National Wildland Fuels Management Survey
(Revised)

Contract Report CR-729(R)

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Table of Contents

Introduction

The behaviour of wildland fire is determined primarily by the weather, the topography, and the fuel. Little can be done about weather or topography. But wildland fuels, which supply the energy that makes some fires uncontrollable, are subject to modification and management (Countryman 1974).

Hazardous wildland fuels exist in varying extents and conditions throughout a diverse mosaic of ecosystems across the Canadian landscape. Wildfire in expanding areas of hazardous wildland fuels is recognized as a threat to communities and other values in many parts of Canada. This has been an on-going cycle of concern dating back to settlement periods in the 1800s and 1900s.

Fuels management is defined as "the planned manipulation and reduction of living or dead forest fuels for forest management and other land use objectives (such as hazard reduction, silvicultural purposes, wildlife habitat improvement) by prescribed fire, mechanical, chemical or biological means, and changing stand structure and species composition" (Merrill and Alexander 1987). Wildfire management agencies across Canada independently develop and implement fuels management programs to inventory, assess and mitigate potentially hazardous wildland fuels.

The Wildland Fire Management Working Group (WFMWG) provides policy advice and strategic guidance to the Canadian Council of Forest Ministers on the subject of wildland fire management in Canada. In 2011/12 the WFMWG developed a working partnership with the Canadian Interagency Forest Fire Centre (CIFFC) Council of Directors to undertake projects of mutual interest. The WFMWG and CIFFC have identified that a more coordinated approach to wildland fuels management across Canada is a desirable strategic goal. Accordingly, they have created a Fuels Management Task Team (FMTT) to undertake three initial deliverables to achieve this goal:

- Complete a survey of wildland forest fuels conditions and management programs across its member agencies.
- Develop a strategy to gather, share and communicate best fuels management practices and policies.
- Pursue innovative approaches to mitigating the costs of fuels treatments.

To address the first deliverable, FPInnovations was contracted to survey the 13 wildfire management agencies across Canada to gather and compile information on the following wildland fuels management issues:

- The extent, cause and risk posed by hazardous wildland fuels; including recent (past 10 years) and expected future trends (next 5 years).
- The availability and suitability of forest health, forest inventory and other surveys in providing information on the extent and severity of hazardous fuels accumulations.
- The application and effectiveness of forest and land management planning policies/guidelines in mitigating forest fuel hazards.
- The extent and effectiveness of current fuels management programs and ways to improve them.

Objectives

1. Compile and organize data collected from the wildland fuels management surveys completed by participating wildfire management agencies.

2. Identify gaps in forest fuels inventory systems; forest fuels management practices; and knowledge transfer between Canadian wildfire management agencies.

Executive Summary

Recent catastrophic wildfires across Canada demonstrate the volatility of wildland fuels and underscore the need for active fuels management programs to mitigate the threat of wildfire. Wildland fuel conditions are constantly altered by degrading influences such as climate change and weather related events, insects and disease, and industrial disturbances. Historical data indicates an increase in areal growth and severity of hazardous wildland fuels with expectations for this trend to continue in most hazardous fuel types.

Forest inventory systems and forest health data management systems used by the member agencies across Canada are at various stages of development and capacity to capture and communicate forest health and fuels management data. Many of the forest inventory systems which are developed to capture merchantable timber data do not adequately meet the needs of fuels management programs to manage fuels management data. Fuels management programs can be enhanced by upgrading to more robust data management systems that incorporate fuels management data layers with nationally accepted standards and requirements for inventory and mapping processes and functionality.

Across Canada, legislation and policy regarding fuel hazard mitigation for industry operation in the wildland are varied and often reflect the extent of industry disturbances and the potential threat to values. Timber harvesting programs may incorporate several mitigation strategies into harvest block design through various planning requirements and tools developed by the wildfire management agencies. Harvest debris management is a common challenge among member agencies which needs to be addressed at a policy level to set appropriate debris loading standards. There is agreement among member agencies that legislation and standards need to be established for development in the wildland-urban interface (WUI) and out to the landscape. Acceptance and adoption of FireSmart guidelines is in the conceptual stage in some agencies while other agencies have well-developed guidelines and requirements for residential and industrial developments in the WUI.

The scale and complexity of fuels management programs across Canada is often a function of the extent of hazardous fuels, threat to values, and resource (monetary and personnel) availability. Delivery of fuels management programs is accomplished in multiple formats through different combinations of administrative agencies, funding agencies, partnerships, and other resources. Disturbances or hazardous fuel conditions common to several agencies are often addressed through universally adopted programs such as FireSmart or prescribed burning. Limited budgets and unsecured funding, limited expertise and capacity in fuels treatment program delivery, public resistance to prescribed burning and fuels treatment projects and multiple layers of jurisdiction in approval processes are seen as barriers to implementation of fuels treatment programs.

While each Canadian wildfire management agency independently addresses unique challenges in managing hazardous wildland fuels, efficiencies and increased capacity in program delivery can be developed through synergies of expertise, technologies, and communication. This survey report attempts to identify common challenges in fuels management programs and synthesizes recommendations that have been presented by responding member agencies.

Methods

FPInnovations and the FMTT developed the National Wildland Fuels Management Survey to address the four fuels management topics. On February 6, 2012, the survey was distributed to member agency representatives. A database was created for the collected data and mirrored the structure and questions contained in the survey.

The following abbreviations for each of the surveyed member agencies (as listed in the CIFFC directory) have been used in this report:

BC – British Columbia
YT – Yukon Territories
AB – Alberta
NT – Northwest Territories
SK – Saskatchewan
MB – Manitoba
ON – Ontario
QC – Quebec
NB – New Brunswick
NS – Nova Scotia
PE – Prince Edward Island
NL – Newfoundland
PC – Parks Canada

Results

Topic 1: Extent, Cause and Trends in Hazardous Wildland Fuels

Definition and Categories of Hazardous Wildland Fuels

Survey respondents were asked to comment on the definition of **"hazardous wildland fuels"** that had been created by the Fuels Management Task Team:

> *'Any fuel that will sustain a fire that has the potential to cause damages to values directly or through the production of flying embers. The degree of hazard may depend on fuel load, fuel condition, and fuel structure. Fuel condition includes degree of curing or damage from insects, environmental factors and pathogens. Fuel structure means horizontal and vertical continuity which affects intensity and rate of spread.'*

Survey responses indicated agreement with the definition with no comments or suggestions for modification or for alternate definitions.

For the purposes of this survey, hazardous wildland fuels included fuels across the landscape as well as wildland/urban interface areas and were categorized as follows:

Category 1: Areas of forest stands or other wildland vegetation impacted by insect or disease.

Category 2: Areas of storm or weather-related damage, or other climatically-influenced impacts on forest/vegetative health.

Category 3: Areas affected by other types of biotic and abiotic influences.

Category 4: Areas affected by industrial operations (forest harvesting, oil and gas exploration and extraction, other industrial operations) that lead to accumulations of hazardous fuels – slash, slash piles, etc., or significantly increased risk of fire ignitions.

Category 5: Areas of hazardous wildland vegetation species or conditions that are in proximity (i.e. 10km radius) to communities, human activity areas, other socio-economic values, or areas otherwise considered to be part of the "wildland-urban interface".

Category 6: Other hazardous fuels important to your agency.

Category 1 fuels had the largest reported areal extent among all categories with mountain pine beetle (Figure 1) and spruce bark beetle cited as the largest causal factors in western Canada. MPB is within 100-200 km of the southern YT border and may migrate into the territory. An impact analysis has been initiated to evaluate the potential impact. MPB has also been found 50 km south of NT in late 2011 and it is expected that the MPB and other insect and pathogen disturbances may move into NT with continued climate change. In eastern Canada, spruce budworm was identified as the most predominant source of insect damage.

Figure 1. Wildfire in Mountain Pine Beetle infested stands.

Reported storm or weather-related disturbances such as Hurricane Hugo experienced in NL and Labrador, and a major wind event in SK, are cited examples of disturbances resulting in Category 2 hazardous fuels (Figure 2). ON fire managers agree that the amount of storm damaged fuels appears to be increasing but a lack of historical data makes quantification difficult. The frequency of extreme wind events appears to be increasing in ON and the overall aging forests are becoming more susceptible to wind damage. Climate modeling suggests that with warming climate, the severity and frequency of storms will increase in North America. If the occurrence of storm damage is relatively uniform over time the risk and hazard at a landscape scale should remain the same. Other climatic factors that can contribute to Category 2 hazardous fuels are drought and hail.

Photo courtesy of Ontario Ministry of Natural Resources.

Figure 2. Hazardous fuels in blowdown at Wabikimi Provincial Park, ON.

In SK, other types of biotic and abiotic influences impacting commercial forests under an FMA are tracked in the agency inventory system through the Animal Kill (AK) disturbance code.

In several areas of Canada, the recent downturn in the forest industry has resulted in a reduction in harvested areas and less hazardous fuel by-products (Category 4) on the landscape. In some cases (ON) this reduction of hazardous fuels created from timber harvesting is offset by hazardous fuels created by the mining industry. However, the net effect is likely an overall decrease in the amount of Category 4 fuels.

The hazardous fuels identified in Category 6 include exposed coal seams, seasonal hazards such grass fuel types, dry standing grain and grass lands, hedgerows and dry wetlands which can carry surface fire to forest stands and structures. As dieback and mortality occur in aspen stands, growing volumes of woody fuel accumulations increase the potential for more intense fire behaviour (Alexander 2010).

Areal Extent and Severity of Hazardous Wildland Fuels

Forest inventory programs and ongoing hazardous fuels survey programs across Canada are in different stages of development and implementation. Table 1 lists the member agencies that have estimates for the areal extent and severity for the hazardous fuels categories within their management areas.

Table 1. Agencies with current estimates of areal extent and severity of hazardous wildland fuels.

Category	Areal Extent Estimate		Severity Estimate	
	YES	NO	YES	NO
1	BC YT AB NT SK MB ON NL QC NS PC[a]	PC	BC YT AB NT SK MB ON QC NS	NL PC
2	BC AB SK ON NS PC	YT NT MB PC	BC AB SK ON NS	NT MB PC
3	BC SK NS PC	YT AB MB PC	BC SK NS	AB MB PC
4	AB NT MB ON	BC YT SK NS PC	AB MB ON	BC NT SK NS PC
5	BC AB NT SK NB NS PC	YT MB ON	BC AB NT NS	NB MB ON SK
6	AB NS[b]	BC YT NT MB SK PC	NS	BC SK MB PC

[a] *Some insect or disease damaged areas have been mapped.*
[b] *NS1 Any area consisting primarily of ericaceous plants, sphagnum or other mosses with less than 25% tree cover.*

The amount and type of data collected through the various forest inventory programs over the last ten years varied across the member agencies. Forestry industry activity is often a key driver in developing forest inventory programs. PC has a high degree of acceptance of natural disturbances as part of the landscape with fewer conflicts between some of the major causal factors and forest values. Hence, less emphasis is placed on data collection for areas of hazardous fuel accumulations in the national parks. In some individual national parks, insect or disease damaged areas have been mapped. The designation of full response zones and modified zones for wildland fire response and suppression operations is not consistently implemented across Canada. Some agencies reported separate data for area occupied by hazardous fuels in full response zones and modified response zones[1]. The fire hazard in some hazardous fuels varies throughout the fire season and may be hazardous only in certain times of year. For example, grass and deciduous species present dynamic fire hazard conditions throughout the fire

[1] Application of 'modified response zones' varies across Canadian wildfire management agencies; parameters for establishing 'modified response zones' could include low values areas, latitude threshold, or protection of ecologically sensitive areas.

season. For purposes of clarity, data is presented in separate tables for the two response areas (Table 2 and 3). Most reported data is a combination of mapping data and estimates.

Table 2. Estimated area (in hectares) of hazardous fuels in full response zones (2011).

