publicly available mapping layers that can be used in conjunction with common platforms such as iMap and Google Earth provide street addresses for land polygons. Canada Post, the mail carrier for Mailworks, would not translate street addresses to rural box addresses. As a result, many of the surveys sent out initially were returned to Mailworks. To circumvent this obstacle and re-send each survey returned with "incomplete address, undeliverable or moved", complete addresses were accessed through the Province of BC-Wildfire Management Branch.

Findings from the Qualitative Assessment

The purpose of the qualitative assessment was to build on the results of chapter 2 which has suggested that home owners are more inclined to engage in fuel management treatments on their own properties if they experience them first hand on adjacent Crown lands by filling in knowledge gaps on FireSmart uptake and additional motivations behind treating their properties. In addition, the survey component was conducted to help identify potential obstacles to fuel mitigation work, identify trends, determine the influence of demographic factors and examine risk perception as it applies to public action.

For residents of the WUI in the Kamloops Fire Zone, wildland fire is a known threat and not tolerated on their property or in their community regardless if adjacent public lands have been fuel-managed or not. Many have already experienced wildland fire, through watching coverage in the media, to feeling the discomfort of smoke produced by wildfires, to feeling anxiety because of them. This is expected given the high frequency and intensity of wildfire coverage in British Columbia during the summer months, particularly when it occurs in wildland urban interface areas and structures are threatened. Many have seen fire near their homes and several homeowners have been placed on evacuation alert or have been ordered to leave their home because of wildland fire. These people believe that wildland fire has a greater than average chance of impacting their community. These experiences have been identified as key drivers of motivating homeowners in neighbourhood wildfire mitigation programs (McGee 2011).

These residents are relatively knowledgeable about fire and consider themselves and their household members as responsible for reducing wildfire risks to their home and property. This is an important finding as previous research has suggested that individuals might not take mitigation action if they feel that another agent is responsible for wildfire protection (Ergibi 2018). This feeling of responsibility is aligned with their belief of considerable control over what happens in their lives, the confidence to solve problems on their own, the willingness to come up with a strategy to solve problems and the confidence to do so. The internet was commonly used by homeowners in treated and in untreated areas as a source of information for wildfire, their impacts and preparing homes and property for wildfire.

The number of respondents that have heard of FireSmart was greater in treated areas than in untreated areas, but overall most homeowners surveyed during this study have heard of the program. This result was greater than the national average (Ergibi 2018) and is supported by research suggesting that risk perception is positively influenced by wildfire experience and proximity to landscape features (Ryan and Wamsley 2008).

Most homeowners in both the treated and untreated groups indicated they have either completed or were planning to complete within the next five years each of the queried FireSmart risk reduction activities except for screening or enclosing the undersides of decks and porches and installing stucco, metal, brick or other fire-resistant exterior siding on their homes. This omission of the structurally based fire mitigation measures by homeowners suggests that modifying fuels is the more achievable and the preferred component to address.

While homeowners in untreated areas reported feeling that more information was required to complete FireSmart treatments, the same could not be said for those residing in treated areas. These homeowners felt stronger about completing FireSmart work, that they have the skills to complete the work that they would not lose their connection with nature by completing the work and did not have the feeling of resignation that wildland fires were too destructive for which to prepare. Those residents in treated areas were also more in agreement with the pre-ignition fire management strategies of fire guards, thinning and prescribed fire and were more accepting and tolerant of allowing fire to burn if it doesn't impact lives or property. This acceptance of a "modified response", by definition the monitoring to steer, contain or otherwise manage fire activity within a pre-determined perimeter to minimize costs and/or damage and to maximize benefits from the fire (BC Government 2019), by those residents in treated areas and rejection by residents in untreated areas is congruent with the belief held by the latter that fire fighters would be unlikely to protect their home in the event of a wildfire.

Education was identified by WUI residents in both treated and untreated areas as an important component to reduce the risk of wildfire in their communities and on their properties, as were the availability of free wildfire hazard assessments. It is critical to educate people about the fire risk to their communities. Previous research has demonstrated that the more awareness of fire risk, the more likely people will search for effective methods to safeguard their property and communities from wildfires (Ryan and Wamsley 2008; McCaffrey 2004). Reduction of home insurance premiums associated with compliance of recommended FireSmart activities was in favour by surveyed residents in the treated and untreated areas. This finding is strongly supported by other FireSmart research (Ergibi 2018). Currently in British Columbia, no such insurance reduction is being offered.

Changes in bylaws were identified as a means of improving the resilience of homes and neighbourhoods under the threat of wildfire. While both groups surveyed agreed with bylaws that would restrict building materials of newly constructed homes to fire resistant materials such as asphalt shingles and stucco siding, those residents in treated areas did not agree to bylaws requiring fuel removal on private properties whereas the residents of untreated areas did.

The concept of using a work bee- individuals of a community coming together and combining efforts for the greater good of the community- to complete fuel management work on private properties was asked of survey recipients. Homeowners in treated areas agreed with this idea, whereas those in untreated areas were not. This is consistent with the sense of community identified by the groups; those in treated areas suggesting they interact more with members of the community, they feel as though they belong, and they would remain in the community if given the opportunity to move.

Notwithstanding the feedback from WUI residents received during this study, further research to validate the responses as representative of a population is required. Given the relatively small sample size (n = 24), land managers and fuel management practitioners should interpret these findings as indications of tendencies rather than irrefutable evidence from which to formally guide policy and practice. To provide such evidence, sampling should be expanded to include a greater number of WUI residents over a greater geographic area that would include interface areas in other areas of the Province of British Columbia.

However, the tendencies derived from this study should by no means be dismissed as anomalies because of the small sample size. They do help corroborate the findings of the Forest Practices Board of British Columbia in their 2015 special investigation on fuel management in the WUI in their determination of opportunities for improvement of the program. The Board suggests that the current model of fuel management is not working, and states that government has a role in education, but homeowners must also take responsibility. Recommendations contained within include the Provincial government working with the insurance industry to provide incentives and penalties to homeowners with reference to building standards and FireSmart principles; empowering Provincial and local governments to compel landowners (through regulations or bylaws) to treat problem fuels to FireSmart standards; advertising and creating greater awareness of fire risk and information sharing by which residents and communities can be connected and educated by sharing successes and failures and lessons learned (FBP 2015).

CONCLUSION

In summary, this study has contributed a human dimension to the adoption of fuel management activities by private landowners that have used the visual reference of adjacent Crown land treatments to guide their own fuel management practices. It has demonstrated that managing forest fuels through FireSmart practices has been readily adopted in areas where treatment on Crown lands have occurred. The residents adjacent to these treated lands have made treatment on their own properties a priority. They are motivated to complete the work, they have the knowledge and feel skilled to do so and understand how mitigation efforts can work in parallel with normal ecological process.

This research has also demonstrated that FireSmart awareness is greater than the national average. It has identified key motivations for completing fuel management treatments on private property and has highlighted obstacles to completing treatments.

