Photo: M. Eldldershaw

Mapping wildfire risk in Canada

Institute for Catastrophic Loss Reduction, Toronto, Ontario, May 22, 2009

Wildfire risk is a complex topic. This document provides an overview of a selection of wildfire risk research issues and challenges.

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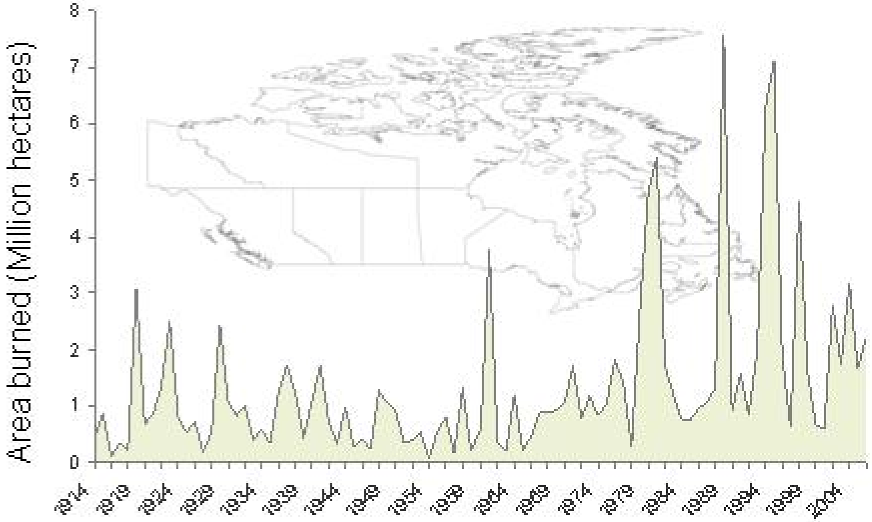
Wildfires are a problem in Canada

Area burned in Canada between 1914 and 2006, exceeded 1 million km²

That's an area equivalent to ~30% of 2001 forest and wooded area.

In short, Canada has a lot of forest land, and these forest areas generate a lot of fire.

Over long time periods, you can expect few areas to remain untouched by fire.



Wildfires are a natural part of dominant forest ecosystems in Canada

Fires are not a problem for the ecological systems where they occur. Wildfires are a natural part of dominant forest ecosystems in Canada. Most notably of these is the boreal forest – where large, intense fires are designed by, and in turn design, the forests.

Here you see an expanse of even-aged, lodgepole pine. This stand was created by a fire and now, 100 or so years later, it creates the perfect conditions for a subsequent stand-replacing fire that will initiate a new even-aged stand and so on.

Many fires over many years create a complex forest patchwork. Patches vary by forest composition (tree species) and structure (ages).

Fire plays different roles in other Canadian forest ecosystems, where you may, for example, have surface fire regimes – but the large, intense, stand-replacing boreal fires are by far the main contributors to area burned in Canada.

Photo: J.Beverly

Wildfires impact forest structure and composition in combination with other disturbances

Fires don't act alone. This photo was taken in the Vanderhoof area of BC. You can see mountain pine beetle (MPB) areas on a hillside of lodgepole pine.

There are two distinct patches here – with a younger age class revealing a fire scar. The younger trees are not suitable for MPB infestation and remain healthy (green).

This is how an old disturbance defines the boundary of the new disturbance and perpetuates variability in the age-class patch work.

Photo: J.Beverly

Human activities also influence forest structure and wildfire activity

Human influences on forest structure further complicate these interactions.

Here you see a fire in MPB killed pine encountered a harvested area which was not receptive to fire – leaving highly flammable MPB areas unburned.

This is an example of how the forest patchwork can limit the spread of a fire. The deliberate use harvest areas, roads, prescribed fire, and/or mechanical thinning of forest stands is considered one way of mitigating the potential for a large fire in an area. This is referred to as landscape 'Firesmart' planning or fuel management and is considered particularly useful for community protection planning.

While anecdotal evidence supports fuel management activities, the general effectiveness of this approach remains unproven in boreal forests.

Fuel management is also costly to conduct and maintain, and can negatively impact forest landscape values.