Agency	Fuel Category					
	1	2	3	4	5	6
BC	7,271,044	52,189	Captured in 1&2	10,000	64,068[a]	n/a
YT	151,000	NO DATA PROVIDED				
AB	767,953	47,849	Captured in 2	39,436	60,000	55,000[b]
NT	41,328	NO DATA	n/a	10,000	4300	Undetermined
SK	28,006	98,955	18,795	Undetermined	4,584,265[c]	n/a
MB	980,289[d]	NO DATA PROVIDED		91,602	NO DATA PROVIDED	
ON	21,850,063	3,295,964	1,329,227			
QC	1,642,957[e]	NO DATA SUMMARY AVAILABLE[f]				
NB	0	0	0	0	124,100	0
NS	95,000	23,000	n/a	199,000	151,800	120,000
PE	NO DATA PROVIDED					
NL	211,000	0	0	0	0	0
PC	9,000	3,000	2,000	n/a	7,100[g]	44,350[h]

[a] *From the BC Provincial Strategic Threat Analysis.*[2]

[b] *Spring/Fall hazard with grass (O1a/b) fuels 2 km from communities.*

[c] *Based on a 20km radius (instead of standard 10km) using a 60% modifier to estimate areal extent of hazardous fuels surrounding community zones.*

[d] *This figure is the sum of annual increases in area over the last 10 years and likely overstates the actual area of hazardous fuel.*

[e] *Spruce Budworm has created the greatest extent of damaged forest. This figure represents the area affected by spruce budworm but does not necessarily reflect the area of 'hazardous fuels'.*[3]

[f] *This information is included in the map of forest fuels*[4] *across Quebec and cannot be extracted in the form of a summary.*

[g] *This figure represents the pre-treatment area. Approximately 4,000 ha have been treated since 2001 in the WUI.*

[h] *This figure represents the pre-treatment area. Approximately 15,000 ha have been treated by prescribed burning since 2001.*

PC has established a reduced radius zone of 200m for WUI fuels classifications. They believed that creating a 10km radius zone around even the most significant values at risk is both impractical and unnecessary for their agency.

The Category 6 fuels data provided by PC represents the area of hazardous fuels within park boundaries that have known potential for fire spread to values at risk.

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[2] https://ground.hpr.for.gov.bc.ca/provincialstrategicthreatanalysis.htm

[3] Aires infestées par la tordeuse du pin gris, au Québec, en 2006 http://www.mrnf.gouv.qc.ca/publications/forets/fimaq/insectes/tordeuse/Tpg_2006_p.pdf

[4] Classification of Forest Stands as Fuels According to the Canadian Forest Fire Behavior Prediction (FBP) System http://www.mrnf.gouv.qc.ca/english/publications/forest/fimaq/classification-forest-stand-third.pdf

Table 3. Estimated area (in hectares) of hazardous fuels in modified response zones (2011).

Agency	Fuel Category					
	1	2	3	4	5	6
BC	BC does not use modified response zones (by latitude) but does have modified response areas identified in fire management plans					
YT	192,000	NO DATA PROVIDED				
AB[b]	30,000	NO DATA PROVIDED		2,500	NO DATA PROVIDED	
NT	n/a – modified response zones not designated in NT					
SK	621	2,045	911	n/a	n/a	n/a
MB	NO DATA PROVIDED			4848	NO DATA PROVIDED	
ON	1,006,068	1,106,808		61,121		
QC	NO DATA PROVIDED					
NB	n/a – all of NB is a full response zone					
NS	n/a					
PE	n/a -- all of PE is a full response zone					
NL	NO DATA PROVIDED					
PC	Fuel in the MR Zone is not located in proximity to values at risk and therefore does meet the definition of hazardous..					

[a] *Application of 'modified response zones' varies across Canadian wildfire management agencies; parameters for establishing 'modified response zones' could include low values areas, latitude threshold, or protection of ecologically sensitive areas.*

[b] *Ecological Wildfire Management Zones.*

Annual Increase in Areal Extent of Hazardous Fuels

Some survey respondents reported annual growth in the areal extent of hazardous fuels consistently above 100,000 ha over the last ten years. However, as one survey respondent noted, the current area occupied by hazardous fuels is not represented by the sum of annual increases. This apparent discrepancy can be explained by fuel transitioning to a less hazardous condition and rejuvenation of attacked species.

Presentation of complete annual area growth statistics over the last ten years in all hazardous fuel categories for all member agencies is not possible in a tabular format for this document. To capture and organize the annual area growth by category and agency, a spreadsheet has been created that will allow ongoing input of annual statistics from member agencies. While some agencies did not have data available for these annual increases, estimates of average annual increases were provided. These estimates and averages from provided annual data are presented in Table 4.

Table 4. Estimated average annual increase in hazardous fuels (hectares).

Agency	Fuel Category					
	1	2	3	4	5	6
BC	808,327 (MPB)	125,000	52,000	10,000	1,000	n/a
YT	75,000	NO DATA PROVIDED				
AB	134,653	15,631[a]	Captured in 2	23,979	61,126	55,000
NT	400	NO DATA	n/a	500	50	0
SK	n/a					
MB	98,028	NO DATA PROVIDED		10,716	NO DATA PROVIDED	
ON[b]	2,285,702	440,276		181,433		
QC	NO DATA PROVIDED					
NB	NO DATA PROVIDED					
NS	DATA DOES NOT EXTEND BACK 10 YEARS					
PE	NO DATA PROVIDED					
NL	22,400	NO DATA PROVIDED				
PC	No figures supplied but indications are that there is an increase in all fuel categories of hazardous fuels (excluding Category 4).					

[a] *Average of 2009-2011 annual increases.*
[b] *This figure represents combined estimates for full response and modified response areas.*

Spatial Formatting Capabilities

Most surveyed member agencies indicated they were able to provide information on certain hazardous fuels in a spatial format with limited capabilities or data for other fuels. In western Canada, Category 1 fuels were the most extensively mapped hazardous fuel type with the greatest mapping capability and collected data for this category. GIS compatible files are the standard format for storing and displaying hazardous fuels data. Attributes identified by mapping tools vary by agency but typical attributes include date of survey, hazardous fuel type, hazard severity and date of occurrence.

ON incorporates unique mapping attributes for Category 2 hazardous fuels to enhance representations of storm damaged fuels. These attributes include disturbance type (blowdown, ice damage, etc.), severity, estimated date of disturbance, and disturbance pattern (straight line or cyclonic).

AB has an annually updated provincial fuel grid which captures recent disturbances. This grid is used in other models, such as the Wildfire Threat Model - fire behaviour potential layer. Both the fuel grid and the fire behaviour potential layer are available to external clients through web-based applications[5] that allow them to spatially view a variety of data including the Wildfire Threat Assessment and submit

[5] Alberta FireWeb
http://www.srd.alberta.ca/Wildfire/FireSmartIndustry/documents/ExternalFireWebAccessandQuickStart-May2006.pdf
Alberta Wildfire System
http://www.srd.alberta.ca/Wildfire/FireSmartIndustry/AlbertaWildfireSystemFireWeb.aspx

Industrial Wildfire Control Plan (IWCP) information and complete a Powerline Hazard Assessment Plan (PHAP).

The Saskatchewan Forest Vegetation Inventory (SFVI) is available for the most active areas of the commercial forest and captures areas of hazardous fuels in Categories 1, 2, and 3. The SFVI inventories forest stands with insect and disease damage, and assigns a severity code: Light, Moderate, Heavy, Severe, and Entire. Category 2 fuels in the SFVI use the same extent/severity code. While QC wildfire management does have most forest data available in a spatial format, the majority of the data does not belong to wildfire management and is managed by another entity. Sharing this information, when applicable, is therefore subject to the terms of various regulations and licenses.

BC has mapped fuel hazards using Vegetation Resource Inventory (VRI) and while it provides the species and stocking density, more information on the fuels arrangement and other wildfire risk related factors would be needed. BC and AB are exploring LiDAR[6] as a potential next step and other emerging products for fuels and fire mapping.

PC has some excellent, but isolated spatial information regarding fuel types and recommended fuels treatments for developed areas (e.g. WUI). Standardized hazard assessments of wildfire risk, including fuel conditions, were conducted around virtually all commercial developments and important park facilities within the Mountain, Prairie, and Atlantic Region parks. That information has been used to guide activities for the abatement of hazardous fuels near vulnerable facilities.

Trends in Hazardous Fuels Occurrence and Area Growth

Historical trends and anticipated future trends are important considerations in developing and implementing hazardous fuels management programs. This section of the survey asked member agencies to indicate recent trends in growth of hazardous fuels area and changes in the factors creating hazardous fuels (Tables 5 and 6). Predicted future trends in area growth and causal factors are presented in Tables 7 and 8.

Table 5. Recent trends in area growth of hazardous fuels.

Fuel Category	Increasing	Decreasing	Same
1	BC AB SK QC PC	MB NL	YT NT NS
2	BC SK MB ON NL PC		YT AB NT QC NS
3	BC PC		YT SK MB QC NS
4	NT	SK MB ON NS	BC YT AB QC PC
5	YT NT NB NS	BC AB PC	SK QC MB ON
6	PC		AB NT MB

[6] Light Detection and Ranging

Table 6. Recent trends in factors creating hazardous fuels.

Fuel Category	Increasing	Decreasing	Same
1	BC AB SK MB QC PC	YT NL	NT NS
2	BC MB ON NL PC		YT AB SK QC NT NS
3	BC PC		YT SK MB QC NS
4	AB PC	SK MB ON NS	NT YT BC QC
5	YT AB NT SK NB NS	BC PC	MB ON QC
6			AB MB NT

Table 7. Anticipated changes in area growth of hazardous fuels.

Fuel Category	Increasing	Decreasing	Same
1	BC YT AB SK MB QC PC NS	NL	NT
2	BC NT MB ON NL PC		YT AB NT SK QC NS
3	BC PC		YT SK MB QC NS
4	YT MB NS	BC SK ON	AB NT QC PC
5	YT SK NB NS	AB BC PC	NT MB QC
6	PC		BC AB MB NT

Table 8. Anticipated changes in the degree of hazard/risk of hazardous fuels.

Fuel Category	Increasing	Decreasing	Same
1	BC YT NT SK MB QC PC NS	NL	AB
2	BC NT MB NL PC		YT AB SK ON QC NS
3	BC PC		YT SK MB QC NS
4	YT SK	BC	AB NT MB ON QC PC NS
5	YT SK NB NS	BC NT PC	AB MB QC
6	PC		BC AB NT MB

Topic 2: Availability and Suitability of Forest Inventory and Health Survey Information

Member agencies across Canada monitor, track, and communicate the occurrence and extent of hazardous wildland fuels and forest health events using various means of detection, inventory, mapping, and information dissemination. The scale and complexity of forest inventory and forest health programs developed and implemented by an agency is generally indicative of the extent of timber harvesting and/or hazardous fuels within that agency's land base. The group or program responsible for tracking, maintaining and reporting on forest inventory and forest for each agency is outlined in Table 9.

Table 9. Agency group responsible for tracking, maintaining and reporting forest inventory and health information.