LITERATURE CITED

Abatzoglou J.T., Williams, A.P. 2016. Impact of anthropogenic climate change on wildfire across western US forests. Proc Natl Acad Sci USA 113(42):11770–11775.

Association for Fire Ecology. 2015. Reduce wildfire risks or we'll continue to pay more for fire disasters. Available: https://www.fireecology.org/Resources/Documents/Reduce-WIldfire-Risk-16-April-2015-Final-Print.pdf. [March 25, 2017].

BC Government. 2019. Response types and stages of control. 1pp. [online] Available: https://www2.gov.bc.ca/gov/content/safety/wildfire-status/about-bcws/wildfire-response/response-terminology [March 16, 2019].

BC Wildfire Service. 2019. Major historical wildfires. 1pp. [online] Available: https://www2.gov.bc.ca/gov/content/safety/wildfire-status/about-bcws/wildfire-history/major-historical-wildfires?keyword=homes&keyword=destroyed&keyword=wildfire [January 30, 2019].

B.J. Stocks Wildfire Investigations Ltd. 2013. Evaluating past, current and future forest fire load trends in Canada. Technical Report. Cited in text as B.J. Stocks 2013.

Boer, M.M., Price, O.F., Bradstock, R.A. 2015. Wildfires: Weigh policy effectiveness. Science 350(6263):920.

Bowman, L. 2012. Wildland – urban interface fires. Natural Resource Canada. Retrieved from: https://www.researchgate.net/profile/Lynn_Johnston5/publication/282610956_Wildland-urban_interface_fires/links/5613e1fd08aed47facedeb83/Wildland-urban-interface-fires.pdf

British Columbia 2003 Firestorm Provincial Review. 2004. Firestorm 2003 Provincial Review. Vancouver, BC. 100 pp.

Brunson, M. W., Shindler, B. A. 2004. Geographic variation in social acceptability of wildland fuels management in the western United States. Society and Natural Resources, *17*(8), 661-67.

Calkin, D.E., Thompson, M.P., Finney, M.A. 2015. Negative consequences of positive feedbacks in US wildfire management. Forest Ecosystems 2(1):1–10.

Cohen, J. D. 2000. Examination of the home destruction in Los Alamos associated with the Cerro Grande Fire-July 10, 2000.

Cohen, J., & Stratton, R. 2003. Home destruction within the Hayman Fire perimeter.

Daniels, L.D., Hagerman, S.M., Ravensbergen, S.L. 2018. Wildfire Prevention & Fuels Management in the Wildland-Urban Interface: BC Community Perceptions May 2018. Report to the Union of BC Municipalities, First Nations' Emergency Services Society, BC Community Forest Association and BC Wildfire Service. 32 p.

Dennison, P.E., Brewer, S.C., Arnold, J.D., Moritz, M.A. 2014 Large wildfire trends in the western United States, 1984–2011. Geophysical Research Letters.41(8):2928–2933.

Ergibi, M.K. 2018. Awareness and Adoption of FireSmart Canada: Barriers and Incentives [thesis]. [Saskatoon (SK)]: University of Saskatchewan.

[FBP] Forest Practices Board. 2015. Fuel management in the wildland urban interface-update. Forest Practices Board. Special Investigation Report 43. Victoria, BC. 34 pp.

Flanagan, H.M. 2008. Residential wildfire mitigation and management preferences in Alberta [thesis]. [Edmonton (AB)]: University of Alberta.

Gayton, D.V. 2001. Ground work: basic concepts of ecological restoration in British Columbia. Southern Interior Forest Extension and Research Partnership, Kamloops, B.C. SIFERP Series 3

Gray, R.W. [Internet]. 2013. B.C.'s fire-reduction strategy misses mark. Vancouver Sun; [cited April 17, 2015]. Available from: http://www.vancouversun.com/business/fire+reduction+strategy+misses+mark/8733516/story.html

Haughian. S., Burton, P., Taylor, S., Curry, C. 2012. Expected effects of climate change on forest disturbance regimes in British Columbia. BC Journal of Ecosystems and Management 13(1): 1-24.

Hessburg, P.F., Spies, T.A., Perry, D.A., Skinner, C.N., Taylor, A.H., Brown, P.M., Stephens, S.L., Larson, A.J., Churchill, D.J., Povak, N.A., Singleton, P.H., McComb, B., Zielinkski, W.J., Collins, B.M., Salter, R.B., Keane, J.J., Franklin, J.F., Riegel, G. 2016. Tamm Review: Management of mixed-severity fire regime forests in Oregon, Washington, and N. California. Forest Ecology and Management 366:221–250

Kalies, E.L., Kent, K.Y. 2016. Tamm Review: Are fuel treatments effective at achieving ecological and social objectives? Forest Ecology and Management 375:84–95.

Kauffman, J.B. 2004. Death Rides the Forest: Perceptions of Fire, Land Use, and Ecological Restoration of Western Forests. Conservation Biology. Volume 18, No. 4: Pages 878-882.

Maranghides, A., Mell, W. E. 2009. A case study of a community affected by the Witch and Guejito Fires. National Institute of Standards and Technology. Building and Fire Research Laboratory.

McCaffery, S. 2004. Thinking of wildfire as a natural hazard. Society & Natural Resources, 17(6), 509-516.

McGee, T.K. 2011. Public engagement in neighbourhood level wildfire mitigation and preparedness: Case studies from Canada, the US, and Australia. Journal of Environmental Management. 92(10):2524-2532.

Mercer, D. E., Zipperer, W. 2012. Fire in the wildland–urban interface. Urban–Rural Interfaces: Linking People and Nature, (urbanruralinter), 287-303.

Moritz, M. A., Parisien, M.-A., Batllori, E., Krawchuk, M.A., Van Dorn, J., Ganz, D.J., Hayhoe, K. 2012. Climate change and disruptions to global fire activity. Ecosphere 3(6):49. http://dx.doi.org/10.1890/ES11-00345.1

North, M., Brough, A., Long, J., Collins, B., Bowden, P., Yasuda, D., Miller, J., Sugihara, N. 2015. Constraints on mechanized treatment significantly limit mechanical fuels reduction extent in the Sierra Nevada. Journal of Forestry 113(1):40–48.

Partners in Protection. 2003. FireSmart: Protecting your Community from Wildfire. Partners in Protection, Edmonton, Alberta. Pp 2-5.

Rea, L.M., Parker, R.A. 2005. Designing and conducting survey research a comprehensive guide. 3rd edition. California (CA): Jossey-Bass. 283 p.

Reinhardt E.D., Keane, R.E., Calkin, D.E., Cohen, J.D. 2008. Objectives and considerations for wildland fuel treatment in forested ecosystems of the interior United States. Forest Ecology and Management 256: 1997-2006.