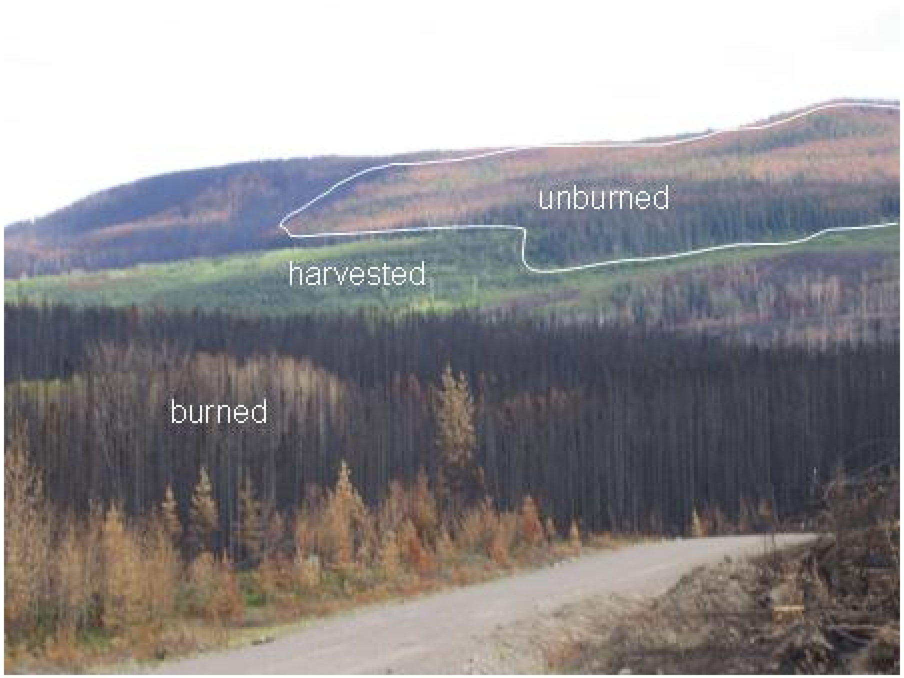


Photo: J.Beverly

There are uncertainties about future wildfire activity in Canada

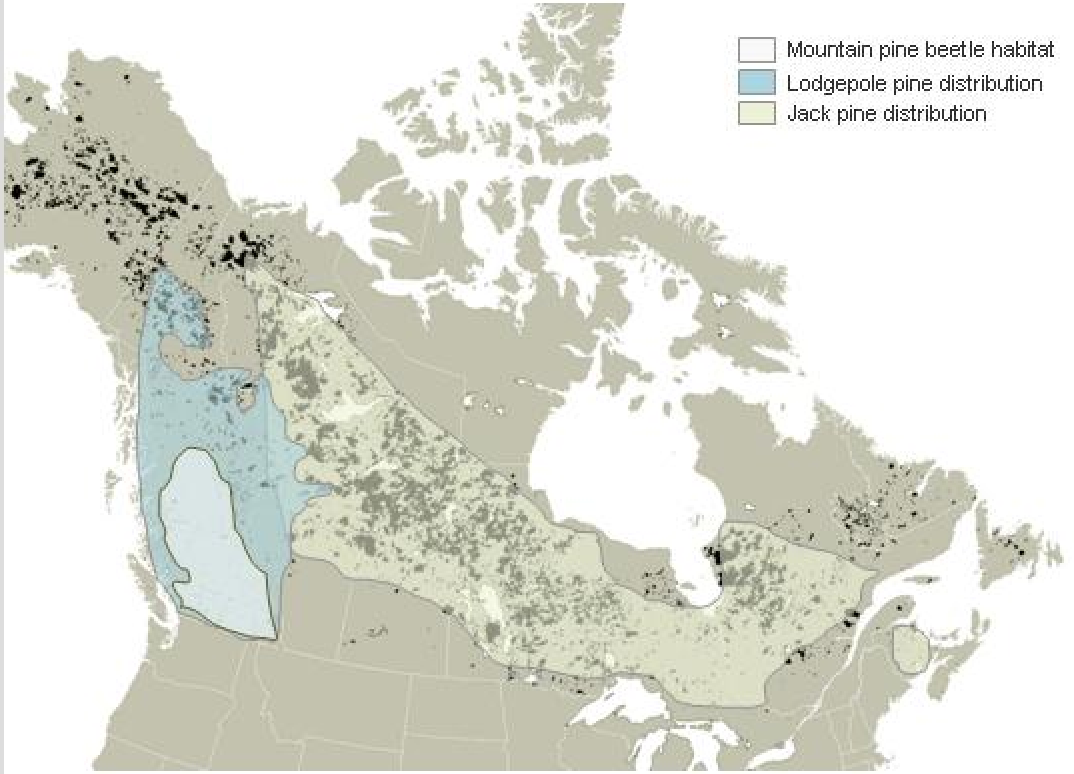
This map shows large fires >200 ha between 1980 and 1999.

We know a fair bit about fire regimes and historical fire activity in Canada. These have been documented in fire history studies and historical fire records and fire ecology studies.

But there's uncertainty about future fire activity because the conditions associated with historical fires no longer exist and will likely continue to change.

The landscape (and forest vegetation/fuels) have changed due to harvesting and development; a warming climate is changing fire weather conditions and influencing other disturbances, like MPB, that can be expected to influence fire activity.

If the MPB continues to spread beyond its natural range, into the expanse of boreal forest jack pine that stretches across the country, we will be dealing with unprecedented conditions.



Large fires (>1000 ha for Alaska, > 200 ha for Canada) 1980-1999 are shown in black/gray

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Wildfires have direct and indirect impacts on people, property and socio-economic systems

We care about assessing historical fire activity and we're concerned about the potential for future increases in fire activity because fire can have significant direct and indirect impacts on people, property, and socio-economic systems.

For example, suppression costs for the Chisholm fire in Alberta were $10 million and estimated timber losses were $20 million. The forest industry is important in Canada and fire impacts on timber supply in Canada has been recognized as an important fire research area.

In contrast fire impacts on property and the mechanisms of property damage have been largely unstudied in Canada.

Photo: P. Darrows, Reuters

Photo: J.Beverly

Major home loss events in Canada since 1950

Kelowna BC August 2003	238 homes
Louis Creek BC, August 2003	62 homes
Liverpool NS, May 1955	28 homes
Penticton BC July 1994	18 homes
Salmon Arm BC, August 1998	16 homes
Leaf Rapids MB, June 1995	17 homes
Interlake region MB, May 1989	15 homes

This may reflect the relatively modest home losses that typically occur in Canada during wildland-urban interface events. Kelowna is an obvious exception. Relative to other Canadian home loss events during the modern fire suppression era, the losses in BC in 2003 were very unusual.

Prior to the modern fire suppression era, individual wildfires in Canada have been responsible for complete destruction of entire towns, leaving thousands of people homeless. Some examples include Newcastle, NB (1825), Fernie, BC (1908), South Porcupine, ON (1911), Matheson, ON (1916), Haileybury, ON (1922).