Agency	Forest Inventory	Forest Health
BC	FAIB-Forest Analysis & Inventory Branch (Previously Inventory Branch)	Ministry of Forest, Lands, Natural Resource Operations - Silviculture Program
YT	Dept. of Energy Mines and Resources - Forest Management Branch	Dept. of Energy Mines and Resources - Forest Management Branch
AB	Forest Management Branch - Resource Analysis Section.	Forest Management Branch - Forest Health Section.
NT	Forest Resources - Forest Management Division	Forest Resources - Forest Management Division
SK	Inventory and Planning Unit	Inventory and Planning Unit, Insect and Disease Unit
MB	Forest Inventory and Resource Analysis Section - Forestry Branch	Forest Health and Renewal Section - Forestry Branch
ON	Inventory, Monitoring and Assessment (IMA) Section, Forest Inventory Unit, Science and Information Branch	Conducted through a partnership between Ontario Ministry of Natural Resources (OMNR) Forest Health Section and Natural Resources Canada-Canadian Forest Service (CFS)
QC	The Direction des Inventaires Forestiers (Forest Inventory Directorate)	The Direction de la Protection des Forêts (Forest Protection Directorate) in the case of forest fires, insects and tree diseases The Direction des Inventaires Forestiers (Forest Inventory Directorate) in other cases
NB	Timber Management Branch	Forest Pest Management Section - Timber Management branch.
NS	Renewable Resources Branch, Forestry Division, Forest Inventory	Renewable Resources Branch, Forest Protection Division, Risk Services Group and the Forest Health Group
PE	Jon Hutchinson and Mike Montigny	David Carmichael
NL	Forest Ecosystem Management Division	Forest Engineering and Industry Services Division Insect and Disease Control Section
PC	Vegetation/Fire and Ecosystem Monitoring Unit within each field unit	

Frequency and Effectiveness of Forest Surveys and Information Sharing

The frequency of forest inventory or forest health surveys varies across the member agencies from infrequent (irregularly, once every ten years) to annually. The extent of activity in the forest fibre industry within an agency land base is often cited as a determining factor in the frequency of forest inventory programs. Much of the remote areas in the YT and NT have little forest fibre industry and minimal (or out of date) forest inventory. With few communities or other values at risk in these areas, these are often treated as modified or no suppression zones. Wildland areas surrounding communities or areas that are more accessible to industry have received infrequent forest inventories or hazardous fuels surveys.

In BC, the Forest Health Conditions website[7] and aerial overviews[8] are updated annually. AB Wildfire Management Branch collects harvest data annually from the forest industry as per the Fire Control Agreement conditions; this data is used to update the provincial Fire Behaviour Prediction[9] (FBP) (Alexander et al. 1992; Wotton et al. 2009) fuel grid. SK conducts annual surveys within study areas for insect and disease damaged areas (Category 1). Inventory programs in SK are generally conducted on a 10 to 15 year cycle, although there are areas of the provincial forest where the inventory is over 30 years old. In MB, forest health surveys are conducted annually while forest inventory is updated as inventoried.

Current forest inventories, data management systems and mapping technologies support the spatial representation of FBP fuel types (Figure 3) across the Canadian landscape. Inclusion of additional mapping layers for different hazardous fuel categories will enhance a national fuels management program and contribute to coordinated strategies for hazardous fuel mitigation.

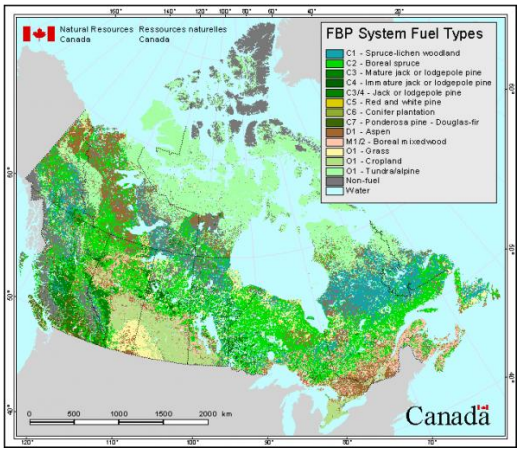

Figure 3. Natural Resources Canada FBP fuel type map.

Disturbances (natural or man-caused) in QC are integrated annually into the forest fuels map[10] using inventory data and various algorithms developed for the purpose of fuels classification according to the FBP system. QC indicated that their programs have direct access to data which is updated on an annual

[7] BC Forest Health Conditions 2011 Aerial Overview Survey Summary Table http://www.for.gov.bc.ca/hfp/health/overview/2011table.htm

[8] BC Forest Health Aerial Overview 2011 http://www.for.gov.bc.ca/ftp/HFP/external/!publish/Aerial_Overview/2011/pdfs/prov_ibm_8_x_11_2011.pdf

[9] Canadian Forest Fire Behaviour Prediction System

[10] Classification of Forest Stands as Fuels According to the Canadian Forest Fire Behavior Prediction (FBP) System – Third Ten-Year Quebec Forest Survey Program (2009) http://www.mrnf.gouv.qc.ca/english/publications/forest/fimaq/classification-forest-stand-third.pdf

basis. While NT does not have a set schedule for fuel and vegetation inventories, insect surveys are conducted annually. NB and NL conduct surveys and fuel inventories annually. Map layers generated from ON forest health surveys are updated annually. The fire management agency has access to these layers and is responsible for compiling into one single map.

Information from forest health surveys and forest inventories is communicated to wildfire management agencies through several different avenues (Table 10). The majority of survey respondents indicated that these processes provided timely and accurate information.

Table 10. Forest data communication methods and effectiveness.

Agency	Method	Satisfied with Timeliness & Accuracy	Comments
BC	Website updates, internal communications, meetings, conferences.	Yes	Website provides detailed information from insect and disease surveys; also includes animal damage, wind-throw, etc.
YT	Personal contact, email, phone.	Yes	Yukon government is small and personal contacts are most often effective.
AB	Through FBP fuel grid. Forest health data and surveys are shared by Forest Health Section. Strong link and sharing of information between the Forest Management Branch – Resource Analysis Section and the Wildfire Management Branch Wildfire Resource Information Unit.	Yes	Information is current on harvested areas from companies who have entered into Fire Control Agreements. However, there are locations where fuels data is not gathered as frequently (provincial parks, forest management units, etc.). SRD Areas are also required to report on non-industrial fuels management activities in the provincial FIRES database.
NT	Personal communication; email; webpages.	Yes	Data is provided as soon as it is ready
SK	Forest Services Branch will typically provide WFM with a map showing new disturbances as they are documented.	Yes	Forest Services Branch is working on a database (FIS) that will formally document the state of the forest. As this is not fully implemented, Wildfire Management Branch (WFM) does not have access to this site. As this is a Forest Services initiative, the data collected is for their use and will not always be directly applicable to WFM needs.
MB	Maps, digital spatial files.	No	No formal annual process is in place.
ON	Map layers are updated annually and the fire management agency has access to these maps.	No	Information is gathered by the Forest Health Section on an annual basis. The Fire Management Section is interested in hazardous fuels as soon as they occur.
QC	QC has direct access to this data through agency systems.	Yes	As a rule, data is updated on an annual basis and this provides timely and relevant information.
NB	Information appears in the fuel type mapping updates.	Yes	
NS	Forest Health information available upon request through direct communication within Forest Protection.		
PE		No	Aerial photography is completed once every ten years under PE legislation.
NL	Informal discussion.	Yes	
PC		Yes	Most of the causal agents of forest change within PC areas are either infrequent or slow acting and, generally, the systematic surveys or incidental observations do provide timely and accurate information to wildland fire personnel. “Timely” in this case can vary from within 1 to 2 years of occurrence.

Coverage of Forest Inventories and Forest Health Surveys

Information provided by forest inventories and forest health surveys does not always provide full coverage for the area managed by a given agency. Seven of 13 survey responses indicated full coverage across their area of responsibility while others indicated that forest inventories or surveys often only cover areas of high priority with reduced coverage for areas of low priority (Table 11). Gaps in coverage are explained by lack of data for private lands and less frequent forest inventories or fuels data collection in certain areas such as provincial parks and forest management units. As mentioned, the territories and northern parts of some provinces have little or no commercial interests and, hence, minimal forest inventory or forest health survey information.

Table 11. Wildfire management area covered by forest inventories and forest health surveys.

Agency	Full Coverage	Comment
BC	Yes	Some gaps in private lands.
YT	No	Extensive areas of Yukon have no forest inventory or poor (out of date) inventory. These are most often in areas where suppression is not carried out. Inventory is concentrated in regions of the territory that are accessible to industry or of interest (near) to communities.
AB	Yes	Fuels data is gathered less frequently in some locations. (See Table 10)
NT	No	Insect surveys and Inventory are only for commercial areas of the territory. Mainly in the south and along major river valleys. Limited to no information for northern or isolated areas. However it must be taken into consideration that in many areas wildfire is allowed to burn naturally except in the case VARs are threatened.
SK	No	The inventory surveys only cover the modified timber, full response timber and full response community zones within the commercial forest zone.
MB	Yes	Interpreted forest inventory information is available for about 65% of the Province with year of photography ranging from 1969 to 2009. The northern portion of the province lacks FRI/FLI coverage. NFI ground plots are randomly selected from a grid of points.
ON	No	FRI[a] is completed only for parts of Ontario that are currently managed for timber production (AOU[b]). It does not include large provincial parks, southern Ontario or far northern Ontario. Work is underway to do some large parks and some areas in northern boreal areas outside the AOU.
QC	Yes	
NB	Yes	
NS	Yes	Surveys cover all areas of the province.
PE	Yes	
NL	No	
PC	No	Fire detection flights or routine aerial patrols concentrate on full response zones and boundary zones of Field Units. Less detection effort is allocated to lower priority response zones.

[a] *Forest Resource Inventory.* http://www.mnr.gov.on.ca/en/Business/Forests/2ColumnSubPage/199556.html
[b] *Area of the Undertaking.* http://www.mnr.gov.on.ca/en/Business/Forests/1ColumnSubPage/STEL02_164530.html

Wildfire Management Agencies Roles in Hazardous Fuels Management Programs

The wildfire management agencies play several roles in hazardous fuels management programs. The roles or support provided in identifying, surveying or reporting new areas of hazardous fuels include:

- Strategic support through meetings, discussions, requests
- Updating the provincial FBP layer with recent cut-and-burn data
- Completing Wildfire Threat Assessments – Fire Behaviour Potential for Industry
- Updating hazard maps used in duty rooms by deleting less hazardous fuels or mapping/including grey and dead MPB attack areas
- Providing expertise for the conversion of inventory data (including annual surveys of selected area) into forest fuel types
- Supervising the FireSmart program
- Evaluating hazardous fuels around communities through CWPPs
- Identifying areas which should be inventoried
- Undertaking a burn severity assessment of fires
- Discussing areas of concern with Forest Management
- Investigating fuel typing as a possible component of inventory surveys
- Mapping areas of storm damaged fuels as soon as they are reported

Topic 3: Effect of Forest Management or Other Planning Policies and Guidelines

The forest management planning policies and guidelines queried in this topic refer to hazardous fuels mitigation in forest industry harvesting practices and development (residential or other) adjacent to areas of wildland fuels.

Debris Management Requirements for Forest Harvesting and Other Industry Operations

There is a broad range of legislation and implemented guidelines for harvesting practices and debris management among the member agencies across Canada. Similar to the broad spectrum of forest inventory products, harvesting practices policy and legislation is often determined by the extent of the forest industry development.

Timber harvesting operations and debris management guidelines are often based on legislation. Four agencies cited legislation[11] which regulates hazard abatement[12] and debris management for timber harvest operations. Six survey respondents m (YT, BC, MB, AB, NB, SK) indicated that their agencies have requirements for reduction or mitigation of broadcast logging slash. While some agencies don't have specific forest management policy to mitigate hazardous fuels, returning harvested areas to a productive forest in a timely way is supported by basic policy and forest guides (ON).

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[11] BC Wildfire Act http://bcwildfire.ca/LegReg,
Alberta Forest and Prairie Protection Act
http://www.qp.alberta.ca/574.cfm?page=F19.cfm&leg_type=Acts&isbncln=9780779726554,
Yukon Forest Resources Act http://www.gov.yk.ca/legislation/acts/fore.pdf,
Forest Protection Act (Northwest Territories) http://www.justice.gov.nt.ca/PDF/ACTS/Forest%20Protection.pdf

[12] BC Wildfire Regulation http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/11_38_2005#part2_division2

Currently in BC, most timber harvesting hazard abatement is conducted through reduction of roadside slash piles, which does not always truly mitigate the risk on the entire block, particularly one to two years after harvest. In AB, piles are permitted for reforestation purposes and wildlife habitat outside of FireSmart Community Zones provided that they meet the standards set in the directive[13] and legislation. AB Sustainable Resource Development (SRD) is currently working with FPInnovations in studying debris loads from timber harvest operations and the effect various levels of harvest debris has on fire behaviour and initial attack capability.