Ryan, R.L., Wamsley, M.B. 2008. Public perceptions of wildfire risk and forest management in the Central Pine Barrens of Long Island (USA). The Australasian Journal of Disaster. 2008-2. Retrieved from: http://trauma.massey.ac.nz/issues/2008-2/ryan.htm

Schoennagel, T., Balch, J.K., Turner, M.G., Whitlock, C., Mietkiewicz, N., Brenkert-Smith, H., Dennison, P.E., Harvey, B.J., Krawchuk, M.A., Morgan, P., Moritz, M.A., Rasker, R. 2017. Adapt to more wildfire in western North America forests as climate changes. Proceedings of the National Academy of Sciences of the United States of America, Vol. 114 Issue 18, p4582-4590, 9p.

Sullivan, A. P., Holden, A. S., Patterson, L. A., McMeeking, G. R., Kreidenweis, S. M., Malm, W. C., & Collett, J. L. 2008G. A method for smoke marker measurements and its potential application for determining the contribution of biomass burning from wildfires and prescribed fires to ambient PM2. 5 organic carbon. Journal of Geophysical Research: Atmospheres, 113(D22).

Walkinshaw, S., Schroeder, D., & Hvenegaard, S. (2012). Evaluating effectiveness of FireSmart priority zones on structure protection. FP Innovations Wildfire Operations Research, Hinton, Alberta.

Westerling, A.L., Hidalgo, H.G., Cayan, D.R., Swetnam, T.W. 2006 Warming and earlier spring increase western U.S. forest wildfire activity. Science 313(5789):940–943.

Westhaver, A. 2015. Risk reduction status of homes reconstructed following wildfire disasters in Canada. Canadian Electronic Library, & Institute for Catastrophic Loss Reduction, issuing body. (2016). (ICLR research paper series; no. 55).

Yue, X., Mickley, L.J., Logan, J.A., Kaplan, J.O. (2013) Ensemble projections of wildfire activity and carbonaceous aerosol concentrations over the western United States in the mid-21st century. Atmospheric Environment (1994) 77:767–780.

CHAPTER 4 – RESEARCH CONCLUSIONS, MANAGEMENT IMPLICATIONS AND FUTURE RESEARCH

Research Conclusions

Wildland fire has always been a natural part of the earth, driving the ecological processes of its terrestrial landscapes over evolutionary time and making essential contributions to the vitality and renewal of its ecosystems (Bond and Keely 2005). The natural patterns, frequency, size and intensity of wildland fires, or fire regimes, that have characterized ecosystems have changed almost exclusively by the hand of man and his unique ability to wrest control of ignition away from lightning and fire at will.

In North America, First Nations people were well adept at utilizing wildland fire as a tool and companion on a local and fine-scale level. The arrival of non-natives from Europe and evolution of that society from nomadic and agrarian roots to industrialization shifted the paradigm of wildland fire in North America, as it did throughout the industrializing world, as valued resources and infrastructure were repeatedly and indiscriminately altered by fire (Beck et al. 2005).

Wildland fires were cast as destructive and dangerous to human well being (Dyck et al. 2003; Parminter 1978). The concept of firefighting developed, fire suppression became a well-accepted practice (Dyck et al. 2003) and the campaign to prevent wildland fires also took root (Parminter 1978). This paradigm shift came with a significant cost in the number of dollars spent and the number of lives lost and is forecast to further increase due to climate change, fuel accumulation and the development of fire prone areas (Brenkert-Smith et al. 2012).

These fire prone areas, where structures such as homes or business are built among the trees and other forest fuels, are known as the wildland-urban interface or the WUI (Partners in Protection 2003). Development here is problematic from a wildfire management perspective and providing effective fire protection for communities in the WUI is one of the greatest challenges currently facing fire officials today (Partners in Protection 2003). Forest fuel management, the planned manipulation of forest vegetation to decrease the intensity and rate of spread of a wildfire (Merrill and Alexander 1987), is recognized as the only feasible option to mitigate wildfire risk by influencing fire behaviour potential (Partners in Protection 2003).

Wildfire threat reduction using fuel management in British Columbia has been occurring on a provincial scale since the introduction of the Strategic Wildfire Prevention Initiative (SWPI) in 2004. Since that year, over $67 million have been allocated to improving fire prevention and community safety in an estimated 43,000 hectares of provincial Crown and municipal lands within interface areas (MFLNRO 2015, WMB 2012). What isn’t known is an estimate of fuel management that has occurred on privately owned properties. Research focusing on wildfire management in the WUI supports the requirement of home owners to complete wildfire risk mitigation on their own properties to aid in overall effectiveness of hazard reduction programs (Cortner et al. 1990; Monroe et al. 2003; Field and Jensen 2005) and also suggests the treatment of fuels in immediate proximity to residences is far more important in determining the survivability of homes than the treatment of fuels in adjacent areas (Reinhardt et al. 2008).

Research has been conducted on the factors that influence homeowner participation in wildfire risk mitigation activities (Beringer 2000; McGee and Russel 2003; McCaffrey 2004; Nelson et al. 2005; Brenkert-Smith et al. 2006) but few studies have examined the relationship between fuel management adjacent to private properties and fuel management conducted by the homeowner on private property.

The aim of this thesis was to determine if fuel management conducted on public lands influenced homeowners on adjacent private lands to conduct fuel management activities on their own properties and to expand on their motivations and rationale for doing so. These determinants were assessed through a two-part study involving a field study of fuel management sites in the WUI and a survey of residents in the same fuel managed sites.

Field Study

The objective of the field study was to determine if fuel management treatment on Provincial Crown Lands has an influence on owners of adjacent private lands to perform similar wildfire risk mitigation activities.

Key Findings of Field Study:

- **Hazard assessment scores of fuel-managed public lands and adjacent private lands were the similar, suggesting that private land owners were reproducing mitigation measures on their own properties.**

Treated public and adjacent private land showed no significant difference in hazard assessment scores. In comparison, untreated public and adjacent private land showed no significant difference in hazard assessment scores. Through statistical analysis, there is an evident relationship demonstrated between fuel management conducted on public lands and the private land owner's propensity to use what they can see as a model for the treatment of forest fuels on their own properties. As previously noted, a limitation of this study was the unavailability of data pre-treatment, meaning that the cause and effect can not be proven despite the relationship that has been demonstrated to exist.

- **Fuel management reduced the hazard assessment scores of Crown and private lands in the areas studied.**

The mean hazard assessment score for treated land, both public and private, was 22, placing these lands just beyond the threshold for a high hazard designation according to the Area Hazard Assessment Form modified from the Partners in Protection (2003) form. The mean scores for untreated lands were 40 and 39 for public and private lands respectively, placing these lands in the extreme hazard category, based on the modified Area Hazard Assessment Form.

- **There is variability in fuel management treatment.**

The standard deviation of the hazard assessment scores for the treated public (SD = 10.23) and private (SD = 9.55) lands were much greater than that of the untreated public (SD = 3.65) and private (SD = 4.49) lands. This difference suggests that the level, and potentially the adequacy, of fuel management treatment was variable within the sampled population when compared with the variability in the control group. Variation in the untreated areas was likely a result of natural site differences such as the biogeoclimatic zone of the site.