Wildfires also have many indirect impacts

Fires also have many indirect impacts on infrastructure (road closures, railway closures, power and communication losses; impacts on forest industry (loss of mills, are closures); impacts on businesses due to evacuations or road/area closures in the short term, and landscape change in the long term (i.e., tourism); impacts on health; longer term impacts on water quality, erosion and so on…

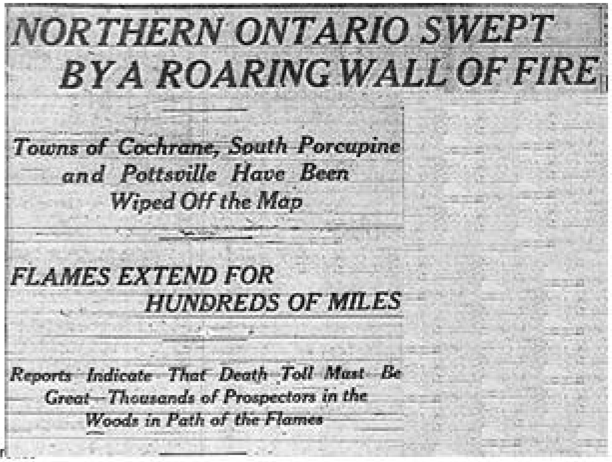
Indirect impacts are sometimes investigated in the aftermath of major fires or fire seasons. A study that looked at the impacts of the Kelowna fire on the tourism industry found that during the fire, the average decrease in business revenue was between 30-40% and losses continued for several months.

A study of the health impacts of smoke from the Chisholm fire found that economic impacts were substantial ($9-12 million) and second only to timber losses.

Wildfires can be a threat to human life

Great Miramichi Fire, NB October 1825	280-300 deaths
Crowsnest Pass Fire, BC August 1908	70-100 deaths
Porcupine Fire, ON July, 1911	at least 70 deaths
Matheson Fire, ON July, 1916	234 deaths
Haileybury Fire, ON October 1922	43 deaths
Dance Township Fire, ON October 1938	17 deaths

Individual wildfires in Canada have been responsible for complete destruction of entire towns and significant losses of life. All of these events occurred prior to the modern fire management era and contributed to the formulation of fire management legislation and initiation of fire suppression organizations.



NORTHERN ONTARIO SWEPT BY A ROARING WALL OF FIRE

Towns of Cochrane, South Porcupine and Pottsville Have Been Wiped Off the Map

FLAMES EXTEND FOR HUNDREDS OF MILES

Reports Indicate That Death Toll Must Be Great—Thousands of Prospectors in the Woods in Path of the Flames

Photo: Henry Peters / Library and Archives Canada / PA-029808

Organized fire management

In Canada, organized fire management was developed in an effort to detect fires early and suppress them before they became large and uncontrollable.

Most fires that are suppressed by Canadian fire management agencies are low to moderate intensity fires that cover less than the area of a football field. Only a very small percentage (<5%) of fires escape and become large. These extremely high intensity fires are the ones that pose a threat to people and property and are responsible for most of the area burned in Canada.

High intensity crown fires characteristic of the escaped fires in dominant Canadian forest ecosystems, like the boreal forest, cannot be controlled. Direct fire suppression by crews on the ground is ineffective and dangerous. In these situations, agencies must rely on indirect methods, such as igniting areas in advance of the fire in an effort to burn-out the fuel. Natural barriers to fire spread like lakes and rivers may also be used in combination with constructed fuel breaks to contain the fire.

A change or break in wind speed, wind direction, or other weather variables are required to stop or slow a crown fire and facilitate direct suppression activities.

Photo: J.Beverly

Photo: J.Beverly

Spryfield, Nova Scotia, April 30, 2009

When escaped fires encounter developed areas, the potential for major impacts on people exist.

The fire in Spryfield, NS is a recent example. Over 400 homes were evacuated - roughly 1200 people. Eight homes were destroyed and 10 were damaged.

Most escaped fire events involve extreme weather conditions. Fuel conditions can also contribute to the development of large, intense fires. In this case, dry fallen brush caused by Hurricane Juan in 2003 may have contributed to the fire.

Photo: M. Eldldershaw

Documentation of community evacuations due to wildfire in Canada 1980-2007

The Canadian Forest Service (CFS) is currently studying fire impacts on communities.

A database of community evacuation events has been compiled for the 1980-2007 period and is currently under analysis.

The database was initiated by Pete Bothwell (formerly CFS-Edmonton) and is being completed and analyzed by Jennifer Beverly (CFS – Edmonton).

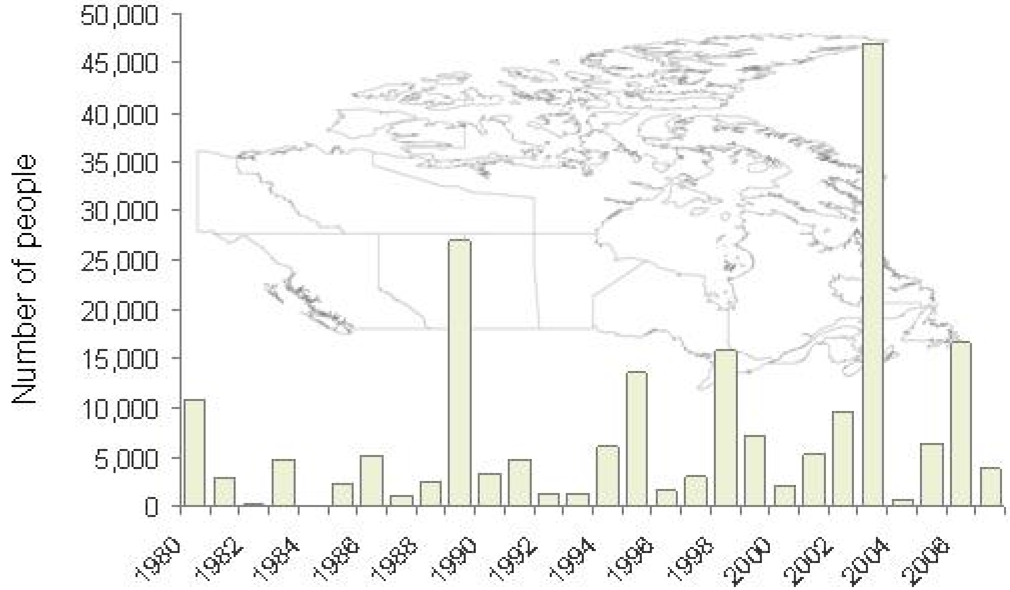
The primary source of information used to document evacuation events is popular media records (newspaper articles). These are supplemented by records from fire management agencies, emergency measures organizations, and other information sources.