Forest industry in SK has the option to either burn slash roadside or spread debris evenly across the block. Once either option is selected by the licensee, they must follow standards developed by the Ministry of Environment. In ON, forest industry is encouraged to burn accumulations of roadside slash and must include a report of this activity as part of their annual work schedule (by Forest Management Unit). The North West Region in ON has policy in place that requires license holders to specifically address the reduction and elimination of slash and chipper piles in their respective forest management plans.

NB harvest operations incorporate full tree chipping and waste is spread across the block in small piles. Timber harvesting activity in NT is limited and individual free fuel wood permits account for a large proportion of the harvest. Required debris management is through lopping and scattering of limbs and branches.

While some agencies see harvesting debris as a hazardous fuel and limit slash accumulations as part of legislated harvesting practices, other agencies (PE) leave harvesting debris on site as a nutrient source and provide no incentives for burning of slash. Harvesting program guidelines in PE are guided by the ecosystem-based Forest Management Manual[14] standards which contains legal restrictions on harvesting within watercourse buffer zones.

Member agencies with active timber harvesting programs have requirements for harvest block planning to account for the creation of large contiguous areas of slash. The AB Forest Management Planning Standard[15] requires timber companies to provide consideration to how timber harvest will impact fire behaviour potential throughout the 20 year harvest sequence. In addition to the debris management standards implemented in AB, a strategic Detailed Forest Management Plan[16] incorporates the Wildfire Threat Assessment Model[17] to analyze fire behaviour potential at the current forest state and years 10, 20 and 50 after harvest.

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[13] Alberta SRD Debris Management Standards for Timber Harvest Operations
http://www.srd.alberta.ca/FormsOnlineServices/Directives/documents/2007-02-DebrisManagementStandards-TimberHarvestOperations-Mar2010.pdf

[14] A Summary of Prince Edward Island's Ecosystem-based Forest Management Standards Manual
http://www.gov.pe.ca/photos/original/ECOformansumm.pdf

[15] Alberta Forest Management Planning Standard – Annex 3 Fire Smart Management
http://www.srd.alberta.ca/LandsForests/ForestManagement/ForestManagementPlanning/documents/Alberta_Forest_Management_Planning_Standard_Version_4_1_April_2006_Final_2.pdf

[16] Alberta Detailed Forest Management Plans
http://www.srd.alberta.ca/LandsForests/ForestManagement/ForestManagementPlans/Default.aspx

[17] Alberta Wildfire Threat Assessment
http://www.srd.alberta.ca/Wildfire/FireSmartLandscapes/WildfireThreatAssessment.aspx

Generally, roads and natural boundaries are incorporated in planning timber harvest block layout. Hazardous fuels mitigation was not cited as an intended outcome for using these features; roads provide ease of access and natural boundaries are used for ecological reasons. Timber types are a consideration in defining plot layout boundaries. AB indicated that fuel modification areas, roads, natural boundaries, and less-flammable forest fuel types are considered in harvest planning when harvest occurs within or adjacent to a FireSmart Community Zone. Timber harvesting operations within AB FireSmart Community Zones must follow stricter debris management standards than harvest operations further away from values.

Some of the member agencies have requirements for forest management operations to create and maintain buffers, non-fuel areas or low-hazard fuel area for the purpose of reducing the spread potential of wildland fire. While this is not a regulatory requirement in SK, some companies incorporate this practice when planning large harvest disturbance events. BC encourages this practice and this area of hazard mitigation is being addressed through landscape level fuels and fire management planning. AB provides provisions for timber harvest companies operating in locations adjacent to or within FireSmart Community Zones to have reforestation waived or to regenerate harvested areas to less flammable species.

While open burning of harvest debris is a common means of hazard mitigation, alternative debris management solutions are being implemented or considered. These include utilization of harvest debris fibre through secondary salvage tenures, firewood permits and bioenergy solutions. Some agencies, especially those with limited access to conventional sources of fuel, see potential in the use of biomass forest fuels in reducing the dependency on conventional fuels. PE envisions that by 2013, biomass will provide 15% of the province's energy mix.[18]

Agencies implementing debris management programs indicate that funding for these operations is generally sourced through a combination of industry and wildfire management agency. Large scale FireSmart projects in YT are planned by YT Forest Management and funded by federal government.

Most debris management operations in SK are funded by the forest industry; however, the SK Wildfire Management Branch does fund some wildfire mitigation projects (fuelbreaks) close to communities. Forest industry in AB is responsible for fuels reduction strategies on the landscape and within FireSmart Community Zones that occur on Forest Management Area lands.

Five of the responding member agencies (AB, MB, NB, NL, BC) have requirements for forestry industry to carry out salvage cutting or other fuel hazard abatement in areas of hazardous fuels caused by biotic or climatic influence on their licensed areas. The forest industry in ON is not required to carry out salvage operations, but are encouraged to do so. If a licence holder decides to carry out a salvage harvest, they are required to ensure that the area is regenerated as per the standards set out in their forest management plan.

The majority of these agencies (BC, MB, NB, ON, NL) provide compensation to industry for these salvage cutting operations. The mechanisms for determining compensation differ across the member agencies with the most common form of compensation delivered through reduced stumpage fees or timber dues.

[18] Prince Edward Island Environment Labour and Justice. State of the Environment. p.36. http://www.gov.pe.ca/fae/state/index.php3

Table 12. Requirements for salvage cutting or other fuel hazard abatement.

Agency	Requirement (Yes/No)	Compensation Provided
BC	Yes	Compensation is provided for MPB salvage or wildfire salvage. Wildfire Act and Regulations[a] include abatement requirements.
YT	No	No compensation provided
AB	Yes	No. Timber dues are reduced for dead or damaged wood as per the Timber Management Regulation[b].
NT	No	No compensation paid. Reduced stumpage for standing dead vs. green.
SK	No	Legislation allows for reduced stumpage in areas impacted by natural events (fires, blowdown, and insects and disease outbreaks).
MB	Yes	Yes
ON	No	Yes
QC	No	Industry is compensated for the additional costs generated by these forest operations.
NB	Yes	Yes
NS	No	Within areas of hazardous fuels - licensees are encouraged to harvest these sites as priorities. Sometimes salvage assist may be provided. On private land, reduced stumpage may be offered.
PE	NO DATA PROVIDED	
NL	Yes	
PC	NOT APPLICABLE	

[a] http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/11_38_2005
[b] http://www.srd.alberta.ca/LandsForests/ForestManagement/TimberDuesCrownFees/Default.aspx

While salvage harvesting can be carried out in QC, the primary purpose is not for hazard abatement but to salvage wood fibre in the wake of forest fires and insect infestations. Industry is compensated for additional costs based on an average cost from prior years. SK has historically directed the forest industry to undertake fire salvage operations and looks to do the same in blowdown areas. Operators have to apply for a stumpage reduction on salvage. In NT, commercial fuel wood lots in old burns or dense forest close to communities have been established with plans for further development of other fuel wood lots across NT. In NT, stumpage fees are reduced in areas of dead standing trees.

Other industries operating in wildland areas have similar hazard abatement policies and guidelines to reduce fuel hazards created by their operations. The AB FireSmart Land Management Program assists the oil, gas and power industries in developing strategies to reduce fuel hazards from their activities.[19] Debris management, clearing and thinning vegetation around industrial sites and industrial camps are some of the strategies used to reduce hazardous fuels. Installation of above ground powerlines in AB requires assessment of hazardous fuels and risk to values. An on-line tool[20] allows industry to view hazardous fuels and adjacent infrastructure and helps determine locations to route powerlines through

[19] FireSmart Guidebook for the Oil and Gas Industry
http://www.srd.alberta.ca/Wildfire/FireSmart/documents/FireSmart-Guidebook-OilAndGasIndustry-2008.pdf

[20] Powerline Hazard Assessment Plan (PHAP)
http://www.srd.alberta.ca/FormsOnlineServices/Forms/ForestryForms/Default.aspx?=IndustryFireSmartForms

less hazardous fuels. ON uses the Modifying Industrial Operations Protocol[21] to direct the management of wildland industrial operations such as pipeline and hydro right of ways and mill and mining operations with respect to fuel hazard and fuels accumulations.

Other industrial operations that have requirements for hazardous fuels reduction include hydroelectric transmission companies, highways departments, agricultural activities and mining operations. Land users in NT such as highways and hydro transmission providers are required to obtain a land-use permit which specifies that hazardous fuel loads (combustible material) must be removed from the site annually. NT is looking to make changes to legislation which would include operations (e.g. seismic, exploration) which are not currently covered.

Planning Policies and Guidelines Governing Development Within or Adjacent to Wildland Fuels Areas

There is a broad mix across the member agencies in the development and implementation of policies and guidelines for residential or industrial development in areas of wildland fuels. While some municipalities have implemented FireSmart guidelines as development requirements, others accept these guidelines in principle and encourage developers to implement these guidelines.

The SK Wildfire Management Branch completes wildfire assessments for all new proposed developments within the provincial forest and burning permit zone. Based on the on-site assessment, a set of FireSmart recommendations are provided to the developer. The Municipal Authority Branch, which gives final approval for new developments, uses the recommendations as conditions for approval. A new Planning and Development Act is being developed where FireSmart principles have been included as part of the recommended considerations for all new developments.

While NT does not have territorial legislation or policies governing development close to wildland fuels, current Community Wildfire Protection Plans[22] include recommendations for development in the WUI. NT promotes FireSmart guidelines and is urging adoption of bylaws by communities which would incorporate FireSmart principles into community planning and expansion.

Generally, policies and guidelines for residential development are implemented by planning authorities within a local municipality, municipal district or county. Some municipalities in AB require implementation of FireSmart guidelines for development of industrial sites and new sub-divisions.

Fuels reduction is often required or recommended as part of a residential or industrial development adjacent to wildland fuels. Some new subdivisions in the Whitehorse area (YT) are now required to carry out fuels management before they get title. This is not consistent but the Department of Community Services has developed some policies that are targeting new lot developments in the WUI.

PC has widespread implementation of FireSmart principles throughout its field units and works closely with appropriate jurisdictions to integrate FireSmart activities. Beyond the community planning and development phases, FireSmart guidelines are also implemented by existing communities as part of a community protection plan. With funding available for fuels management in SK, communities can request FireSmart assessments and then carry out the fuels management work on their own. Similar fuels reduction programs using FireSmart guidelines are implemented in other parts of Canada.

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[21] Modifying Industrial Operations Protocol http://www.mnr.gov.on.ca/en/Business/AFFM/Publication/MNR_E000014P.html
[22] NWT Community Wildfire Protection Plans http://www.nwtfire.com/cms/cwpp

ON is currently in the process of modifying the Provincial Policy Statement[23] that will include high to extreme risk forest fuel types as an identified hazard that will require mitigation work to occur prior to allowing development in these areas. Without modifications to the hazard, development cannot occur. The FireSmart Communities program is being actively promoted for local municipal officials to follow as a mitigation program. There is no requirement for municipalities to implement the FireSmart program into existing infrastructure.

