Examination of Incipient Wildfire Analyses in Selected Wildfire Agencies

By

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Abstract

This study examines how early wildfire analysis, referred to as incipient wildfire analysis is structured and represented across selected Canadian wildfire management agencies. Despite its operational importance, research in the Canadian context has focused primarily on fire behaviour modelling and suppression effectiveness, with limited attention to the analytic processes that inform early response. This study addresses that gap by analyzing organizational documents used in Alberta, Ontario, Parks Canada, and Yukon.

The dataset consists of initial fire reports, wildfire analysis documents, and procedural "how-to" guides. These materials represent formalized analytic structures used to assess wildfire conditions and inform response decisions. Using a combination of inductive and deductive qualitative content analysis, this study examines both what is represented in these materials and how that representation is structured. Deductive analysis is guided by the Canadian Forest Fire Danger Rating System (CFFDRS) to assess the use of standardized fire characteristics and terminology, while inductive analysis identifies broader analytic domains, including spatial references, values at risk, operational constraints, risk representation, and strategic direction. Findings show that while agencies share a common analytic purpose, they differ in many ways. For example, agencies vary in how they define fire characteristics, identify constraints to response, and express risk through both qualitative and quantitative inputs. The use of CFFDRS components also differs. These variations shape how incipient wildfires are documented and how fire management agencies interpret the situation to structure how to respond to these fires.

This study does not evaluate the effectiveness of analysis or decision-making outcomes. Instead, it provides a comparative account of how incipient wildfire analysis is constructed as an organizational process. By making these structures visible, the study contributes to a clearer understanding of how analysis supports response planning and highlights implications for interagency coordination and information translation in Canadian wildfire management.

Keywords: Wildfire management, wildfire analysis, wildfire response planning, incipient wildfire

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Glossary

Acceptable Burned Area (ABA) The extent of fire growth deemed acceptable under a managed response plan. If fire spreads beyond the ABA, pre-identified mitigation actions are triggered.

Alberta Wildfire Coordination Center (AWCC) Alberta's provincial coordination center.

Allow Area Burned (AAB) A managed response objective in which fire spread within a defined area is permitted in alignment with management goals.

Appropriate Response A fire-by-fire decision-making approach in which management efforts are calibrated to policy objectives. Supports full, modified, or monitored response types.

Buildup Index (BUI) A CFFDRS index representing total fuel available for combustion.

Canadian Forest Fire Danger Rating System (CFFDRS) A national system that produces codes and indices used to assess fire danger and support fire management decisions in Canada.

Canadian Interagency Forest Fire Centre (CIFFC) A national organization that coordinates resource sharing and interagency operations across Canadian wildfire agencies.

Crown Fraction Burned (CFB) The fraction of tree crowns predicted to be consumed by a fire.

Cumulonimbus (CB) A large convective cloud associated with thunderstorms and erratic fire behaviour.

Decision Support System (DSS) A structured tool that organizes information and produces outputs to support response decision making.

Deductive Content Analysis (DCA) A qualitative method in which pre-defined categories are applied to the data.

Drought Code (DC) A CFFDRS index representing the moisture content of deep compact organic matter.

Duff Moisture Code (DMC) A CFFDRS index representing the moisture content of moderately deep organic material below the surface litter.

Escalation Criteria The conditions triggering a move from IFR-level assessment to WFA-level assessment. Criteria vary by agency.

Fine Fuel Moisture Code (FFMC) A CFFDRS index representing the moisture content of fine surface litter.

Fire Appropriate Response (FAR) Ontario's WFA process. A sequential workbook covering fire assessment from initial report through response planning.

Fire Ban A regulatory tool used to reduce wildfire likelihood by restricting ignition sources.

Fire Behaviour Prediction (FBP) System A component of the CFFDRS that models fire behaviour across major Canadian fuel types.

Fire Behaviour Analyst (FBAN) A specialist role involving advanced fire behaviour analysis.

Fire Complexity Rating A quantitative scoring process used by Parks Canada to assess the overall complexity of a wildfire. Outputs a numeric rating corresponding to an ICS incident type.

Fire Load The total number and severity of active wildfires an agency is managing at a given time.