The following pages present some early findings from this work. These results are preliminary and may change. PLEASE DO NOT CITE.

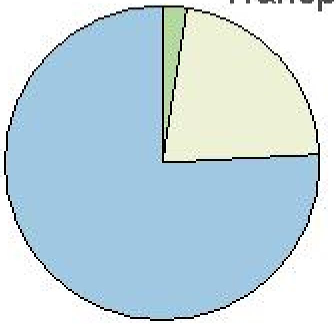
Photo: G. Marchand

Number of people evacuated 1980-2007

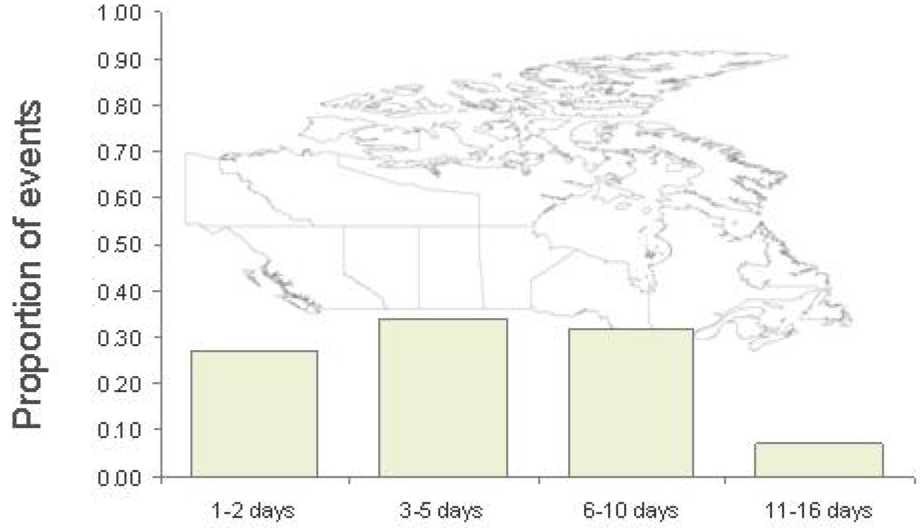
Over 200,000 people were evacuated due to wildfire in Canada between 1980 and 2007. This is an average of about 7,400 people per year.



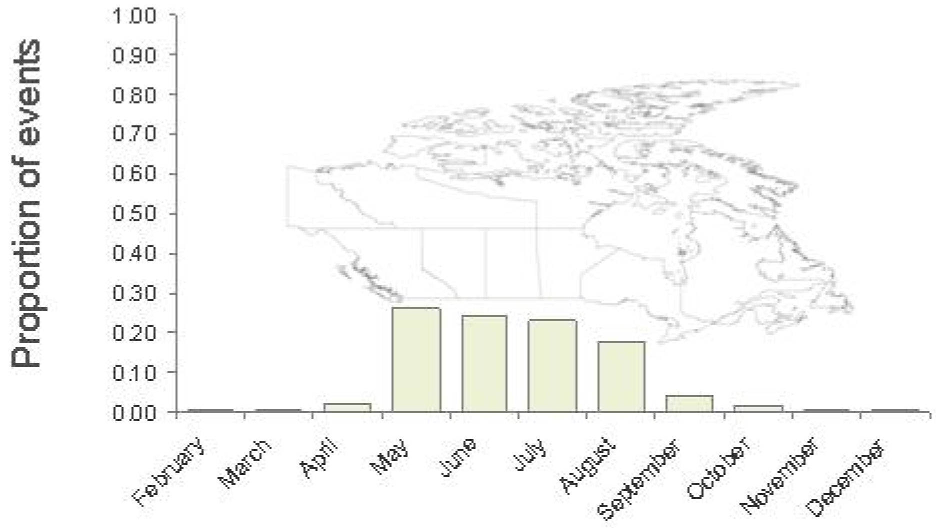
Evacuation cause (n=465)



Evacuation duration (n=355)



Evacuation events by month (n=542)

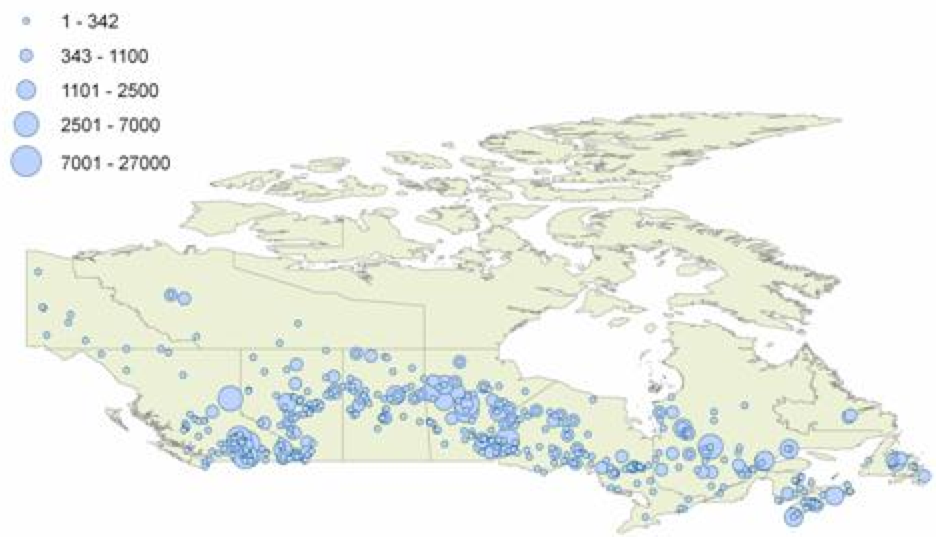


Spatial distribution of evacuation events

Evacuations occur in all parts of the country (except the arctic).