Survey

The objective of the survey component of this study was to address knowledge gaps in motivations, obstacles and trends of WUI residents on FireSmart uptake and mitigation work on their properties in addition to determining the influence of demographic factors and examination of risk perception as it applies to public action. The importance of understanding what motivates private actions, given the ideological shift from treating fuels on public lands to mitigating risks on private property, has been identified by Hesseln (2018) and other researchers.

Key Findings of Survey:

- **Residents of the WUI are aware of the risk of wildland fire impacting their communities.**

Wildland fire was a widely recognized threat by surveyed residents living within the WUI. Many have had previous experience with the impacts of fire, and many have a good knowledge about fire and its role in the ecosystem. This is an important finding and is consistent with the research of Daniels et al. (2018), as the success of implementing and adopting wildland fire prevention programs require knowledge about what to do, an awareness of the risks involved, and often, the risks associated with not taking action (Hesseln 2018).

- **The majority of WUI residents were familiar with the FireSmart program.**

The number of respondents that have heard of FireSmart was greater in treated areas than in untreated areas, but overall most of the homeowners surveyed during this study have heard of the program. This result was greater than the national average (Ergibi 2018) and is supported by research suggesting that risk perception is positively influenced by wildfire experience and proximity to landscape features (Ryan and Wamsley 2008).

- **Education continues to be an important component of any forest fuel mitigation effort.**

Previous research has demonstrated that the more awareness of fire risk, the more likely people will search for effective methods to safeguard their property and communities from wildfires (Ryan and Wamsley 2008; McCaffrey 2004; Champ et al. 2013). Education is also an important tool for public engagement, and as research by McGee (2011) has suggested there is a need to engage members of the public in wildfire prevention and mitigation in order to reduce wildfire impacts (McGee 2011).

- **WUI residents in treated areas generally felt a greater sense of community than those residing in untreated areas.**

Residents in treated areas reported interacting more with members of their community, feeling as though they belonged to their community and would more likely stay within their community if given the opportunity to move. The networks formed within a community can be an important component of community preparedness. Agrawal and Monroe (2011) found that people who perceive greater networking in their communities were more likely to engage in activities that build knowledge and skills to prevent wildfire, create defensible space around their property, and to communicate and collaborate with others. Social interactions among members of a community have also been shown to have a positive influence on fuel management (Dickinson et al. 2015). The very building of social networks within the community to strengthen communication may even increase the resilience in the face of fire and enable individuals and communities to more effectively deal with crisis (Hesseln 2018).

Management Implications and Future Research

Though fuel management can be simply defined as the planned manipulation of forest vegetation to decrease the intensity and rate of spread of a wildfire (Merrill and Alexander 1987), putting it into practice on the land base is often a complex endeavour, requiring the careful balance of ecological, social and economic factors.

Notwithstanding the efforts by the Province of British Columbia to address the widespread concerns of the state of BC's forests and the unprecedented threat of fire within wildland-urban interface areas identified in the Filmon report (BC 2003 Firestorm Provincial Review 2004), many pundits and arm-chair fire-fighters alike believe they have simply not been enough.

Many of the lessons learned in 2003 appeared to have nearly been forgotten by the time 2017 came to pass. During that year, British Columbia was again under siege, experiencing what would be remembered as one of the worst wildfire seasons in the Province's history. It was unprecedented, eclipsing previous totals for the amount of land burned (over 1.2 million hectares), the total cost of fire suppression (over $568 million), and the amount of people displaced (roughly 65,000 evacuated). This was the longest Provincial State of Emergency in the Province's history, and the first to be declared since the 2003 firestorm (BC Government 1 2019). From the ashes of that fire season came yet another independent review, this time the BC Flood and Fire Review. This review, much like the Filmon report, identified the need for fuel management as a mitigation strategy among its 108 recommendations (Abbott and Chapman 2018). It would appear as though the pundits were right.

Perhaps the overall fuel management strategy the Province adopted on the heels of 2003, although grandiose and headline making at the time, was short sighted, mis-directed and completely unsustainable. The overall success or failure of the Strategic Wildfire Prevention Initiative since its inception in 2004 will remain the subject of debate, and though it tempers the management implications from this study it should not be considered as directly within its scope.

Residents living within the wildland-urban interface are aware of the risk of wildland fire impacting their communities. From a management perspective, this awareness suggests a greater success at engaging the public with fuel management strategies, as research has proven that people aware of the risks are far more likely to act to mitigate those risks than people who are not (McFarlane et al. 2011). The research of Faulkner et al. (2009), has suggested that awareness does not necessarily translate into action.

Consider the relationship that has been previously established between fuel management on public lands and the uptake of the mitigation strategies by owners of adjacent private lands. The suggestion that people copy what they see has a number of implications on how a fuel management treatment could be applied on a given site and in the context of a broader fuel management program that has the protection of homes and structures as its first priority. First, it suggests a cause and effect that links awareness of risk to action by residents in the WUI. Second, by owner treatment of private properties, the continuity of fuel within the WUI is modified, which in turn modifies fire behaviour and improves the success of fire suppression tactics and resources (Partners in Protection 2003). Third, private land owner uptake of fuel management techniques could reduce the overall number of hectares on public lands required to be treated, as areas of forest that are beyond the sightline of landowners but may have been included within a traditional treatment prescription, could be eliminated. The resource savings, whether that be in the form of equipment, personnel, dollars or a combination thereof, could then be reassigned to other potential treatment areas that otherwise could not have been considered because of limited resources.

The public use of Crown land treatments as a model for private land treatments also implies that forest fuels on public lands must be treated adequately to achieve the desired result of reducing the overall hazard assessment score to within the medium range (Partners in Protection 2003). This will consistently pose a challenge, as foresters tasked with prescribing fuel mitigation treatments on Crown land are inevitably faced with balancing the competing needs of soils, timber, wildlife, riparian area, fish habitat, community watersheds, biodiversity, visual quality and cultural heritage (BC Government 2 2019). In the balance, the end result may not adequately reduce the hazard risk, nor may it provide the visible template for the landowners to mitigate risk adequately on their own property.

Education continues to be an important component of any forest fuel mitigation effort (Ergibi 2018; Daniels et al. 2018). This identified need suggests that a paradigm shift in the manner by land managers and the Province conducts fuel management work should also be considered, given the ideological shift from treating fuels on public land to mitigating risks on private property as Hesseln (2018) has suggested. FireSmart has been well received by participants of this study, and information is obtained through a number of different media channels. Reduction of the overall amount of land requiring treatment creates a greater availability of resources. These resources, in the form of personnel, could be tasked to education. For example, BC Wildfire Service fire crews could be repurposed during periods away from the operational rigours of fire suppression to conduct door-to-door campaigns in areas of WUI. These men and women, based on their training and experience, could appropriately convey knowledge about what to do, the hazards of the environment and the risks associated with not taking action, all essential to adopting wildfire prevention programs (Hesseln 2018). They could also provide hazard assessments for the private landowners during the door-to-door campaigns.