Fire Management Zones (Yukon) A zonation system dividing Yukon into five zones — Critical, Full, Strategic, Transitional, and Wilderness — each with corresponding response priorities.

Fire Projection Map A map showing modelled future fire growth used to support response planning.

Fire Regime The characteristic pattern of fire activity in a given area, described through factors such as frequency, size, intensity, and seasonality.

Fire STARR A fire growth modelling tool used by Ontario to project fire spread.

Fire Type (FT) A classification of fire behaviour based on Crown Fraction Burned. Categories are surface fire, intermittent crown fire, and continuous crown fire.

Fire Weather Index (FWI) System A component of the CFFDRS that uses weather observations to produce indices describing fuel moisture and fire behaviour potential.

Fire Weather Index (FWI) A CFFDRS index representing overall fire intensity potential.

Forest Protection Area (FPA) Alberta's legislated area of responsibility for wildfire suppression.

Full Response Aggressive suppression of a wildfire until it is under control.

Head Fire Intensity (HFI) The predicted energy output at the head of a fire, measured in kilowatts per meter.

Incident Command System (ICS) A standardized management framework used across Canadian wildfire jurisdictions to organize and coordinate emergency response.

Incident Commander (IC) The individual responsible for managing all aspects of an incident. Certification levels IC1–IC5 correspond to incident complexity.

Incident Management Team (IMT) A pre-assembled team that takes command of a wildfire when it exceeds initial attack capacity.

Inductive Content Analysis (ICA) A qualitative method in which analytic categories are developed from the data itself.

Initial Attack (IA) The first suppression response to a wildfire.

Initial Fire Report (IFR) The first documented assessment of an incipient wildfire, completed by initial attack crew leaders upon arrival.

Initial Spread Index (ISI) A CFFDRS index representing expected rate of fire spread.

Incipient Wildfire In this study, the period from initial fire assessment to long-term planning. Long-term planning is defined as either beyond seventy-two hours or an incoming incident management team taking control.

Interoperability The ability of wildfire agencies from different jurisdictions to work together effectively, sharing resources, terminology, and operational frameworks.

LACES A firefighter safety acronym: Lookout, Anchor Points, Communication, Escape Routes, Safety Zones.

Limit Area Burned (LAB) A managed response objective in which suppression efforts are directed at restricting fire spread to a defined area.

Modified Response A combination of suppression tactics aimed at containing a wildfire within a defined perimeter while potentially allowing some fire activity.

Monitored Response Observing a wildfire without active suppression when allowing it to burn aligns with management objectives.

Mutual Aid and Resource Sharing (MARS) Agreement The agreement enabling transfer of personnel, equipment, and aircraft between Canadian wildfire agencies.

National Fire Restoration Target A Parks Canada policy requiring larger parks to target an area burned over a twenty-year period equal to at least 20% of the historical burn area based on the reference fire cycle of the park.

Next Generation CFFDRS (NG-CFFDRS) A modernized version of the CFFDRS with improved predictions across a broader range of fuel types including grasslands and peatlands.

Preparedness Level A numerical ranking reflecting current wildfire activity and resource capability at provincial and national levels.

Pre-positioning The strategic placement of resources in locations that maximize flexibility and response capability.

Prometheus A Canadian fire growth modelling tool used by Alberta to project fire spread.

Provincial / Regional Duty Officer (RDO) An agency official responsible for coordination and oversight of wildfire response within their region or province.

Rate of Spread (ROS) The predicted speed at the front of a fire, measured in meters per minute.

Sector Response Officer (SRO) A role referenced in Ontario's WFA approval chain responsible for completing interim response plans.

SMART Objectives An objective-setting framework used in Yukon's WFA process. Stands for Specific, Measurable, Achievable, Relevant, and Time-Oriented.

Standard Operating Procedure (SOP) A documented set of instructions governing how specific tasks or processes are carried out within an agency.

Trigger Points Pre-defined conditions that prompt a change in response strategy or require reassessment of a fire.

Values at Risk (VAR) People, infrastructure, and ecological or cultural assets that may be impacted by a wildfire.