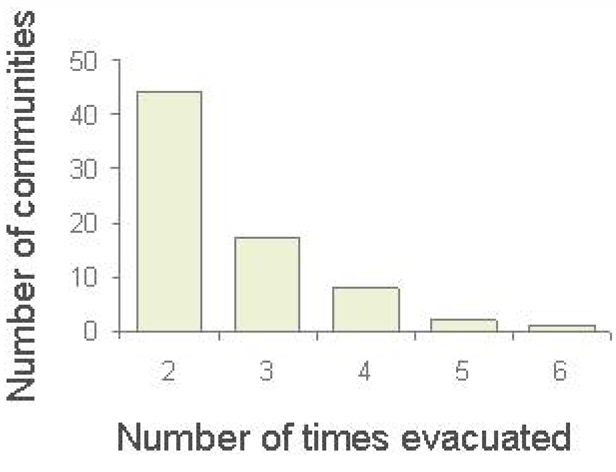
60% of evacuees were located in the boreal shield and boreal plain ecological zones.

30% of evacuees were located in in the montane cordillera (BC)



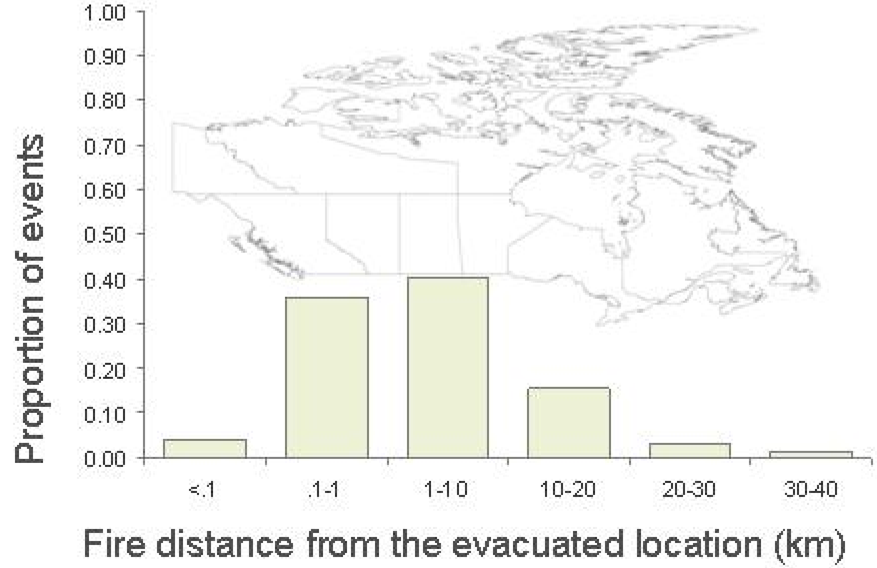
Locations with repeat evacuations (n=72)

Repeat evacuations have occurred for over 70 communities.



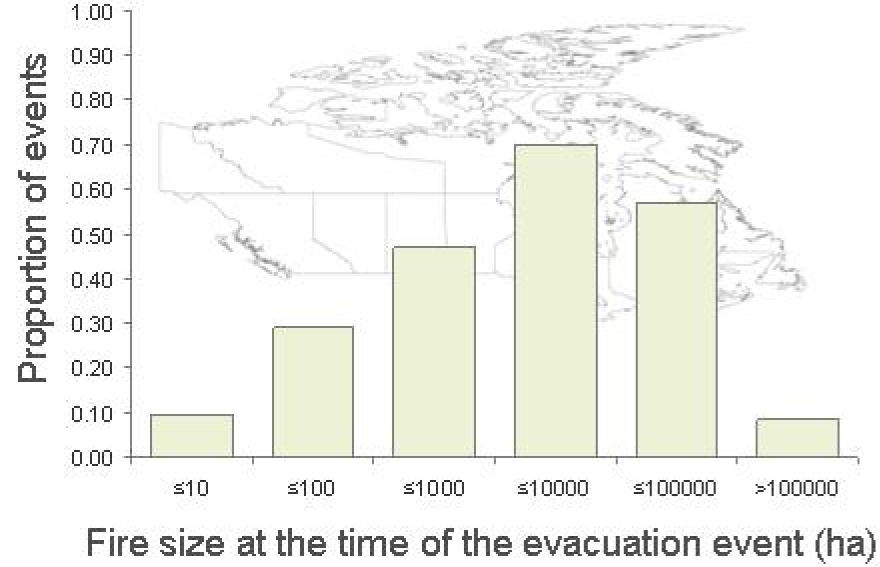
Fire distance from evacuation locations (n=149)

Most fires that prompt evacuations are within 10 km from the community.