Use of Vegetation Debris from FireSmart Projects for Bioenergy Production

Using vegetation debris created by FireSmart projects or other salvage operations as a form of bioenergy is in the early stages of implementation. Currently in AB, the bio-industry uses waste wood from mills and some wood from harvest operations, and in MB the Pineland forest nursery uses overburden[24] from a peat development to fuel boilers. With increasing demand as more bio-industry projects develop, it is anticipated that more wood from FireSmart treatments will be used for bio-industry applications. Other agencies have bioenergy facilities in the development phase (SK) and mobile and stationary pellet mills are being considered in NT. Less than 10% of the fuels treatments carried out in BC use the biomass for bioenergy production. There is a recognized need for expansion of these programs; however, several factors such as fluctuating markets and haul distances may impact the viability of bioenergy projects. Continued innovations in technology and development of bioenergy production facilities are seen as positive solutions that will address debris management issues faced by most member agencies. Disposal of hazardous debris from FireSmart projects or other fuels treatments can be accomplished while creating a viable form of energy. Remote communities face high costs in importing fuel for energy production heating and would benefit from local sources of bioenergy. NT is considering the establishment of 'crop' fuelbreaks around communities comprised of less flammable species (deciduous or willow) which would also supply biomass to bioenergy plants in the community. A sufficient supply of biomass is recognized as a requirement for long-term viability of bioenergy production. Areas of spruce bark beetle kill in southwest YT are being considered as potential fuel for planned bioenergy projects; however, the amount of residue from FireSmart treatments is not sufficient to feed a bioenergy installation.

FireSmart Requirements for Building Materials and Clearances

There are minimal requirements for developments in areas of hazardous wildland fuels to use less combustible building materials or to maintain recommended clearances suggested by the FireSmart guidelines. Wildfire management agencies are working closely with municipalities, housing corporations, fire marshals, and other authorities to adopt and implement FireSmart guidelines for residential developments within or close to the WUI. Some local governments have adopted FireSmart guidelines as requirements[25] in their development permits; however, these implementations are minimal.

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[23] http://www.mah.gov.on.ca/Page215.aspx

[24] Vegetative material or mineral soil that lies above an area of economic or scientific interest.

[25] Resort Municipality of Whistler Fire Protection and Fireworks Bylaw Amendment http://www.whistler.ca/images/stories/PDF/Fire/bylaw1720_roofing.pdf

Topic 4: Extent and Effectiveness of Active Fuels Management Programs

Hazardous Fuels Management Program Identification

The nature of hazardous wildland fuels and the extent of development of fuels management programs across Canada are diverse. While some agencies with landscape fuels management issues develop forest inventory programs and forest health monitoring programs, other agencies address smaller scale issues using grassroots fuels management programs such as chipping and composting as part of a waste management program and issuing homeowner burn permits to conduct open burns for reducing backyard slash accumulations.

The mountain pine beetle outbreak in western Canada has been the catalyst for the development of large scale forest health surveys and mitigation programs. In AB, the Mountain Pine Beetle Management Strategy includes the MPB Municipal Grant Program and the Forest Resource Improvement Association of Alberta MPB Grant Program. The MPB Municipal Grant Program was established in 2006 to support the costs of beetle control operations for municipalities and private landowners. The program provides funding and expert advice to municipalities that support mountain pine beetle management on municipal and private lands through activities such as ground surveys and mapping, treatment of infested trees, communication, education and outreach efforts, prevention of additional attack and project management.

The Forest Resource Improvement Association of Alberta (FRIAA) MPB Grant Program administers a mountain pine beetle grant program on behalf of the department to assist with activities traditionally managed by the department. Forest companies can access these funds to address expenses incurred in Level 1 control, aerial and ground surveys, containment baiting, seed collection and protection of progeny sites. The prescribed burn program is also an integral program in AB for the mitigation of Category 1 fuels.

BC has implemented the Mountain Pine Beetle Action Plan to guide responses and coordinate efforts to mitigate the impacts of MPB. The BC Strategic Wildfire Prevention Initiative (SWPI) is designed to provide support to communities to mitigate risk from wildfire in the wildland urban interface. The SWPI is a suite of funding programs administered by Union of BC Municipalities (UBCM) and managed through the Provincial Fuel Management Working Group.

In NT, bioenergy is considered a potential solution to use ‘waste’ biomass or hazardous fuels. A pilot program was started in 2011 for the establishment of a pellet mill and to explore other bioenergy solutions. The Department of Environment and Natural Resources (ENR) recognizes wildfire as a significant and natural phenomenon and allows for fire to burn naturally when opportunities permit. This helps to maintain the natural mosaic as well as remove areas of hazardous fuels. ENR is establishing community woodlots which will be located in areas of dense fuel stands close to communities or in old burns. Free fuel wood permits encourage people to harvest fuel wood from hazardous fuels areas.

FireSmart is the most commonly cited hazardous fuels management program. The extent of development and implementation of FireSmart programs (Table 13) among member agencies ranges from ‘under consideration’ to detailed implementation plans for homeowners, developers, and industry operators. Category 5 fuels (areas of hazardous wildland vegetation in the WUI) are typically the focus of FireSmart programs, with Category 1 fuels (insect killed or diseased fuels) being a major contributor to hazardous fuels in some of the WUI areas in western Canada.

Table 13. Degree of FireSmart program implementation among agencies.

Agency	Degree	Comments
BC	Extensive	• Well established funding mechanisms in place through several partners. • FireSmart program guidelines have been implemented through the SWPI since 2004 with programs conducted by WMB, local governments, and First Nations. • Business and private land owners are encouraged to follow FireSmart principles with consideration given to suitable roofing and building materials. • Some communities have by-laws implementing FireSmart guidelines. Some local governments have requirements for development permits that incorporate FireSmart principles. • FireSmart e-tool[a] being developed and tested.
YT	Extensive	• Good funding in place for FireSmart projects. • New subdivisions in Whitehorse are required to carry out fuels management provisions before the land title is issued. While this is not a consistent application, Dept. of Community Services of Yukon Govt. has developed policies targeting new lot development in the WUI. • While there are no special codes or regulations to address, FireSmart guidelines for building materials and clearances NFPA associated regulations apply (as per other jurisdictions in Canada).
AB	Extensive	• Municipal bylaws and land use bylaws developed by local municipalities, municipal districts or counties determining the requirements for applying FireSmart principles in new developments. • Oil and gas developments are encouraged to follow principles outlines in the FireSmart Guidebook for the Oil and Gas Industry. • AB SRD is working with Partners in Protection and other agencies regarding FireSmart building materials to be used in structures located in the WUI. • FireSmart initiatives in AB include: FireSmart Community Grant program, FireSmart Community Protection Initiatives. FireSmart fuels management projects continue to be well funded.
NT	Early Stages	• GNWT is promoting adoption of FireSmart principles and practices in community planning and maintenance. ENR has a full time Risk Management coordinator and a FireSmart coordinator. • Fuel modification projects in and around communities have been conducted since 2009. Some communities fund and conduct fuel modification and FireSmart projects. • Free fuel wood permits encourage public to harvest fuel wood from hazardous fuels areas.
SK	Extensive	• Wildfire Management Branch completes wildfire assessments for all new proposed developments within the provincial forest and burning permit zone and the developer is provided with a set of FireSmart recommendations. The Municipal Authority Branch uses the recommendations as conditions for final approval. • Fuels treatment programs receive excellent buy-in from the public and other partners.
MB	Preliminary Stage	• FireSmart program is currently being introduced in MB. FireSmart principles and guidelines will be implemented upon launch of program. FireSmart program will delivered jointly by the Office of the Fire Commissioner and the Fire Program. Response to pilot project has been favorable.
ON	Established	• Fuel modification is promoted in the FireSmart Communities Program.
QC	None	• QC survey response indicates there are no requirements for FireSmart principles for developments adjacent to wildland fuels areas.
NB	Discussion Stage	• There has been little interest expressed by planners in incorporating FireSmart principles to development planning policies and guidelines. The WUI problem is just starting to be addressed. Some small scale projects are in the discussion phase.
NS	Promotional Stage	• The Wildfire Management group is promoting FireSmart practices to woodlot owners, residential landowners, developers and municipalities. More work on this effort is expected in the future.
PE	None	• Issue of backyard burn permits is believed to be the primary factor that has led to the reduction in wildfire frequency on PE
NL	None	• NL does not have planning policies/guidelines in place governing development adjacent to the wildland.
PC	Extensive	• PC has been a lead/sponsoring agency in development of FireSmart concepts through Partners in Protection since 1992. Use of FireSmart principles is widespread throughout PC Field Units. PC works closely with appropriate jurisdictions to integrate FireSmart activities.

[a] http://www.crmltd.ca/firesmart-wildfire-risk-assessment-application

Fuels management programs that address Category 2 fuels (storm or other weather related damage) are implemented in varying degrees. In BC, storm damaged fuels are monitored annually through aerial surveys and staff observation. ON has a large proportion of Category 2 fuels and prescribed burns are conducted in blowdown areas. This hazardous fuel type has been salvage harvested in AB and NB after damaging weather events.

Hazardous fuel conditions presented by Category 4 fuels (areas affected by industrial operations) are addressed through the implementation of bioenergy programs, legislation reform, silviculture stocking, and landscape planning (BC). In AB, a MPB amendment as part of a Detailed Forest Management Plan will generally allow industry to target pine dominated and pure pine stands outside of their previously approved harvest sequence. The strategy is to harvest the pine prior to it being attacked by beetles.

Community Wildfire Protection Plans (CWPPs) are commonly used as tools to assess the threat of wildfire to a community in the WUI. NT has CWPPs in place for all the communities within the tree-line with plans for review every 5 years. Fuels Modification Projects are being undertaken in and around communities as part of CWPPs in the NT. Previous to this, some projects related to community risk mitigation, usually cat guards, were carried out. Many of these older projects are no longer effective and are being upgraded or otherwise incorporated into the current CWPP prescriptions.

Fuels management programs to address hazardous fuels in the WUI in AB include FireSmart Grant Programs, Fire Smart Community Protection Initiatives and other local initiatives implemented by a municipality, municipal district or county.

SK WFM has a small fuels management budget that focuses on community protection projects. Many communities have an active prescribed burn program to mitigate hazardous fuels which is strongly supported and encouraged by WFM. Burning permits are currently required for any burning done within the provincial forest and a 4.5km wide buffer to the provincial forest. WFM also recommends that communities institute their own burning permit requirement for areas outside of the provincial forest and 4.5km buffer zone. Forest Protection Officers are developing wildfire pre-plans in their high risk communities and developing sprinkler plans for individual communities as part of the pre-planning effort.

Active fuels management for Category 6 fuels (other hazardous fuels important to your agency) outlined in this survey includes annual hazard reduction burning to mitigate the threat of wildfire in cured grass.

Fuels Treatment Program Production

Numerous fuels management programs across Canada conduct hazardous fuels treatments at different levels on the landscape (WUI, community, and landscape). Some programs have been established to address fuel hazards at a specific level on the landscape while the other programs conduct fuels treatments at several levels on the landscape. FireSmart and prescribed burning are the most commonly used terms as program descriptors. Productivity data for fuels treatment programs identified in this report is generally presented as the total area treated by the program. The parameter used in this report to categorize program productivity is location of the fuels treatment with total area treated in the WUI presented in Table 14 and total area treated at the landscape level presented in Table 15.

AB productivity data for fuels treatments is collected through three programs. The FireSmart Community Grant Program administers fuels treatment programs in the WUI while the FireSmart Vegetation Management program conducts fuels treatments at both the WUI and the community level.

The Prescribed Burn program captures data for burns of all complexities and scale across all levels of the landscape. Given this unique data capture, AB fuels treatment program productivity is presented separately in Table 16.

Table 14. Area (in hectares) of fuels treatment in the WUI.

Agency	Year										
	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001
BC	3347	2478	1989	2587	2312	2777	123	NO DATA PROVIDED			
YT	122	156	90	120	120	120	120	120	120	75	50
AB	See Table 16										
NT*	72.3	80.5	NO DATA PROVIDED								
SK	132	113	36.5	68.5	112	155	10	148	0	92	105
MB	NO DATA – FireSmart program is just being introduced										
ON	5[b]	NO DATA PROVIDED									
QC	NOT APPLICABLE										
NB	NO DATA PROVIDED										
NS	Currently, there are no formal fuels management programs in place										
PE	No formalized active fuel (landscape) management program in place										
NL	NO DATA PROVIDED										
PC	400	400	400	400	400	400	400	400	400	400	400

* *Figures do not include approximately 150 ha/year over the last 10 years (WUI and landscape level) that have been cleared through use of community woodlots; an NT bioenergy program has treated 5 ha in 2011.*

[b] *Area treated at the WUI level in ON is through Municipal Agreements.*

Table 15. Area (in hectares) of fuels treatment at the landscape level.