Wildfire Analysis Document (WFA) A follow-up assessment document completed when a fire exceeds routine initial attack. Supports expanded risk assessment, response framing, and strategic direction.

Wildland Urban Interface (WUI) Areas where human development meets wildland vegetation, creating elevated wildfire risk.

Wright-Beall Tracer Index An early fire danger tool linking fuel moisture content to fire behaviour. A foundational precursor to the CFFDRS.

Yukon Duty Officer (YDO) The senior Yukon official responsible for approving WFAs and overseeing territorial wildfire coordination.

Zonation A pre-IFR structuring mechanism in which geographic zones are pre-designated with corresponding response types, shaping response options before a fire is assessed.

Chapter 1: Introduction

Wildfire is a natural disturbance, part of an ecological process contributing to shaping and maintaining many ecosystems in Canada.[1,2] The annual burned area in Canada varies greatly, ranging from 218,232 hectares (ha) in 2020 [3] to 15 million ha in 2023.[4] Canadian fire management agencies excel at managing fire with only 4% of fires exceeding 200 ha (1990-2016).[3] However, this small percentage is responsible for 97% of the area burned (1990-2016).[3] Historically, fire management revolved around fire abolition and suppression, but this model today faces a growing list of challenges. Aggressive fire control has contributed to a changed fire environment, leading to rising societal, ecological, and fire suppression costs as well as increased fire severity.[5,6] There is evidence that North America can expect an uptrend in both the frequency and severity of wildfire incidents due, in part, to anthropogenic climate change.[7,8] The impacts of a shifting wildfire management landscape means contemporary wildfire agencies face a far more complex challenge than their forebearers, whose objectives rarely strayed outside of pure fire control.[9–11] Today's wildfire agencies contend with a changing fire environment, decreased workforce capacity, rising costs, an ever-growing wildland urban interface (WUI), increased societal pressure, and more nuanced management objectives.[5,11,12] Unlike managers of other disasters, fire managers can influence both the likelihood and severity of incidents, resulting in a growing reliance on decision making.[13–15] Likelihood can be understood as the potential for a fire at a particular location[11], it can be influenced through regulatory tools such as such as fire bans or forest area closures.[16] Severity describes the amount of organic matter consumed [17] and can be influenced through response choices and suppression operations.[13] Incipient is often used to describe the phase from ignition before spread, however, in the context of this study it is defined as the period from initial fire assessment to long term planning. Long term planning is either a timescale longer than seventy-two hours or an incoming incident management team (IMT) taking control of the fire. The first portion of the incipient stage is the highest leverage point of a wildfire's life operationally, representing the greatest chance for initial attack (IA) success at the lowest economic cost.[18] The latter portion of the incipient phase after a fire escapes initial attack represents a stage of complexity and uncertainty for wildfire management. Organizationally, operational and strategic planning documents aid in mitigating rising complexity and provide fire managers with a toolkit of options with which to respond to incipient wildfires. Wildfire analysis documents feature as the data gathering sources that drive subsequent response planning.

Early Canadian Fire Management

Stephen J. Pyne's *Awful Splendor: A Fire History of Canada* [9] is the principal source for this section and remains the most complete account of Canadian fire history. This history is important because the organizational structures of contemporary wildfire management agencies in Canada were shaped by the institutional and economic conditions through which fire management developed.

The Dominion of Canada

European settlement transformed fire regimes in what is now known as Canada through the suppression and marginalization of Indigenous burning practices and the introduction of new ignition sources, especially through forestry. [9] The emphasis on fire suppression by Europeans had wide ranging effects that continue to reverberate today.[9] As the timber economy matured, the Crown's tenure system tied government and industry together: The Crown retained ownership of land while leasing harvesting rights to timber companies.[9] In doing so, forestry and fire protection became institutionally linked.[9]

The 1906 Dominion Forest Reserves Act marked an important institutional step, placing the Dominion Forestry Branch in charge of protected Crown land. Early efforts focused primarily on prevention through education, access regulation, permit systems, and railway controls.[9] These systems required a growing institutional presence through rangers, roads, trails, lookouts, and communications infrastructure.[9] As forestry expanded, so too did the scale and ambition of fire control [9]. New technologies such as pumps, radios, and aircraft further reinforced the idea that fire could be controlled systematically.[9] Although control over natural resources later shifted to the provinces through Confederation, the philosophy fusing fire protection with forestry remained largely intact.[9]