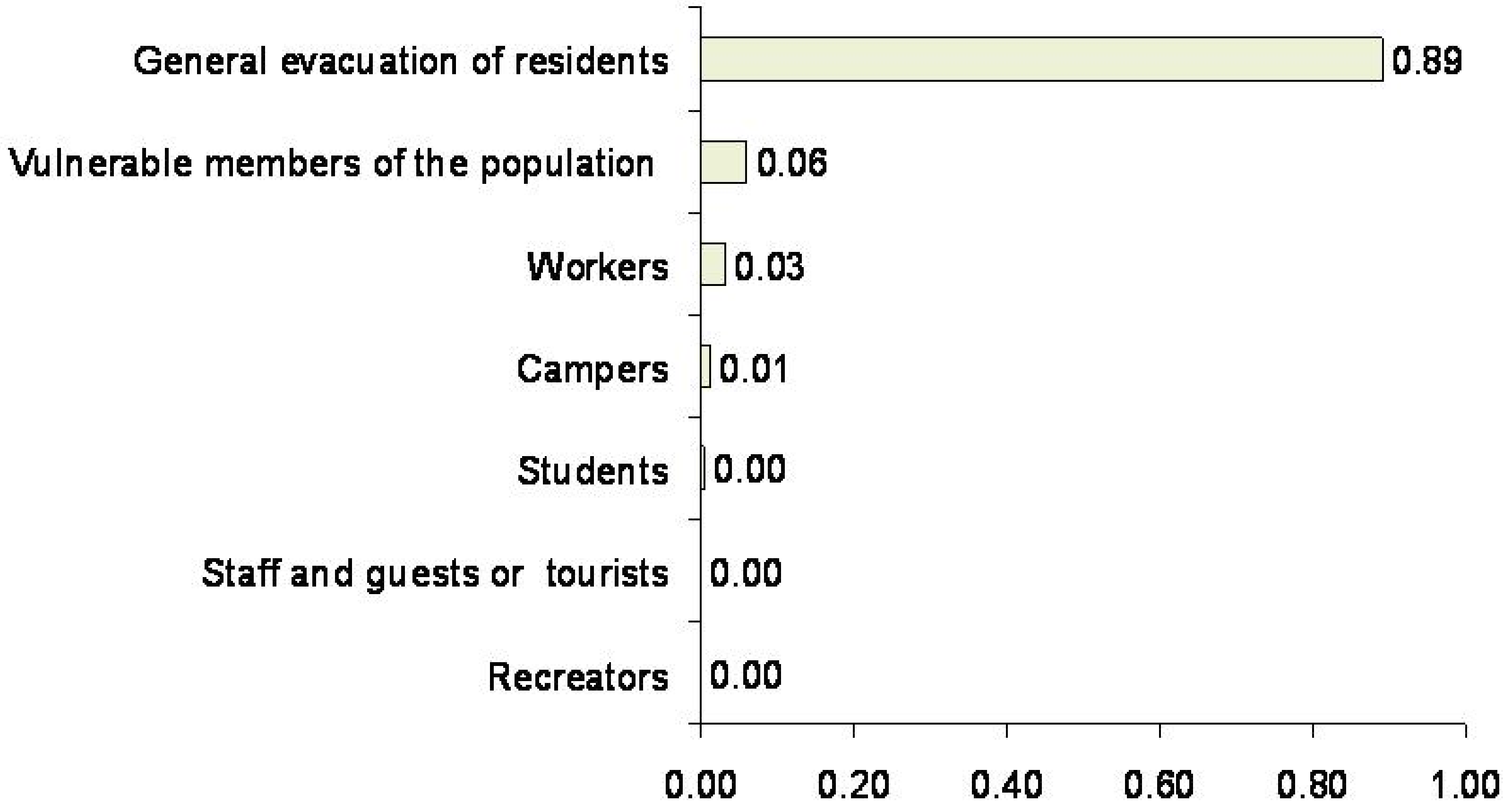


Sizes of fires that prompt evacuation events (n=183)

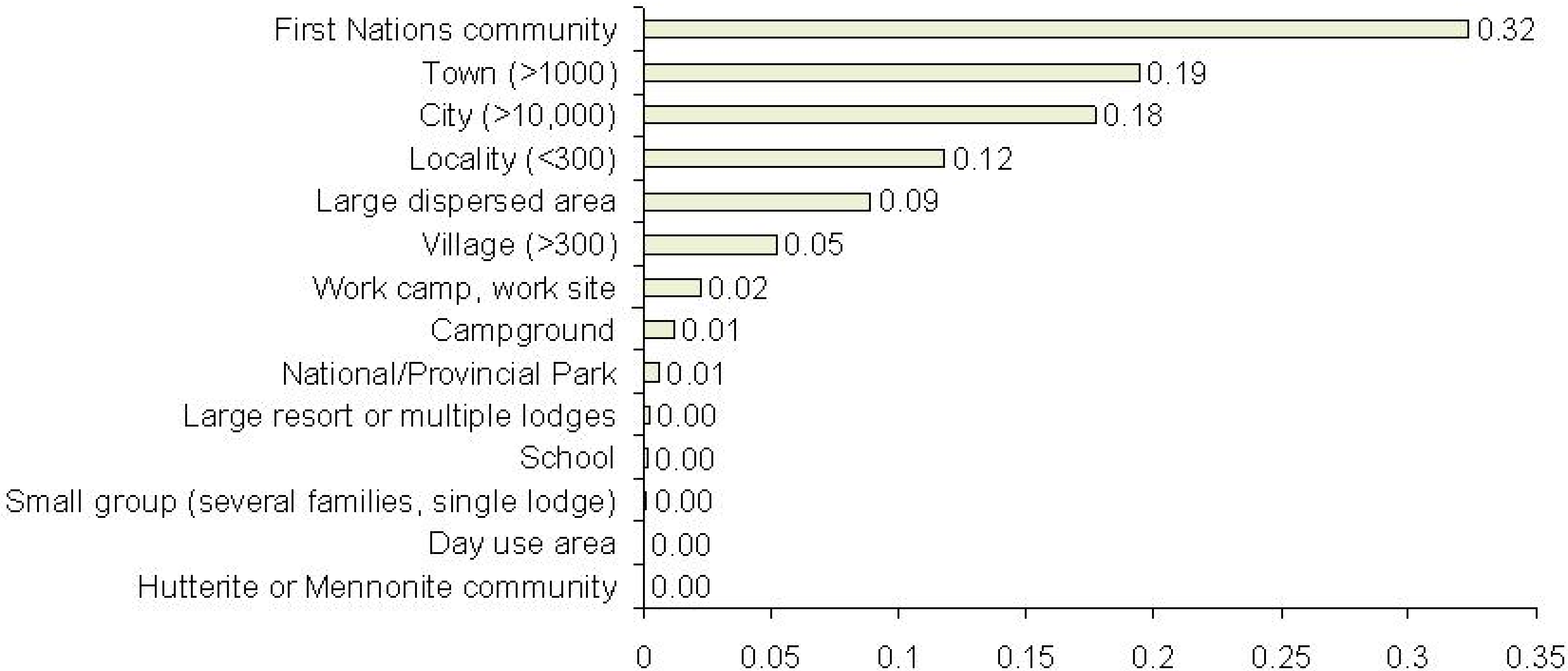
Fires of all sizes can prompt evacuations.