Within the context of a broader fuel management program, education through visual modelling could open additional and perhaps non-traditional avenues for completing mitigation work. Managers should consider the use of demonstration forests. Demonstration forests could provide a valuable visual model for those WUI residents that either have not yet had or may not have an adjacent parcel of Crown land fuel managed from which they can use for guidance. Although there is no set size for the development of a demonstration forest, managers should consider treating enough forest to provide viewers with a clear model of adequate treatment from which they can mimic and consider implementing this strategy in highly frequented areas. Informational signs should also be integrated to help viewers fully comprehend what they are seeing.

Wildland-urban interface residents in treated areas generally felt a greater sense of community than those residing in untreated areas. The significance of community and the communication of neighbours in mitigation success has been well documented (McGee 2011) and has been leveraged by organizations such as FireSmart Canada in their community recognition program (FireSmart 2019). Monroe et al. (2006) have suggested that involving local residents in deciding how to create a FireSmart community will help build positive relationships between fire suppression agencies and communities, empowers residents, and encourages the development of preparedness as a community norm. Community level wildfire mitigation programs are not only reducing the wildfire risk in their communities, but are building community relationships and enhancing the relationship between communities and the government agencies (McGee 2011). The importance of fostering community involvement in fuel mitigation work cannot be overstated nor ignored by the Province as it is a key component of treatment on private lands.

The prospect of the private land owners taking greater accountability to mitigate the hazards associated with living in the wildland-urban interface is beneficial to government, land managers and homeowners alike. As Mileti (1999) argued, a model community of hazard mitigation would facilitate a shift in emergency management from the governments to local responsibility. This study suggests that WUI residents in Kamloops Fire Zone are aware of the risks and willing to engage in measures to mitigate them with proper education and a visual template fuel management. Given that this fire zone is just one of many fire prone areas throughout the Province of British Columbia, future research should focus on these areas such as the dry belt regions of the west and east Kootenays as well as the Cariboo-Chilcotin. In addition, further study could be conducted to gauge the potential changes in public response and action in the wake of the 2017 and 2018 fire seasons that ravaged the Province once again.

LITERATURE CITED

Abbott, G., Chapman, M. 2018. Addressing the new normal: 21st century disaster management in British Columbia. A report for government and British Columbians.

Agrawal, S., Monroe, M.C. 2011. Using and improving social capital to increase community preparedness for wildfire. In: McCaffrey, S., Fisher, C., editors. Proceedings of the Second Conference on the Human Dimensions of Wildland Fire. Northern Research Station, Newton, PA: USDA Forest Service; 2011. General Technical Report NRS-P-84. 96–103.

Beck, J., Parminter, J., Alexander, M., MacDermid, E., Van Nest, T., Beaver, A., Grimaldi, S. 2005. Fire Ecology and Management. In: Watts, S.B., Tolland, L., editors. Forestry Handbook for British Columbia, part 2. 5th edition. The Forestry Undergraduate Society, University of British Columbia. P. 490-525.

BC Government 1[Internet]. c2019. British Columbia; [cited 2019 Mar 10]. Available: https://www2.gov.bc.ca/gov/content/safety/wildfire-status/about-bcws/wildfire-history/wildfire-season-summary

BC Government 2[Internet]. c2019. British Columbia; [cited 2019 Mar 14]. Available: http://www.bclaws.ca/civix/document/id/complete/statreg/14_2004#section1.1

Beringer, J. 2000. Community fire safety at the urban/rural interface: the bushfire risk. Fire Safety Journal, 35: 1–23

Bond, W.J., Keeley, J.E. 2005. Fire as a global ‘herbivore’: the ecology and evolution of flammable ecosystems. Trends in Ecology & Evolution 20:387–394.

Brenkert-Smith, H., Champ, P.A., Flores, N. 2006. Insights into wildfire mitigation decisions among wildland–urban residents. Society and Natural Resources. (19): 759–768.

Brenkert-Smith, H., Champ, P.A., Flores, N. 2012. Trying not to get burned: Understanding homeowners’ wildfire risk-mitigation behaviours. Environmental Management. 50: 1139-1151.

British Columbia 2003 Firestorm Provincial Review. 2004. Firestorm 2003 Provincial Review. Vancouver, BC. 100 pp.

Cortner, H.J., Gardner, P.D., Taylor, J.G. 1990. Fire hazards at the urban–wildland interface: What the public expects. Environmental Management 14(1): 57–62.

Champ, P.A., Donovan, G.H., Barth, C.M. 2013. Living in a tinderbox: wildfire risk perceptions and mitigating behaviours. International Journal of Wildland Fire. 22:832–40.

Daniels, L.D., Hagerman, S.M., Ravensbergen, S.L. 2018. Wildfire Prevention & Fuels Management in the Wildland-Urban Interface: BC Community Perceptions May 2018. Report to the Union of BC Municipalities, First Nations’ Emergency Services Society, BC Community Forest Association and BC Wildfire Service. 32 p.

Dickinson, K., Brenkert-Smith, H., Champ, P., Flores, N. 2015. Catching fire? Social interactions, beliefs, and wildfire risk mitigation behaviors. Society & Natural Resources. 28:807–824.

Dyck, B.W., Gawalko, L., Rollins, R.B. 2003. Public perceptions of fire management practices in BC provincial parks. Forest Practices Code of BC Act. Forest Fire Prevention and Suppression Regulation.

Ergibi, M.K. 2018. Awareness and Adoption of FireSmart Canada: Barriers and Incentives [thesis]. [Saskatoon (SK)]: University of Saskatchewan.

Faulkner, H., McFarlane, B.L., McGee, T.K. 2009. Comparison of homeowner response to wildfire risk among towns with and without wildfire management. Environmental Hazards 8(1): 38-51.

Field, D.R., Jensen, D.A. 2005. Humans, fire, and forests: expanding the domain of wildfire research. Society and Natural Resources. 18: 355–362.

FireSmart Canada [Internet]. c2019. FireSmart; [cited 2019 Mar 14]. Available: https://www.firesmartcanada.ca/firesmart-communities/firesmart-canada-community-recognition-program/become-a-firesmart-community/

Hesseln, H. 2018. Wildland fire prevention: a review. Current Forestry Reports, 4(4), 178-190.

McFarlane, B.L., McGee, T.K., Faulkner, H. 2011. Complexity of homeowner wildfire risk mitigation: an integration of hazard theories. International Journal of Wildland Fire. 20(8): 921-931.

McCaffrey, S.M. 2004. Thinking of wildfire as a natural hazard. Society and Natural Resources 17: 509–516.

McGee, T.K., Russell, S. 2003. 'It's just a natural way of life. . .' An investigation of wildfire preparedness in rural Australia. Environmental Hazards 5: 1–12.

McGee, T.K. 2011. Public engagement in neighbourhood level wildfire mitigation and preparedness: Case studies from Canada, the US, and Australia. Journal of Environmental Management. 92(10):2524-2532.