Ontario

The Province of Ontario set the pace and direction for Canadian fire management as the first province to formalize wildfire management in 1885.[9] Reforms following major fires in the

Ottawa Valley led to the Fire Act of 1878 and the creation of the Fire Ranging Service in 1885.[9] The ranging service was jointly funded by government and industry.[9] By the late nineteenth and early twentieth centuries, Ontario had developed an increasingly sophisticated protection apparatus organized through zoning, ranger systems, and detailed reporting structures.[9] These developments reinforced the belief that systematic control and scientific forestry could suppress fire effectively.[9] Later investments in aircraft and airtankers strengthened this confidence further, even as severe fire seasons continued to demonstrate the limits of suppression.[9]

Alberta

The Province of Alberta inherited much of the Dominion Forestry Branch's personnel, infrastructure, and fire abolitionist philosophy when it assumed control over its natural resources through Confederation in 1930.[9] Its fire management system reflected regional differences in landscape and access, but the agency continued to pursue aggressive initial attack under the belief that fires could and should be controlled.[9] Postwar expansion greatly increased institutional capacity, yet severe fire seasons and rising costs gradually forced debate over whether universal suppression was either economically or ecologically defensible.[9] This contributed to a shift from asking only how to fight fire, to asking where and when suppression is warranted.[9] In turn this lead to hazard reduction programs such as wide spread spring burning efforts.[19]

Parks Canada

Parks Canada diverged from provincial models. Fire management in the national parks had to respond to diverse ecological settings, and the contrast between near-total fire exclusion in Banff National Park and the limits of aggressive suppression further north in Wood Buffalo National Park helped prompt a broader reassessment.[9] By the 1980s, ecological research and changing conservation values supported a shift away from fire abolition and toward restoration.[9] Parks Canada's Management Directive 2.4.4 (1986) formally recognized fire as a natural and desirable ecological process, placing ecological integrity at the centre of decision making and creating space for prescribed fire and selective suppression.[9] This marked a major turning point in Canadian fire management and helped push recognition of fire's ecological value into broader wildfire management in Canada today.[9]

Yukon

The Territory of Yukon followed a different path. Without a timber-based political economy, the territory's fire management system developed primarily around the protection of settlements, transportation routes, and other socially valued sites.[9] Zonal protection strategies reflected this orientation, prioritizing communities, roads, recreation sites, and cultural assets rather than pursuing province-style universal suppression.[9] In this context, Yukon developed a more selective protection model and became an early innovator in techniques such as aerial ignition and automated lightning detection.[9]

Summary of Key Features in the Development of Selected Wildfire Management Agencies

Two broad forces were especially important in the development of Canadian fire management: the railway and the relationship between forestry and fire control.[9] Railways were major ignition sources, key access routes, and instruments of national coordination.[9] Forestry gave land economic value and justified the growth of costly fire protection systems.[9] Together, these forces helped institutionalize fire protection across the country.[9] Over time, science and technology were repeatedly adopted as solutions to the fire problem, further reinforcing the fire abolition trajectory.[9] Innovations such as pumps, aircraft, airtankers, and eventually the Canadian Forest Fire Danger Rating System supported increasingly organized and technical approaches to wildfire management.[9] Although philosophies have changed, many of the institutional logics established in this earlier period still influence wildfire management in Canada today.[9] Technological innovation continues to feature prominently, with the Canadian Forest Fire Danger Rating System playing an important role in the contemporary system.

The Canadian Forest Fire Danger Rating System (CFFDRS)

The Canadian Forest Fire Danger Rating System (CFFDRS) is important to understand as it is an integral part of both this research and fire management in Canada. It is a national system used to rate the risk of forest fires in Canada.[20] Forest fire danger refers to a variety of factors such as fire severity, ease of ignition, fire impact, and difficulty to control.[20] The forest fire danger rating system produces qualitative and quantitative codes and indices used as guides for a variety of fire management needs, including planning and wildfire response.[20] There are four subsystems: the fire weather index (FWI), the fire behaviour prediction system (FBP), the fire occurrence prediction system (FOP), and the accessory fuel moisture system (AFM). The two most widely used subsystems for understanding fire danger and behaviour in Canada are the FBP and FWI.