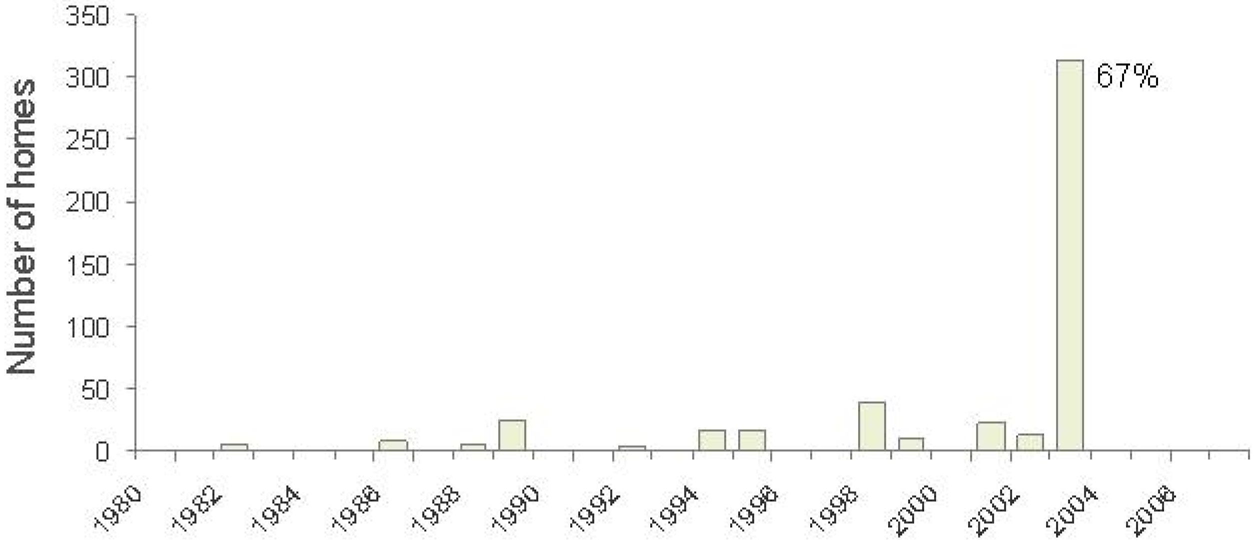
Proportion of evacuees by category



Proportion of evacuees by location category



488 home losses between 1980 and 2007



Photos: K. Hayes

Modeling fire risk in west central Alberta

Canadian Forest Service (CFS) researchers study approaches for assessing forest fire risk across landscapes and communities. A recently completed research project developed risk assessment methods using a case study area in west central Alberta.

Project Team

Jennifer Beverly (Project Leader)

Pete Bothwell, Fire Ecologist

Emily Herd, Spatial Data Analyst

Ross Conner, Spatial Data Analyst

Paul Way, Socio-Economic Analyst

Justin Wilkes, Spatial Data Analyst

Kinga Uto, Socio-Economic Analyst

Ana Espinoza, Spatial Data Analyst

Project partners

Alberta Sustainable Resource Development

Millar Western Forest Products Ltd.

ANC Timber Ltd.

Blue Ridge Lumber Inc.

Slave Lake Pulp Corporation

Fox Creek, Whitecourt, Slave Lake, Swan Hills

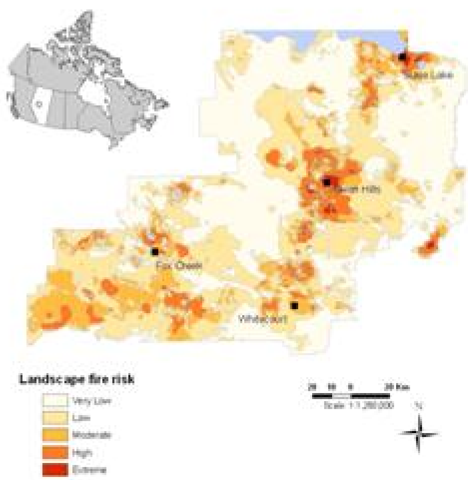
Project funding

Forest Resource Improvement Association of Alberta (FRIAA)

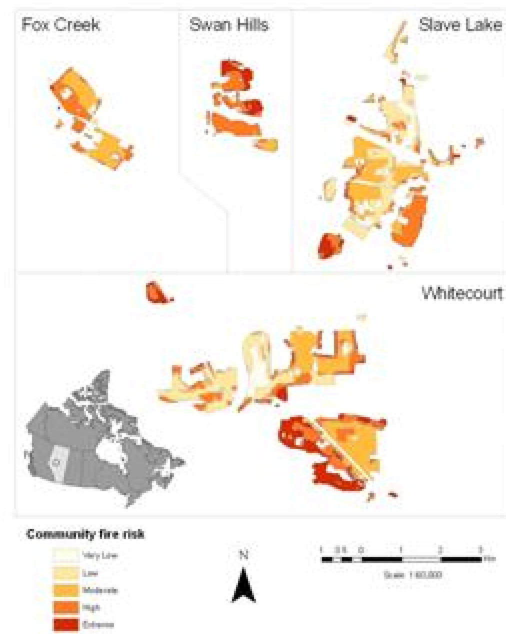
280K June 2005 – July 2007

The objective of the project was to map wildfire risk across a 2.4 million ha study area and to develop separate community fire risk maps for the four main communities within this area.