Agency	Year										
	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001
BC	145	2473	8700	13,775	936	1560	NO DATA	2887	NO DATA	NO DATA	NO DATA
YT	NO DATA PROVIDED										
AB	See Table 16										
NT*	389,987	351,202	2051	400,208	458,838	48,105	234,071	481,926	117,864	22,982	96,907
SK	NO DATA PROVIDED										
MB	NO DATA PROVIDED										
ON[b]	2203	1400	316	1716	119	NO DATA PROVIDED					
QC	NOT APPLICABLE										
NB	NO DATA PROVIDED										
NS	NOT APPLICABLE										
PE	NOT APPLICABLE										
NL	NO DATA PROVIDED										
PC	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500

** NT fuel treatments at the landscape level are through natural fire.*

[b] Landscape level treatments in ON are implemented through the Hazardous Fuels Initiative[26] and Slash Pile Burning Program.[27]

Table 16. Area (in hectares) of fuels treatment in AB.

Fiscal Year	FireSmart Community Grant Program	FireSmart Vegetation (Fuel) Management	Prescribed Fire
2010	NONE	258	1,666
2009	54	225	10,470
2008	117	185	3,111
2007	50	144	1,913
2006	49	153	2,421
2005	-	356	2,930
2004	-	202	3,038
2003	-	264	2,480
2002	-	201	2,586
2001	-	66	716

[26] Weather Damaged Forest Fuels Initiative Task Team Update: March 2011. OMNR Aviation, Forest Fire and Emergency (AFFES) Internal Document.

[27] http://www.mnr.gov.on.ca/stdprodconsume/groups/lr/@mnr/@affm/documents/document/197289.doc

Factors Influencing or Impacting Annual Production in Fuels Management Programs

Lack of funding is seen as a limiting factor in the annual production of fuels management programs with funding cycles limiting the scheduling of fuel treatment projects and limiting productive work at appropriate times of the year. However, three agencies (SK, YT, AB) noted substantial and consistent funding through different sources in the past that has had positive influences in annual production. The funding sources and grant programs which have contributed to successful program delivery in these agencies are described in the following sections. ON has experienced limited funding for hazardous fuels management however funds have been allocated annually since 2008. Slash burning in ON was curtailed by forest industry due to potential for slash as a biofuel and to reduce costs.

Continued success of fuels treatment programs or projects often hinges on having a committed champion at an influential level in the community or agency. Shifting priorities may not allow wildfire management agencies to continue to champion fuels management programs and external champions are needed. Retirement of successful champions can impact programs or projects if a committed replacement is not identified. Capacity at different levels (executive, program managers, supervisors and crews) and staffing changes or retirements at all levels have an impact on the success and continuity of fuels treatment programs.

Shifting program priorities such as a busy fire season can reduce staff availability for fuels treatment program implementation and project work. Funding for extensions for seasonal firefighters vary from year to year and will have an impact on fuels treatment work done after the core fire season.

Program Administration, Funding and Delivery

Hazardous fuels management programs across Canada are administered through agencies, contractors, municipalities, industry or other cooperating agencies with advantages and/or disadvantages for each approach.

Fuels management programs in AB are administered by SRD; however, programs can also be administered by municipalities, municipal districts and counties. Prescribed fire is administered by SRD with local fire departments conducting hazard reduction burning around communities and within the WUI.

AB provides funding support to municipalities, municipal districts and counties, Métis settlements, and registered non-profit societies (community associations and organizations) within the Forest Protection Area (FPA) through the FireSmart Community Grant Program. This program focuses on the community involvement and ownership of wildland/urban interface issues within municipal jurisdictions. Some groups fund and administer their own fuels management activities on lands they manage with funding through other grant sources or fund the activities themselves.

From 2008 to 2010, joint funding between the federal and provincial government was administered by the Forest Resource Improvement Association of Alberta (FRIAA) under the Fire Hazard Reduction and Forest Health Program. This program was administered on lands inside and outside of the FPA and included hazardous fuels management. In AB, industry is responsible for funding programs on allocated lands/dispositions. Municipalities, municipal districts, counties, Métis settlements, First Nations reserves, are encouraged to fund and administer fuels management activities on the respective lands they manage. AB SRD funds priority fuels management activities and prescribed burning subject to annual budgets.

On the ground implementation of fuels management programs in AB is carried out predominantly by contractors, municipalities and industry. AB SRD staff does carry out fuels management work on a smaller scale. The role of SRD staff is generally in the form of contract supervision, planning and providing expertise to external clients. The advantage of using contractors and industry is the ability to get work done quickly and safely through mechanical fuel removal and at a scale not feasible with hand crews. Municipalities may employ contractors or hand crews to carry out fuels management activities. Municipalities, municipal districts and counties in the Forest Protection Area work closely with local SRD Area staff in identifying problem fuel areas. If the land is under their jurisdiction, they lead the implementation of fuels management. This process is advantageous as it allows for community involvement and responsibility for fuels management in the WUI. Potential disadvantages arise with quality control of fuels management treatments when the treatments are not carried out under the supervision of SRD, or by an individual who understands FireSmart and fuels management principles.

Administration and implementation of fuels management programs in NT is accomplished in different ways depending on the program and funding source. Generally, fuels modification projects are funded by the territorial or federal government and administered by the Ministry of Environment and Natural Resources (ENR). Some communities have funded and conducted fuels modification and FireSmart projects. Community woodlots and free fuel wood permit programs are administered by ENR. Bioenergy projects in NT have been initiated by ENR and are being promoted by small businesses. No funding is available for private lands in NT. If fuels management programs are administered and funded by other agencies, ENR can have a difficult time collecting data on areas treated. Quality control can suffer if the work is not carried out or inspected by qualified staff. Project specifications and goals need to be communicated clearly to contractors and crews in order to avoid costly or damaging errors in fuels treatments. For example, a work crew could confuse stem spacing with crown spacing. Issues like this are usually corrected fairly quickly if audits are carried out soon after work has commenced.

Fuels management programs in PC are part of the broader fire management program in most of its field units and projects are conducted by the Resource Conservation function. Funding for PC fuels management projects is allocated by PC's National Fire Centre, either in its entirety or to augment field unit budgets for fuels reduction activities. Timber that must be removed through fuels reduction projects can be salvaged and sold with funds returned to the project or other ecological restoration projects. Land owners or leases are responsible for funding fuels management on private or leased lands within national parks.

Fuels management programs in ON are administered through the agency and implemented through the agency and other entities including contractors, municipalities, and industry. The primary partner in program delivery is forest industry in conducting hazardous fuels management through slash pile burning. Some partnering is being done with municipalities to conduct FireSmart fuels management.

Program implementation by a member agency ensures that contractors completing the fuels modification projects adhere to specific contract details resulting in improved quality control and efficiency. SK WFM may make recommendations to communities who choose to conduct the fuels treatment project on their own. This type of collaboration can have good cost effectiveness. Where other agencies administer the project, WFM does not have any direct ability to ensure quality control and often ends up supervising with no power to directly address staff and quality issues. WFM funding can only be used on crown land which limits where provincially funded work can take place. SK WFM has yearly provincial funding allocated for fuels management projects, which is sometimes boosted

when savings are found internally. Other examples of funding include Community Adjustment Fund (Federal), First Nation Forestry Fund (now called the Aboriginal Forestry Initiative Fund) (Federal) and a partnership with Sask Power. In some cases, WFM has completed a timber harvesting projects where the contractor has completed the work in exchange for the commercial timber. WFM has worked with forestry contractors and Forest Service Branch to design their cut blocks (and slash management conditions) to act as community fuelbreaks.

YT fuels management programs are administered by the agency and have been implemented by contractors, municipalities and First Nations. This collective approach creates support at the community level where the work is being done and builds capacity within the community. However, the quality of work may not be consistent from one project to another. A disadvantage of the application/award process is that priorities may be skewed to groups that submit proposals instead of groups in areas of higher hazard. An annual allocation is made to YT and contribution agreements are made with community groups, First Nations or non-profit groups to fund work for fuels reduction projects on annual basis with funding ranging from $30K to $50K per group per year.

Fuels management programs in BC are administered by BC Ministry of Forests, Lands and Natural Resources Operations WMB and are implemented by a combination of WMB, contractors, municipalities, industry and other agencies. Funding for fuels treatment programs has been through a combination of federal and provincial government funds. Collaborations between WMB and other entities have proven to be successful since the WMB began formally administering fuels management programs in 2004. There has been good participation from the majority of communities in high risk areas with continued funding from 2004-2012. The BC Ministry has no direct control of participating local governments and First Nation communities to develop CWPPs and treatments (other than advising them that funding and an application process are available). Some communities are still not participating for a number of reasons (limited local capacity, thinking it is not their direct responsibility, or focusing on other priority areas). There is no guarantee of sustained funding for future years nor is there funding for private land owners. FireSmart principles are encouraged but not always implemented by business or private land owners.

The member agencies across Canada collaborate with a several agencies as partners in fuels treatment program delivery. The most common partnerships include First Nations, municipalities, community associations, housing authorities, volunteer fire departments, industry, Metis settlements, registered non-profit societies and the Office of the Fire Marshall.

Several large-scale fuels treatments are being planned and have been implemented along national park boundaries through collaborations between PC and other agencies. Often, these occur in conjunction with planning of landscape level prescribed burning. Cooperative efforts of this type have been commonplace in the mountain parks and in Wood Buffalo, but are now becoming more widespread in prairie and eastern parks as fire use expands to these ecosystems and regions of Canada within PC.

Specific entities noted as partners include:

- First Nations Emergency Services Society (FNESS)
- Union of British Columbia Municipalities (UBCM)
- Alberta Municipal Affairs
- Alberta Emergency Management Agency (AEMA)
- Indian and Northern Affairs Canada
- Alberta Tourism, Parks and Recreation

- Parks Canada
- Manitoba Parks and Special Areas
- Manitoba Forestry Association
- Whiteshell Cottage Owners Association
- Municipal and Community Affairs (NT)
- Natural Resources Canada
- Sask Power

Level of Investment

The six wildfire management agencies that implement fuels management programs have unique funding processes with various levels of investment through different funding sources. Rough estimates of program investment are reported in the surveys; however, complete figures for some programs are not available due to the numerous partners and confidentiality issues.

The cost to AB to implement the FireSmart program (Community Protection, Community Grant and prescribed fire) for the 2010/11 fiscal year was $2.5 million.

Since 2009, over $2 million has been devoted to fuels management projects in and around communities in NT through funding provided by the federal stimulus program. Some NT communities have self-funded projects with investments by these direct partners estimated at $10-70 thousand per year.

SK estimates the level of investment by SK WFM in fuels management programs at $100,000 per year. In YT, the government has committed $1-1.5 million for the past 12 years to community-based FireSmart projects. Cost to direct partners is highly variable with in-kind funding estimated to be $100-150 thousand per year.

In BC, initial funding (2004) of $37 million was provided by the provincial and federal governments with fuels treatment projects administered through the SWPI. In total, $62 million has been spent on fuels management in the form of CWPPs, prescriptions, and treatments for local governments and First Nations communities. In April 2011, $25 million of provincial funding was made available for fuels treatments conducted by local governments and First Nation communities. Annual intake of approved funding will vary between $7 and $12 million. Funding for fuel treatments by WMB crews fluctuates annually depending on surplus funds available.

The PC National Fire Centre annual average investment in WUI fuels reduction is about $250 thousand which results in about 200ha of intensive fuels treatment per year. PC invests about $500 thousand per year in strategic prescribed burns producing about 1500ha of treated fuels.

In addition to monetary investment in fuels treatment programs, wildfire management agencies also commit personnel to administration and implementation. Estimates of person-years committed to these programs are provided in Table 17.