Wright-Beall Tracer Index

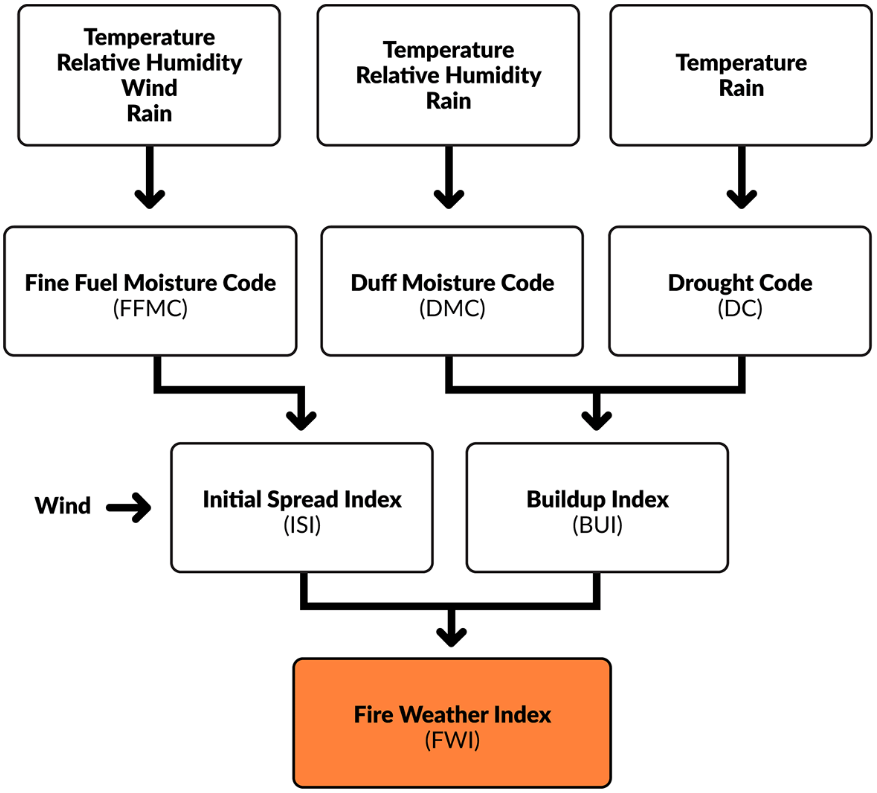
The focus of foresters who shepherded Canada's early fire control efforts was on fire abolition, not on the science behind the flames.[9] Beginning in 1925, using federal funding, J.G Wright set out to explore the relationship between weather, fuel moisture and fire behaviour.[21] Wright and Herb Beall lit copious test fires, leading them to firmly establish the relationship between fuel moisture content and fire behaviour.[9] The "Tracer Index" linked the moisture content of a fuel and determines its behaviour in the presence of ignition. Additionally, it meant that isolating the weather factors influencing moisture content should made it possible to understand flammability under different conditions. [9]

These findings led Wright to publish "Forest Fire Hazard Tables for Mixed Red and White Pine Forests" in 1933, a foundational document for all future fire hazard science.[9] This publication used the Tracer Index to correlate recorded weather with fuel flammability, and provided operationally useful tables for use that could be taken out to the field.[9] This crucial first step in wildfire science empowered early fire control agencies to employ the "Wright system" in their decision-making process.[9]

Fire Weather Index (FWI) System

In response to growing demands from quickly developing provincial agencies, Forestry Canada began working on a fire danger rating system in the late 1960s.[21] The Fire Weather Index (FWI) system was built upon the Tracer Index but had now evolved to consider six components that account for the effects of fuel moisture and wind on fire behaviour.[22] These six components input observations of, mean wind speed (km/h) at ten metres above surface, relative humidity (%), temperature, (°C) and precipitation (mm) total over 24 hours, to model the systems primary outputs, as shown in Figure 1.1.[21,23] Observations must be collected from a weather station 100 metres in diameter that is both sheltered and not adjacent to a water body.[23] Daily observations are collected at 1200 local standard time (LST).[23]