Merrill, D.F., Alexander, M.E. 1987. Glossary of forest fire management terms (4th edition). Canadian Committee on Forest Fire Management, National Research Council of Canada, Ottawa, Ontario.

[MFLNRO] Ministry of Forests, Lands and Natural Resource Operations .2015. Fuel Management 2pp. [online]. Available: http://bcwildfire.ca/fuelmanagement/ [January 7, 2015].

Mileti, D.S. 1999. Disasters by design: A reassessment of natural hazards in the United States. Joseph Henry Press, Washington, DC.

Monroe, M.C., Long, A.J., Marynowski, S. 2003.Wildland fire in the southeast: Negotiating guidelines for defensible space. Journal of Forestry 101(3): 14–19.

Monroe, M.C., Pennisi, L., McCaffrey, S., Mileti, D. 2006. Social science to improve fuels management: A synthesis of research relevant to communicating with homeowners about fuels management. US Forest Service.

Nelson, K.C., Monroe, M.C., Johnson, J.F. 2005. The look of the land: homeowner landscape management and wildfire preparedness in Minnesota and Florida. Society and Natural Resources 18: 321–336.

Parminter, J. 1978. A historical review of forest fire management in British Columbia (thesis). Vancouver, BC: University of British Columbia; November 1978. 105 pp.

Partners in Protection. 2003. FireSmart: Protecting your community from wildfire. Partners in Protection, Edmonton, Alberta. pp 2-5.

Reinhardt, E.D., Keane, R.E., Calkin, D.E., Cohen, J.D. 2008. Objectives and considerations for wildland fuel treatment in forested ecosystems of the interior United States. Forest Ecology and Management 256: 1997-2006.

Ryan, R.L., Wamsley, M.B. 2008. Public perceptions of wildfire risk and forest management in the Central Pine Barrens of Long Island (USA). The Australasian Journal of Disaster. 2008-2. Retrieved from: http://trauma.massey.ac.nz/issues/2008-2/ryan.htm

[WMB] Wildfire Management Branch. 2012. Proactive wildfire threat reduction. Discussion paper. 1-4.

Appendix A-Private/Public Interface Hazard Assessment Form

Private/Public Interface Hazard Assessment Form

Date:				
Site:			Remarks:	
	Latitude	Longitude		
Coordinates: (dd°mm.mmm)				
Elevation (m)				
	Public	Private		
Assessment (✓)				

Criteria	Characteristics and Point Rating				Score
Forest Vegetation (overstory)	Deciduous	Mixed Wood	Coniferous		
			Separated	Contiuous	
	0	15	15	30	
Surface Vegetation	Lawn or non-comubistible	Wild grass or shrubs	Dead and down woody material		
			Scattered	Abundant	
	0	5	5	15	
Ladder Fuels	Absent	Scattered	Continuous		
	0	5	10		
				Total Score for Criteria	
				Hazard Level	

Hazard Level Low < 13 Moderate 13-21 High 22-27 Extreme >27

Criteria Description

Forest vegetation, or over story, will be categorized as deciduous if greater than 90 percent of the assessed stand is deciduous. Mixed wood describes those stands greater than 50 percent deciduous and less than 50 percent coniferous. Coniferous stands are greater than 50 percent coniferous; separated coniferous stands have a low stand density where trees are widely spaced and crowns do not touch or overlap. Continuous coniferous stands are those with a high stand density where trees are tightly spaced and crowns frequently touch or overlap.

Surface vegetation may consist of lawn or non–combustible material or wild grass or shrubs. It may also be dead and down woody material. These are considered scattered if groups of logs, branches and twigs are widely spaced, separated by 3-5 metres or more. They are considered abundant if groups of logs, branches and twigs are continuous or nearly continuous.

Ladder fuels are shrubs, immature trees and branches extending to the ground. Trees with branches extending within 2 metres of the ground have ladder fuels. Ladder fuels are considered absent if fewer than 25 percent of trees on site have ladder fuels, scattered if 25-75 percent of the trees on site have them and abundant if more than 75 percent of trees have ladder fuels.

Appendix B-Cover Letter and Survey

You, Your Property and Wildfires

Every year wildfires impact woodlands, properties and homes. In British Columbia, catastrophic losses came with the wildfires of the 2003 and 2009 fire seasons. More recently, wildfire in Alberta has devastated the communities of Slave Lake and Fort McMurray.

The survey included in this package is being conducted by a Masters of Environmental Science candidate at Thompson Rivers University in Kamloops in an effort to understand how British Columbians view wildfires and understand the impacts that wildfires have on property and communities. You have been selected to receive this survey as an owner of property in the wildland urban interface - the area where homes are built among forested lands. Your participation is extremely valuable as the information you provide will be used to determine British Columbian's expectations for managing and reducing the potential impacts of wildfires and can help wildfire management agencies protect British Columbians and their communities from wildfires.

This voluntary survey will take approximately 15 minutes to complete. Please try to answer all of the questions. If there are any questions you do not wish to answer, please leave them blank and move to the next one. Your participation and identity will be kept confidential. Only your survey responses will be used for the project and associated publications and presentations.

Please return your completed questionnaire in the postage paid envelope provided to: Colin Swan C/O Dr. Wendy Gardner, Thompson Rivers University, 900 McGill Road, Kamloops, BC V2C 0C8. Thank you for taking the time to complete the questionnaire.

If you have any questions regarding this survey please contact: **Colin Swan** by phone at (250) 819-1232 (leave a message) or email at swanc113@mytru.ca. Questions can also be addressed to the Chair of the Thompson Rivers University Research Ethics Board by email at TRU-RED@tru.ca or by phone at 250-828-5000.

Thank you again for your time and participation. Your support of this project is important and greatly appreciated.

Sincerely,

Colin Swan

MSc Environmental Science Candidate

Before you Begin

In this questionnaire the term wildfire refers to any forest fire, grass fire or brush fire that is caused by nature (lightning) or by humans (campfires, cigarettes, etc.)

Section 1: Wildfire Risk

We would like to start by asking you some questions about how risky you feel wildfires and other hazards are to yourself, your property and your community.

1. **Wildfires and other hazards can affect people and communities in British Columbia. How much of a risk do you feel each of the following could pose to you and your property in the next 5 years**? On a scale of 1 (no risk) to 7 (great risk), please circle the number that best represents your response.

	No Risk						Great Risk	No Opinion
Wildfires	1	2	3	4	5	6	7	□
Hail	1	2	3	4	5	6	7	□
Climate Change	1	2	3	4	5	6	7	□
Drought	1	2	3	4	5	6	7	□
Tornadoes	1	2	3	4	5	6	7	□
Mountain Pine Beetle	1	2	3	4	5	6	7	□
Flooding	1	2	3	4	5	6	7	□

In the next few questions, we would like to get your opinion on the risk wildfires pose to your property, your community and the environment, as well as whether or not the impacts can be controlled and if the impacts are acceptable to you.