Partnerships in fuels treatment programs require additional management provided by partnering entities. Member agencies were asked to estimate the total number of land managers that they work with in each of these partner agencies. The general response is that it is difficult to estimate due to the number of partners and varying scope of the fuel treatment programs. Often, wildfire management agencies are not dealing with land managers but with a community association president who is simply

a volunteer. Location and public profile of a fuels treatment project will have an influence on the number of land managers and their degree of involvement.

While most of the survey respondents did not estimate the number of land managers that they partner with, BC provided a summary of partnering entities as 189 local governments, 201 First Nation communities, Ministry Forest District and region offices, and other Ministries. The main land managers that SK works with include Parks Canada, Forestry, community, First Nations and Metis leaders.

Table 17. Personnel committed to fuels treatment programs.

Agency	Resource Commitment (person-years)	
BC	9	9 dedicated positions (1 Fuels Management Superintendent; 6 Fire Centre Fuels Management Specialists; 2 Geomatics Specialists); there is also support from a Fire Science Officer and 3 Fire Management Specialists on the Provincial Fuel Management Working Group; there is also dedicated fuels staff at FNESS.
YT	Approx. 2.5	
AB	27	0.6 years per person with four individuals per area = 2.4 years x 10 areas = 24 + 3 PFFC Staff.
NT	4	Wildfire Risk Management Coordinator; FireSmart Coordinator; plus each region has one staff person as the FireSmart/Risk Management contact. Forest Resources and HQ also devote staff time to bioenergy initiatives.
SK	3	
MB	1	
ON	<1 FTE	
QC	NOT APPLICABLE	
NB	NO DATA PROVIDED	
NS	Wildfire Management group has a Prevention Officer who promotes FireSmart and fuels management.	
PE	NOT APPLICABLE	
NL	NO DATA	
PC	NO DATA	

Several factors affecting the cost of hazardous fuels treatments (Table 18) were noted in the survey responses. These factors included fuel type and loading, type of treatment, time of year and region of application. High production rates with reduced cost can be achieved with prescribed burns in light fuels in easily accesible areas using basic resources such as drip torches (Figure 4). Resource intensive fuels treatments in heavy fuels in remote areas (Figure 5) will be less productive and more costly.

Table 18. Average cost of fuels treatments (per hectare).

Agency	Mechanical Treatment	Manual Treatment	Prescribed Burning	
BC	$5,000-8,000	$7,360	<$100 (light fuels) $1,000-4,000 (other fuels)	Varies by region and fuel type/loading. Manual treatments in coastal regions can be $10-15,000/ha in heavy fuel loading. Cost of prescribed burn very dependent on fuel type and loading, and other factors.
YT	NO DATA	$7,500-9,500	NO DATA	
AB	$5,000-8,000	$8,000-10,000	NO DATA	Variable – costs are lower for timber harvest and fireguard construction.
NT	No data. Most mechanical work carried out by communities.	Thinning - $18,000 Clearing - $22,300	NO DATA	Thinning costs range ($3,000-58,000/ha). Clearing costs range ($3,700-49,000/ha). Wide range of costs is due largely to the amount of material to be treated. High costs are largely due to timing of funding and operations in winter conditions (Jan-Mar).
SK	$4,000	$6,500-8800	NO DATA	
MB	NO DATA PROVIDED			
ON	NO DATA PROVIDED			
QC	NOT APPLICABLE			
NB	NO DATA PROVIDED			
NS	NOT APPLICABLE			
PE	NOT APPLICABLE			
NL	NO DATA PROVIDED			
PC	NO DATA PROVIDED			

Figure 4. Prescribed burn in grass/willow fuel type at Willow Creek, AB.

Figure 5. Fuels treatment in MPB infestation at Manning Park, BC.

Photo courtesy of BC Ministry of Forests and Range WMB.

Program Effectiveness and Stakeholder Support

Member agencies rated the effectiveness of fuels treatments in reducing the areal extent of hazardous fuels and the level of risk posed by hazardous fuel complexes (Table 19). While several agencies have only recently initiated fuels treatment programs such as FireSmart, the limited work that is being done is considered to be reasonably effective; although, there is a lot of work to do with limited funding. Established FireSmart programs implementing several combinations of approaches to fuels treatments and partnering with different agencies has resulted in considerable gains in hazardous fuels reduction on the landscape (BC, AB).

One respondent suggested that risk posed by hazardous fuels is significantly reduced through fuels management activities and subsequent maintenance adjacent to communities and other values. Another respondent maintained that until fuels treatments are tested by wildfire, or without construction standards for fuelbreaks, there will be continued debate as to how effective fuels treatments will be.

Public support for fuels treatment programs is mixed across the various agencies' implementations (Table 19). There are some members of the public opposed to vegetation removal but the overall demand for this type of work far exceeds the ability to deliver. There has been resistance from tourism groups to modify their property due to a perceived negative affect on the clients' experience to visit the tourist area with fuel modifications. Privacy that trees offer creates resistance in implementing fuels management programs at a homeowner level. Communities like the local employment opportunities that fuels treatment work offers. With good communication of the potential wildfire hazards, most people support fuels management programs and contribute to fuels management through vegetation management on their own property. Success in pilot projects, with clear demonstration of site modifications, builds public support and demand for future fuels treatment projects. Education, communication and consultation were noted as key elements in gaining public and partner support in these projects.

Similar ratings were noted for partner or other agency support for fuels treatment programs. In AB, industry and other partners are aware of the risk that hazardous fuel complexes create on the landscape and as a result are eager to assist in reducing the risk through harvesting, thinning, and disposing of debris. Getting support is an ongoing process and AB SRD is committed to strengthening current partnerships and developing new partnerships with industry (forest and oil & gas companies) and other users of the forested land-base. BC recognizes that utility companies such as BC Hydro have vegetation management programs to manage their extensive network of hydro rights of way but adds that other industries (forest, and oil & gas) could play a larger role in fuels treatments.

In BC, past projects speak to the success of partnerships in delivering fuels treatment programs. In BC under the Strategic Wildfire Prevention Initiative, 289 CWPPs have been developed or are in progress (local governments and First Nation communities combined) with 345 fuels management prescriptions written and 207 fuels treatment projects conducted.

Table 19. Fuels treatment program effectiveness and support.

Agency	Perceived Effectiveness of Program in Reducing:		Level of Support From:		
	Extent of hazardous fuels complexes	Level of risk posed by hazardous fuels complexes	Public	Partners	Other Agencies
BC	Good	Good	Fair	Good	Fair
YT	Fair	Fair	Fair	Fair	Fair
AB	Good	Excellent	Good	Good	Good
NT	Fair	Good	Good	Good	Fair
SK	Fair	Good	Excellent	Excellent	Good
MB	n/a[a]		Good	Good	Good
ON	Fair[b]	Poor to Excellent[c]	Poor to Good[d]	No Response	
QC	NOT APPLICABLE				
NB	NO DATA PROVIDED				
NS	NOT APPLICABLE				
PE	NOT APPLICABLE				
NL	NO DATA PROVIDED				
PC	Good	Excellent	Excellent	Good	Excellent

[a] *MB FireSmart is currently being introduced.*
[b] *Fuels treatments are viewed as somewhat ineffective given the vast extents of hazardous fuels. 500,000 ha of storm damaged fuels have been identified while only 20-1400 ha is treated each year.*
[c] *Level of risk varies according to proximity of hazardous fuels to values.*
[d] *Support is good if programs directly impact people, communities or infrastructure; however, support is poor when there is little benefit or commercial value impacted in remote areas.*

Barriers to Implementation or Expansion of Programs

Funding is seen as the major barrier to implementation or expansion of hazardous fuels management programs. Multi-year funding would allow for more effective planning and timing of fuels treatment projects. Project funding needs to be in place to allow planning of projects. Ideally project proposals should be submitted in the spring, reviewed and awarded by midsummer with the bulk of the project work carried out in the fall or early winter. With delayed funding cycles, fuels treatments are often delayed until mid-winter which creates operational challenges.

Compounding a funding shortfall, restrictions on how or where provincial funding can be applied creates issues in setting priorities for fuels treatments and treating the highest risk areas. SK has several First Nation communities where work should take place on their land; however, provincial funding cannot be used for work on First Nation lands.

Limited capacity, expertise and resources are seen as hindrances to the delivery of fuels treatment programs. Succession planning and lack of fuels management training in Canada are seen as factors which will impact future program delivery. Lack of manpower resources dedicated to these programs is limiting the extent or success in program delivery. Limited numbers of personnel in some agencies are

often concentrated in fire suppression programs with minimal resources remaining for prevention activities.

While policy in northern territories recognizes wildfire as an essential part of the ecosystem and allows the opportunity for fire to burn naturally when conditions merit, there is a reluctance to allow prescribed burning close to values at risk. Education of, and communication with the public and stakeholders is critical to developing an understanding of the risks and threats of wildland fuels, and gaining support for prescribed burn and fuels treatment programs. There is a general misunderstanding of what is natural and a misconception that the world is static. Humans have been suppressing fires for over a hundred years and as a consequence, the public assumes that no smoke in the summer is normal and trees from valley floor to alpine is 'natural'.

Other groups (government, industry, housing authorities, homeowners and other stakeholders) are not taking responsibility for fuels hazard management or are creating resistance to fuels treatment programs. Dialogue and education may help in realigning responsibilities for protection of values at risk and reducing resistance to fuels treatment projects. Wildfire management agencies are often regarded as experts in values protection and relied on to coordinate and conduct values protection projects which are often in the domain of other agencies.

Jurisdictional issues among multiple levels of government and authorities create inefficiencies in program delivery. Fuels management planning and project implementation can be impeded by conflicting land-base values (reclamation vs. wildlife habitat vs. wildfire management) and land management priorities within an agency (reduced ecological footprint vs. adjacent area treated or disturbed).

Reduced insurance premiums for homeowners and other property owners who make fuels modifications according FireSmart guidelines is seen as a positive measure in promoting values protection by property owners. Developing support from the insurance industry is important in implementing this strategy.

With low timber values, slowdown in the forest industry and associated mill shut downs, fuels reduction programs through commercial harvesting are often not economically viable due to low demand for timber or long haul distances. Projects are delayed and will be reconsidered when market conditions improve and mills are reopened. Limited timber milling or processing capacity in northern territories or remote areas is seen as a limiting factor in fuels treatment programs. Developing markets or uses for byproducts of fuels treatments would have a positive impact on program implementation.

Follow-up to the 2009 FPInnovations Fuelbreak Effectiveness Report

Three agencies responded to this request to identify any agency updates that have occurred since the time of the 2009 survey. BC has developed several case studies to document the success of fuels treatments which had mitigated wildfires through fuels reduction projects (e.g. West Kelowna, Alexis Creek). BC has also begun working towards Landscape Fire Management Planning, expanding out from the WUI. The Cranbrook Landscape analysis was initiated in 2011 and the analysis is quickly expanding out to other strategic locations in BC in future years.

AB SRD continues to monitor fuelbreak effectiveness and provides maintenance and construction funding through the Provincial FireSmart Program.

SK has established fuel plots in all of the fuelbreaks in an effort to document site conditions and to monitor for maintenance requirements. SK also has guidelines established for fuels management; Managing Fuels and Vegetation with Fire & Non-Fire Related Fuel and Vegetation Management.

Knowledge and technology gaps such as those identified by the Wildland Fire Management Working Group have been addressed with the formation of the CIFFC National Fuels Management Task Team in October 2011.

Additional knowledge and technology gaps identified by survey respondents include:

- Research required to verify fuelbreak effectiveness
- Fuelbreak policy and practice
- Fuelbreak maintenance requirements and standards
- Fuels treatment cost reduction
- Data collection and knowledge transfer
- Alternative innovations in equipment, techniques, and bioengineering opportunities

An opportunity has emerged with the identified demand for waste wood for the biomass plants. Additional research is required to exploit potential opportunities in bioengineering technology. These opportunities may result in lower fuels management treatment costs in locations where the waste can effectively be utilized.