Figure 1.1 Fire Weather Index (FWI) System Components.[24]

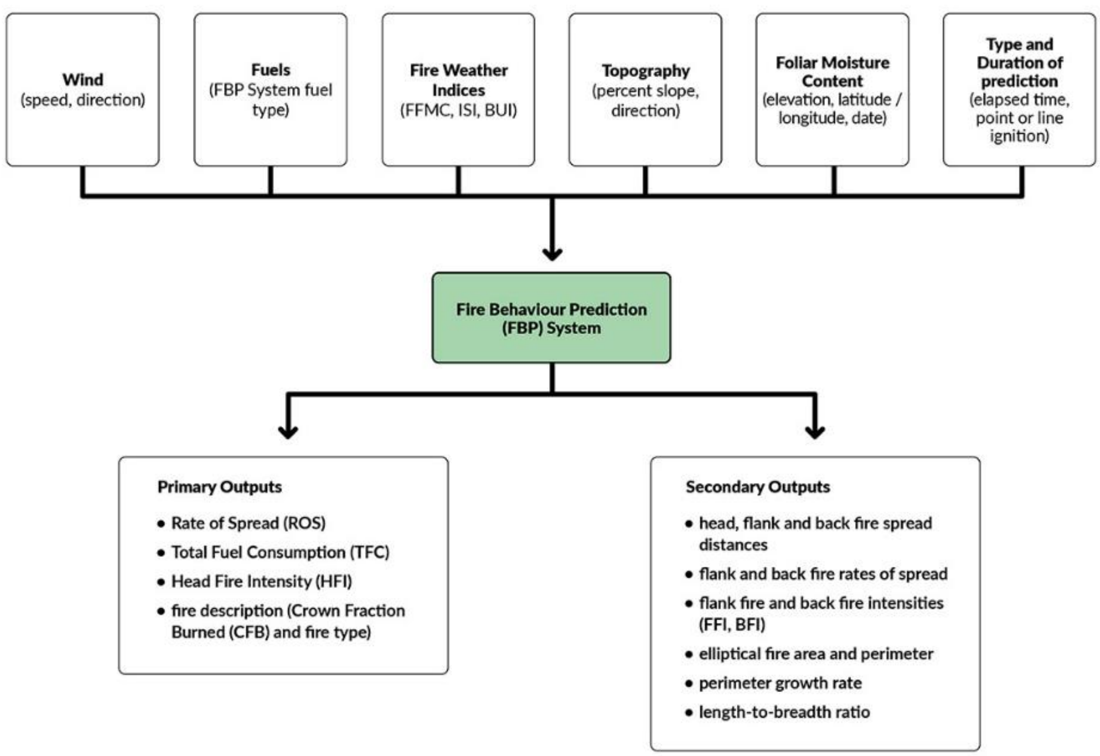


The three moisture codes are the Fine Fuel Moisture Code (FFMC), the Duff Moisture Code (DMC) and the Drought Code (DC).[24] These codes "are numerical ratings of the moisture content of fine surface litter, loosely compacted duff of moderate depth, and deep compact organic matter, respectively."[22] The three fire behaviour indexes are the Initial Spread Index (ISI), the Buildup Index (BUI) and the Fire Weather Index (FWI).[24] These indices represent the rate of fire spread, the fuel available for combustion and the frontal fire intensity.[21,22] The relationships between these six components and the weather variables are illustrated in Figure 1.1. The FWI is a strong indicator of expected fire activity, used in both operational and administrative settings.[21,22] Even though the FWI scale is uniform, the range of fire environments across Canada has resulted in jurisdictions developing their own fire danger classification scheme to that best represents their landscapes.[21,22]

Fire Behaviour Prediction System (FBP)