2. **On a scale of 1 (no risk) to 7 (great risk), how much of a risk do you feel wildfires could pose to each of the following in the next 5 years?** Please circle the number that best represents your response.

	No Risk						Great Risk	No Opinion
Your property	1	2	3	4	5	6	7	□
Your community	1	2	3	4	5	6	7	□
The natural environment	1	2	3	4	5	6	7	□

3. **In your opinion, how controllable are wildfires in terms of people's ability to control their impacts to each of the following?** On a scale of 1 (not at all) to 7 (very), please circle the number that best represents your response.

	Not at all						Very Controllable	No Opinion
Your property	1	2	3	4	5	6	7	□
Your community	1	2	3	4	5	6	7	□
The natural environment	1	2	3	4	5	6	7	□

4. **How acceptable are wildfires to you in terms of their general impact on each of the following?** On a scale of 1 (not at all) to 7 (completely), please circle the number that best represents your response.

	Not at all						Completely Acceptable	No Opinion
Your property	1	2	3	4	5	6	7	□
Your community	1	2	3	4	5	6	7	□
The natural environment	1	2	3	4	5	6	7	□

5. How much negative emotion (i.e. anger, fear) do you feel when you think about wildfires and their impact on you, your family and your property? On a scale of 1 (none) to 7 (high), please circle the number that best represents your response.

None						High	No Opinion
1	2	3	4	5	6	7	◻

6. How likely do you think it is that a wildfire will occur near your community in the next year?

Very Unlikely	Unlikely	Not Sure	Likely	Very Likely	No Opinion
◻	◻	◻	◻	◻	◻

Section 2: Wildfire Awareness

We are also interested in how familiar you are with wildfires.

7. How often do you think and talk about wildfires?

	Never	Rarely	A few times a year	Once a month	Once a week or more	Not sure
Think about wildfires	◻	◻	◻	◻	◻	◻
Talk about wildfires	◻	◻	◻	◻	◻	◻

8. For each of the following true or false statements, please check the box that best describes your view.

	Mostly true	Mostly false	Not sure
Wildfires burn faster going uphill.	◻	◻	◻
Houses only burn when flames from a wildfire reach the house.	◻	◻	◻

Wildfires can be an important force in controlling outbreaks of disease and insects in forests.	◻	◻	◻
It takes decades before plants grown in a fire damaged forest.	◻	◻	◻
Wildfires usually result in the death of most animals in a burnt area.	◻	◻	◻
Wildfires help recycle minerals and nutrients needed by trees and other plants.	◻	◻	◻

9. Have you ever searched for information about wildfires, their impacts or preparing your house and property for wildfires?

◻ Yes → Where did you search for this information (Select all that apply)

- ◻ Internet
- ◻ Neighbours
- ◻ Friends and relatives
- ◻ Local fire department
- ◻ Provincial forestry department
- ◻ Do not remember
- ◻ Other ____

◻ No

10. Have you ever heard of the term *FireSmart?*

◻ Yes → Where do you recall hearing this term? (Select all that apply)

- ◻ Radio
- ◻ Television
- ◻ Newspaper
- ◻ Internet
- ◻ Relative, friend or neighbour
- ◻ Brochures or pamphlets
- ◻ Do not remember
- ◻ Other ____

◻ No

Section 3: Your Property and Wildfires

The next section asks you about activities that can be used to prepare homes and properties for wildfires.

11. In regards to your home and property, please indicate whether or not each of the following activities is done already or if you plan to do them.

	Done	Plan to do in the next year	Plan to do in the next 5 years	Do not plan to do	Does not apply
Keep grass short and water frequently during the spring, summer and fall	□	□	□	□	□
Remove shrubs, trees or fallen branches close to your house	□	□	□	□	□
Thin shrubs or trees so that nearby plants and trees do not touch	□	□	□	□	□
Store firewood well away from your house	□	□	□	□	□
Remove needles, leaves and overhanging branches from the roof and gutters	□	□	□	□	□
Landscape with fire resistant materials and vegetation (such as rocks, aspen, maple or poplar trees)	□	□	□	□	□
Remove debris or needle build up under balconies and porches	□	□	□	□	□
Prune large trees by removing all branches that are close to the ground	□	□	□	□	□
Screen house vents, gutters and the underside of eaves with metal mesh	□	□	□	□	□
Screen or enclose the undersides of decks and porches	□	□	□	□	□

	Done	Plan to do in the next 5 years	Plan to do when it needs replacing	Do not plan to do it	Does not apply
Install metal, asphalt, slate, tile or other fire retardant roofing materials on your roof	☐	☐	☐	☐	☐
Install double/thermal pane or tempered glass in windows and exterior glass doors	☐	☐	☐	☐	☐
Install stucco, metal, brick or other fire resistant exterior siding on your house	☐	☐	☐	☐	☐

12. Each of the following statements relates to the activities in question 11. Please indicate your level of agreement with each statement.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	No opinion
I need more information before I can complete some of these activities	☐	☐	☐	☐	☐	☐
If I made all or some of the suggested changes, my family or neighbours would like it	☐	☐	☐	☐	☐	☐
It would be difficult to find the money to make some of these changes to my property.	☐	☐	☐	☐	☐	☐
Implementing these activities is a priority for me.	☐	☐	☐	☐	☐	☐
For physical reasons I am unable to complete some of the activities without assistance.	☐	☐	☐	☐	☐	☐
I do not have the skills to complete some of the recommended activities	☐	☐	☐	☐	☐	☐

If I made these changes I would not feel as connected to nature.	☐	☐	☐	☐	☐	☐
I do not consider the threat of wildfire significant enough to warrant doing some of the activities.	☐	☐	☐	☐	☐	☐
Preparing for wildfires will significantly reduce damage to my house should a wildfire occur.	☐	☐	☐	☐	☐	☐
Wildfires are too destructive to bother preparing for.	☐	☐	☐	☐	☐	☐

13. In the event of an evacuation, do you have a plan prepared for yourself, and other members of your household (such as a safe route away from the fire, a meeting location and a place to stay)?

Done	Plan to do	Do not plan to do
☐	☐	☐

14. To what extent do you agree that each of the following are responsible for reducing wildfire risks to your house and property, well before a wildfire occurs?

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	No Opinion
Myself and my household members	☐	☐	☐	☐	☐	☐
Local fire department	☐	☐	☐	☐	☐	☐
Municipal government	☐	☐	☐	☐	☐	☐
Provincial government	☐	☐	☐	☐	☐	☐
Federal government	☐	☐	☐	☐	☐	☐

15. In your opinion, how likely is that firefighters could protect your home if it was threatened by a wildfire?

Very Unlikely	Unlikely	Not Sure	Likely	Very Likely	No Opinion
☐	☐	☐	☐	☐	☐

16. Has your property had a wildfire hazard home and site assessment done?

☐ Yes → Who conducted the assessment?

- ☐ You or someone in your household?
- ☐ Your local fire department
- ☐ Private contractor
- ☐ Provincial government
- ☐ Other____

Have you completed any of the suggestions made during the assessment?