In addition to research in fuelbreak effectiveness of different fuels treatments, consideration should also be given to how different fuels treatments in various fuel types can incorporate fire suppression strategies and tactics under varying fire conditions.

Discussion

Challenges Posed by Hazardous Fuels

Any type of vegetation can be a hazardous fuel given the right conditions. The transition of fuels from a hazardous fuel type to a less flammable fuel should be considered when discussing historical and future trends of area growth in hazardous fuels. For example, a slash fuel can transition to grass, then plantation, and eventually to mature pine with varying degrees of hazard at each stage.

Climate change is creating longer wildfire seasons with more intense wildfires. Successful wildfire suppression is adding to the historical fuel loading, yet the ability to maintain sustained funding and focus on fuels reduction and mitigation efforts is a continuing challenge. Staff expertise for much needed prescribed fire activity needs to be re-built.

Aging and diseased forests are creating potential for extreme fire behavior. MPB areas in BC and AB may be decreasing at the red stage; however, recent documentation of wildfires in the grey stage show aggressive fire behavior and increased spotting distances from ember transport. More research is required to learn more about fire behaviour in stands transitioning from red to grey. In parts of eastern Canada, the most active disturbance is the spruce budworm infestation. The extent and severity of this disturbance is expected to increase over the next ten years.

In many parts of Canada, expanding communities and increasing numbers of recreational properties create larger and more numerous areas of values at risk from hazardous wildland fuels. The risk of hazardous fuels in the wildland urban interface is greatest in many parts of Canada prior to spring green-up and returns to less hazardous levels after spring green-up. In some parts of Canada, there are values at risk in the WUI in areas of the province where government policy limits or prohibits forestry activity.

Recommendations for Capturing and Communicating Hazardous Fuels Information

Several recommendations were made to provide more accurate, accessible and timely hazardous fuels information. The majority of these recommendations focused on innovations in technology and information exchange. Upgraded, more robust data management systems should incorporate standardized systems for tracking, classifying and reporting hazardous fuels. Universal standards and requirements for fuels management data layers, data management and mapping attributes can enhance hazardous fuels data collection and communication.

Enhanced fuels inventory and mapping techniques would assess and display development boundaries around communities and areas that are in close proximity to hazardous fuels such as black spruce or grass fuels. Accuracy in fire behaviour predictions can be enhanced with the addition of modified fuels such as thinned or pruned forests fuel types to fire behaviour prediction models such as the Canadian Forest Fire Behaviour Prediction System. Classifying forest stands according to FBP fuel types can be accomplished by collecting more appropriate ecological information.

Development of a true vegetation inventory system (as opposed to a harvest oriented inventory system) is recommended to capture more representative fuels information. Other recommendations for data collection include the investigation of LiDAR technology to improve the accuracy and precision of fuels information. Satellite imagery and surveys should be considered for mapping and updating areas of hazardous fuels on a landscape level. Collection of hazardous fuels data can be accomplished at multiple levels and operations. Mission reports for fire patrol and observation flights could include data

fields to record disturbances and hazardous fuels conditions; these data fields would facilitate data upload to a centralized repository.

Forest inventories and forest health surveys should capture fuels and vegetation data for both public and private lands and extend beyond merchantable timber stands. Effectiveness of inventories can be improved by prioritizing areas to be inventoried. Development of consistent formal annual inventory processes will require additional funding to achieve timelier forest inventory and hazardous fuels assessments.

Recommended Policies and Guidelines to Mitigate Hazardous Fuels

FireSmart vegetation management principles and fuels treatment guidelines are seen as integral components of hazardous fuels mitigation policy. The recently launched FireSmart Canada website[28] provides a unified national focus on applying vegetation management principles to community protection and reviewing and implementing provincial and municipal legislation in community and industrial developments in the wildland. Revised legislation and policy should include requirements for FireSmart guidelines to be adopted in municipal planning and the Canadian Building and Fire Code for residential and industrial development.

FireSmart planning requirements should be implemented for holders of industrial dispositions located in hazardous fuels areas. Other legislation will provide industry hazard abatement policy to address appropriate loading of logging slash debris. In the future more attention to landscape management projects and prescribed burning is required.

Additional legislation would require that FireSmart guidelines be applied to existing residential, industrial and commercial properties in the form of fuels treatments or maintenance and upgrading of properties to include FireSmart building materials. Other recommended changes to legislation include stricter regulations to reduce human caused fires during the critical spring period.

Legislation should require all new developers within the provincial forest to carry out FireSmart initiatives based on the relative wildfire risk for that site. Homeowner insurance rebates are suggested as an incentive for homeowners to apply FireSmart principles to their home building materials and surrounding vegetation. Increased resources (funding and staffing) are noted as key requirements for successful delivery of established directives[29] and for the development and growth of programs to support these directives. With additional resources, landscape fuels management programs and prescribed burn programs could be established and grown to include larger wildland areas that require organized active fuels management.

Discussions are on-going within a variety of task teams and committees to address land management issues such as adjusting silviculture stocking standards within the 2km interface zone and feathering out to the landscape (2-10km and +10km). There are also considerations needed for species selection (deciduous vs. coniferous) near interface areas. Changes to leased land policies in ON are recommended to allow residents to modify the priority zones from 0-100m from primary structures.

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[28] https://www.firesmartcanada.ca/

[29] Canadian Wildland Fire Strategy
http://www.ccmf.org/pdf/Declaration_E_web.pdf,
British Columbia Wildland Fire Management Strategy
http://www.bcwildfire.ca/Prevention/PrescribedFire/docs/BCWFMS.pdf

Recommendations for Improvements to or Expansion of Programs

Knowledge transfer can be used as an all-encompassing term to address the recurring recommendations from survey respondents for communication and information sharing. Development of best practices for prescribed burning and fuels treatments in different fuel types with associated case studies can be posted on a website, SharePoint site or through emails. Relevant science, research programs and case studies can also be posted with links to other research websites.

Several wildfire management agencies have posted Community Wildfire Prevention Plans to their agency websites. This continued information sharing can benefit other practitioners writing fuels treatment prescriptions or community planners developing or expanding communities in the WUI. Fuels treatment prescriptions with documentation of results could be communicated through a regular annual publication.

Further research is recommended to evaluate the effectiveness of fuels treatments and determine appropriate prescriptions in different fuel types. Documentation of fuels treatments and associated costs with enhanced information sharing processes can lend to efficiencies and cost reductions. Communicating the science behind various fuels treatments can lead to enhanced understanding and potential innovation of fuels treatments. Maintenance requirements for fuels treatments are not well understood and this requires further research.

More research is required to determine appropriate loading of harvesting debris left on site to mitigate hazardous fuels accumulations. Other at-the-stump hazard abatement issues include debris reduction policies (roadside abatement vs. reduced loading across the entire block). Innovations and emerging options in bioenergy technology may provide future solutions to debris management issues and alternate fuels for communities living in areas of heavy accumulations of hazardous fuels.

Strengthening cross-government partnerships and partnerships with non-government entities will lead to increased fuels treatment production over a broader area. Decision making processes or models to aid with conflicting interests between government departments can streamline and expedite approval processes. Partnerships can improve funding and support to increase the implementation of FireSmart guidelines at both the homeowner and landscape level. Broad-based support for the National FireSmart initiative is seen as a beneficial goal.

Sustained or additional funding in combination with staff training and capacity building are requirements for growth in fuels treatment programs. A strategic shift in funding formulae is required to place greater emphasis on risk mitigation through active fuels management programs to facilitate a long-term reduction in wildfire suppression and responses expenses. Additional personnel should be dedicated to the fuels management programs to grow these programs and to mitigate personnel shortages due to attrition. Present staff workload should be adjusted to focus on current and emerging priorities.

Conclusion

Response to this survey indicates that there is great diversity in the scale and complexity of fuels management programs implemented by the 13 Canadian wildfire management agencies. Each agency responds to unique hazardous wildland fuel challenges by developing and implementing fuels management programs shaped by factors such as extent and severity of hazardous fuels, threat to values and resource availability. In spite of differences in the delivery of fuels management programs, there are common goals, strategies, objectives and practices that can be exploited in the development of a national fuels management strategy. Adoption of a national fuels strategy will create opportunities for agencies with well-established programs to take the lead in national program development while allowing other agencies to capitalize on successful processes.

Knowledge and technology gaps in existing fuels management programs were identified in the survey. Capacity building, sharing of information and best practices, knowledge transfer, and research are implied as desirable goals through a number of tactical recommendations to bridge these gaps. With the development of a solid foundation of a universal fuels management strategy, these recommendations can be prioritized and implemented to support the overall fuels management strategy and goals.

Consistent data management goals and standardized data collection processes are critical to the accurate representation and comparisons of fuels management program deliverables. If agencies need to make 'apples to apples' comparisons and compile compatible data on various fuel treatments it will be necessary to establish fuel treatment goals and parameters for distinguishing between fuel treatment types at multiple levels on the landscape. Similarly, forest inventories and health surveys need universally adopted data collection systems with defined parameters for assessing the extent and severity of hazardous fuels and spatially displaying the data. Annual updates to agency databases with uploads to a national data management system would contribute to timely and accurate communication of the national wildland fuels situation.

Canadian wildfire management agencies implement fuels management strategies and conduct various fuel treatments at different levels on the landscape. Development of a national fuels management strategy will require clarification and adoption of fuel treatment strategies and scalable initiatives that can be implemented to meet the unique needs of each Canadian agency. The widespread implementation of FireSmart policy and guidelines as part of existing fuels management programs is indicated in the survey responses. Partners in Protection Canada is the only nationally adopted fuels management program and should be considered as a model for future initiatives that contribute to a national fuels management strategy.

Canada's forested land-base is comprised of 12 ecozones[30] with varying extents of hazardous wildland fuels. While the specific fuels management needs of each Canadian wildfire management agency are unique, a coordinated approach to wildland fuels management across Canada can lead to shared efficiencies and cost effectiveness in program development, data management and fuel treatment projects. Continued discussion of these survey responses by the Fuels Management Task Team will be

[30] Natural Resources Canada. Forest Types and Inventory. http://cfs.nrcan.gc.ca/pages/125

instrumental in developing effective knowledge and data transfer systems, and creating innovative approaches to mitigating fuels treatment costs.

Wildland fire risk mitigation and fuel modification solutions proposed by Countryman (1974) almost 40 years ago clearly resonate in current discussions.

> *'The best prospect for alleviating the potential of conflagrations is to create fuel situations through a coordinated program of fuels management that will reduce the energy output of fire starts to a point where conventional firefighting methods can be effective and thereby limiting their size. In this light, fuels management should be viewed as an integral supplement to fire suppression in controlling unwanted fires'.*
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> *(Alexander 2003)*

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- Implementation Coordinator - Paul Ward (ON-retired)
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Appendix A: Follow-up Survey

National Wildland Fuels Management Survey
Follow-up Questionnaire

March 2012

National Fuels Survey Participant:

The Fuels Management Task Team would sincerely like to thank you and your agency for participating in the recent National Fuels Survey. The recent survey is currently being summarized by FPInnovations, and the final report will be shared out to agencies this spring.

We also wanted to give you the opportunity to share any feedback you may have on the survey itself for potential improvements for future surveys. This should take only 5-10 minutes of your time.

The Canadian Interagency Forest Fire Centre's Council of Directors (CoD) is supportive of this initiative, and also appreciates the agencies participating to the extent possible in providing data and information to the completed surveys.

Here are some brief feedback prompts; however, feel free to provide additional comments:

- How did you find filling out the National Fuels Survey? (easy, challenging, or other descriptors)

- How much time approximately did it take you or others in your agency to complete the survey? (hours, or portions of a day)

- What are your comments for potential improvements to the survey if a future survey was conducted? What would you like to see changed?

- Did you find the detail requested in the survey too detailed, or appropriate to the task?

Thank you!

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