Landscape risk



Community risk



Landscape fire risk

The landscape fire risk map was a composite of two sub-maps.

Landscape susceptibility was mapped using a landscape simulation model that simulated the spread of thousands of fires across the study area to see which areas were most likely to burn. The simulations required extensive data and parameter inputs to ensure that the fires would reflect known fire environment conditions (fuel/vegetation, weather, topography) and known fire regime conditions (fire sizes, fire ignition patterns etc..).

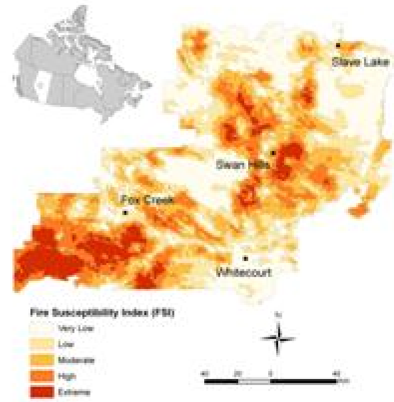
The landscape impacts map was developed from a map of forest landscape values collected in a participatory mapping exercise.

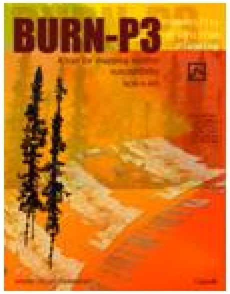
Methodological details are documented in:

Beverly, J.L., Uto, K., Wilkes, J., and Bothwell, P. 2008. Assessing spatial attributes of forest landscape values: an internet-based participatory mapping approach. Canadian Journal of Forest Research 38: 289-303.

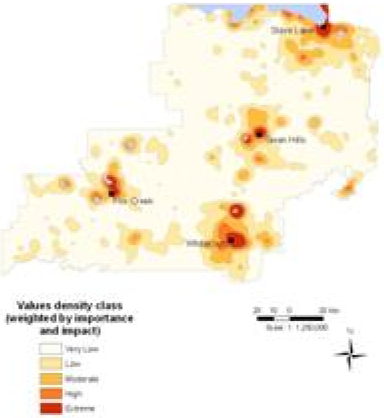
Beverly, J.L., Herd, E., Conner, C. Modeling fire susceptibility in west central Alberta, Canada. Accepted with minor revision, May 2009, Forest Ecology and Management.

Landscape susceptibility





Landscape impacts



Community fire risk

The community fire risk map was also a composite of two sub-maps. The goal was to provide a mid-scale assessment that would summarize risk at the neighborhood level and serve to inform more detailed site level assessments.

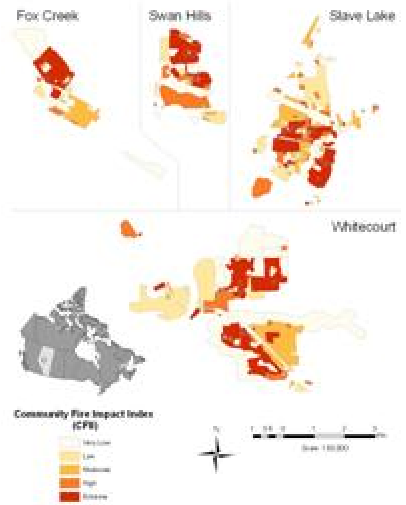
Community susceptibility was mapped by investigating the exposure of locations within the community to fuels/vegetation capable of producing ignition sources. Three ignition methods were included in the assessment (radiant heat, short range spotting, and long-range spotting).

Mid-scale community impacts were also mapped. Our goal was to evaluate potential disruptions to social and economic systems associated with three different fire event scenarios (emergency fire, local fire, regional fire) First we defined "functional units" within the community and conducted semi-formal interviews to determine how these establishments would be impacted by wildfire (i.e., rate their vulnerability). A fire impact rating was calculated by inventorying the units and rating the Influence of the functional unit on individuals (number of employees employed) and on the community (scarcity/duplication); the importance of the functional unit (essential vs. non-essential); and the replaceability/vulnerability of the functional unit.

Manuscripts documenting the community fire risk assessment method are currently under review.

Community susceptibility

Community impacts



Concluding comments

- Wildfires are a problem in Canada
- There are uncertainties about future wildfire activity
- Wildfires have direct and indirect impacts on people, property and socio-economic systems
- Direct timber losses typically exceed the value of other impacts
- Fire impacts on property and the mechanisms of property damage have been largely unstudied in Canada
- Documentation of fire impact events can help us to understand community fire risk factors
- Fire risk mapping can inform strategic level fire management related to both fire suppression and mitigation activities
- Comprehensive fire risk assessments must be done at multiple scales (landscape, community, site)
- Landscape scale analysis is challenged by data availability and quality; modeling limitations and complexity
- There is a need for simplified approaches
- Approaches to community fire risk analysis are less established and landscape level fundamentals don't necessarily apply
- Innovation in the way we think about protecting communities from wildfire need to be explored and promoted