- ☐ Yes
- ☐ No

☐ No

☐ Not Sure

The following are some ways to reduce the risk of wildfires to your community. To what extent do you favour or oppose each of the options?

	Strongly oppose	Somewhat oppose	Neutral	Somewhat favour	Strongly favour	No opinion
Educate homeowners about ways to reduce wildfire risk on their properties	☐	☐	☐	☐	☐	☐
Bylaws requiring homeowners to remove shrubs, trees and dead branches close to their house	☐	☐	☐	☐	☐	☐
Reduced insurance premiums if recommended activities are done	☐	☐	☐	☐	☐	☐
Neighbourhood work bees to help people prepare homes and properties for wildfires	☐	☐	☐	☐	☐	☐
Free wildfire hazard assessments for residential properties	☐	☐	☐	☐	☐	☐
Bylaws requiring new houses to use fire retardant building materials	☐	☐	☐	☐	☐	☐
Restrict houses from being built in high risk areas	☐	☐	☐	☐	☐	☐

Section 4: How Should Wildfires Be Managed?

Another aspect of our study is to understand British Columbian's opinions on management approaches that may be used to reduce the potential impacts of wildfires.

17. Fireguards are areas of vegetation around communities that are cleared. To what extent do you favour or oppose the use of fireguards around your community as a wildfire management approach?

Strongly oppose	Somewhat oppose	Neutral	Somewhat favour	Strongly favour	No Opinion
☐	☐	☐	☐	☐	☐

How effective do you feel fireguards would be at protecting your community?

Very ineffective	Ineffective	Neutral	Effective	Very effective	No Opinion
☐	☐	☐	☐	☐	☐

18. **Thinning is the selected removal of trees in forested areas. To what extent do you favour or oppose thinning as a wildfire management approach?**

Strongly oppose	Somewhat oppose	Neutral	Somewhat favour	Strongly favour	No Opinion
☐	☐	☐	☐	☐	☐

How effective do you fell thinning would be at protecting your community?

Very ineffective	Ineffective	Neutral	Effective	Very effective	No Opinion
☐	☐	☐	☐	☐	☐

19. **Prescribed burning is the intentional burning of vegetation under controlled conditions (such as firefighters on site to monitor the burning). To what extent do you favour or oppose the use of prescribed burning as a wildfire management approach?**

Strongly oppose	Somewhat oppose	Neutral	Somewhat favour	Strongly favour	No Opinion
☐	☐	☐	☐	☐	☐

How effective do you feel prescribed burning would be at protecting your community?

Very ineffective	Ineffective	Neutral	Effective	Very effective	No Opinion
☐	☐	☐	☐	☐	☐

20. Are any of the above management approaches (fireguards, thinning and prescribed burning) being done in or around your community?

- ☐ Yes
- ☐ No
- ☐ Not sure

21. There are several approaches that can be taken once a wildfire starts. To what extent do you favour or oppose each of the following approaches?

	Strongly oppose	Somewhat oppose	Neutral	Somewhat favour	Strongly favour	No opinion
Wildfires should be allowed to burn themselves out, as long as human safety and public and private structures are not in danger.	☐	☐	☐	☐	☐	☐
Wildfires should only be fought if the fire is likely to be very intense and spread very quickly.	☐	☐	☐	☐	☐	☐
Wildfires should only be fought if the fire is likely to burn large areas of land.	☐	☐	☐	☐	☐	☐
Wildfires should be fought as soon as they start, no matter what the cost.	☐	☐	☐	☐	☐	☐

Section 5: You and Wildfires

We are also interested in your personal experiences with wildfires and wildfire management.

22. Please indicate if you experienced any of the following situations by checking all that apply.

I have read about or watched coverage of wildfires in the media (i.e. television, news).	☐
I have felt fear or anxiety because of a wildfire.	☐
I have experienced discomfort or health problems from smoke from a wildfire.	☐
I have been placed on evacuation alert because of a wildfire.	☐
I have been evacuated because of a wildfire.	☐

I have experience or training in fire management and/or as a firefighter.	◻
I have lost my house or other structures on my property because of a wildfire.	◻
Someone close to me has lost their house because of a wildfire.	◻
I have personally seen smoke or flames from a wildfire near my house.	◻
Wildfire has come close to my community.	◻
I do not have any experience with wildfires.	◻

Section 6: You and Your Community

Finally we would like to ask a few questions about you to help determine if there are connections between peoples' characteristics and their opinions. This information will be kept confidential. If there is a questions you do not wish to answer please leave it blank and move on to the next question.

23. In regard to the issues and problems that you deal with in your everyday life, please indicate your level of agreement with each of the following statements.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	No Opinion
I have considerable control over what happens in my life	◻	◻	◻	◻	◻	◻
I can solve most of my problems by myself.	◻	◻	◻	◻	◻	◻
I sometimes feel helpless when dealing with problems.	◻	◻	◻	◻	◻	◻
I try to come up with a strategy about what to do.	◻	◻	◻	◻	◻	◻
I think about how I might best handle the problem.	◻	◻	◻	◻	◻	◻

24. Please indicate your level of agreement with each of the following statements.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	No Opinion
I often interact with other members of my community.	☐	☐	☐	☐	☐	☐
I feel like I belong in this town.	☐	☐	☐	☐	☐	☐
Even if I had the opportunity I would not move out of this town.	☐	☐	☐	☐	☐	☐

25. App**roximately how long have you lived in your town?**

______________________________ years **OR** _________________________________ months

26. Please indicate your gender:

Female ☐

Male ☐

27. In what year were you born? 19__________

28. Please indicate your highest level of education.

- ☐ Some grade school or high school education
- ☐ High school education
- ☐ Some post-secondary education
- ☐ College or trades certificate or diploma
- ☐ University or post-graduate certificate, diploma or degree

29. Which category best describes your total household income before tax in 2015?

- □ Less than $20,000
- □ $20,001- $40,000
- □ $40,001- $60,000
- □ $60,001- $80,000
- □ $80,001- $100,000
- □ More than $100,000

If there is any other information that you would like to provide to us concerning you views about wildfires, wildfire management, wildfire risks or preparing homes and properties for wildfires, please use the space below.

____

____

____

____

____

____

____

____

____

____

____

____

A summary of the results can be obtained by visiting our website October 1, 2016
http://colinswan7.wix.com/wildfires

Thank you very much for your participation!
Please return your completed survey in the enclosed postage paid envelope.

Appendix C-Reminder Card

THOMPSON RIVERS UNIVERSITY

You, Your Property and Wildfires

This is a follow-up reminder regarding a voluntary survey being conducted at Thompson Rivers University that was recently sent to you by mail. Please take a few minutes to share your opinions - your input is critical. Your answers are completely confidential and will be released only as summaries.

If you have any questions, please contact Colin Swan, MSc Environmental Science Candidate at swanc113@mytru.ca or250-819-1232.