The Fire Behaviour Prediction (FBP) system was released by Forestry Canada in 1990, comprising of a series of quantitative fire behaviour models for major Canadian fuel types.[21,25] The FBP system's primary outputs of The FBP systems primary outputs include: Rate of Spread (ROS), Total Fuel Consumption (TFC), Head Fire Intensity (HFI), Crown Fraction Burned (CFB), and Fire Type (FT).[24,25]The ROS is the predicted speed at the front of the fire, measured in meters per minute. The TFC is the predicted weight of fuel consumed by fire, including both the forest floor and crowns of the trees, measured in kilograms per square meter of ground surface.[24,25]The HFI is the predicted energy output at the head of the fire, measured in kilowatts per meter and is a key metric used to estimate control difficulty.[24–26] The CFB is the fraction of tree crowns predicted to be consumed by the fire.[25,26] The FT describes the fire and is based on the CFB, which directly correlates with crown engagement of the fire.[25,26] Figure 1.2 shows which inputs feed into the FBP system. One important limitation of the FBP system is the requirement to assign fuels into one of 14 available fuel types.[27]

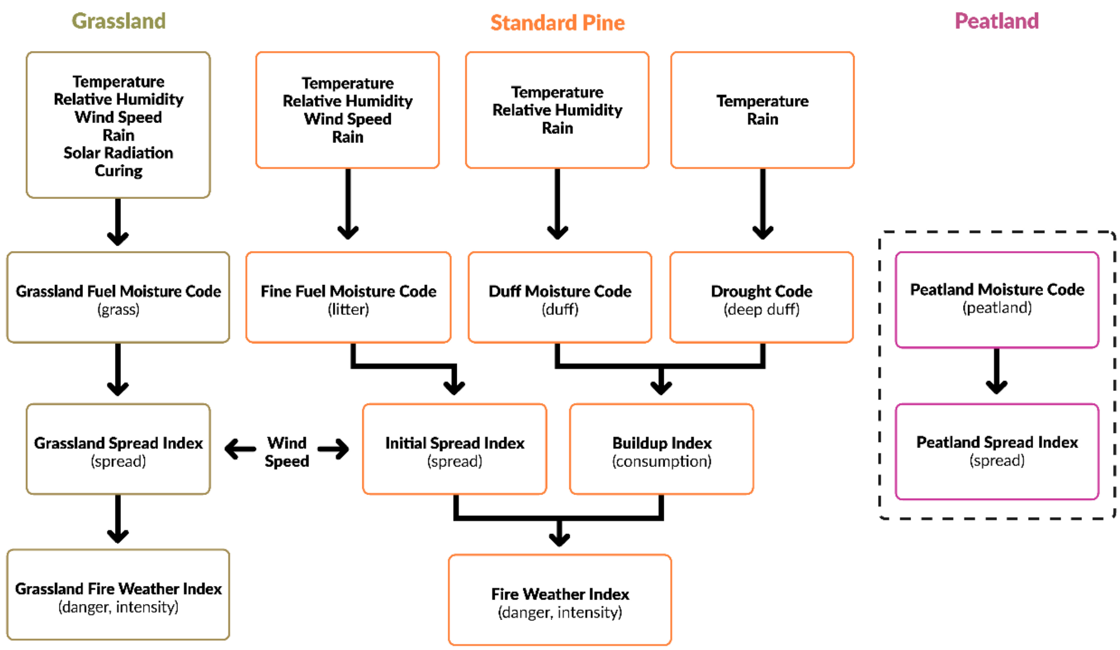
Figure 1.2 Table shows Fire Behaviour Prediction (FBP) System.[26]



Next Generation Canadian Forest Fire Danger Rating System (NG-CFFDRS)

The Canadian Forest Fire Danger Rating System (CFFDRS) was last updated in 1992. Next Generation Canadian Forest Fire Danger Rating System (NG-CFFDRS) aims to modernizes the systems to match the needs of modern fire management.[28] The modernized NG-CFFDRS will provide better forecasts of; i) the onset of elevated spring fire danger and fire behaviour in deciduous and mixed wood stands, ii) include fire danger beyond forests, such as grasslands and peatlands, and iii) better predictive potential for large fire occurrences.[28] Through enhanced modularity, the NG-CFFDRS will better evaluate fire behaviour potential at the forest stand and incident level through modelling improvements.[28] Modelling improvements are focused on the following: i) fire behaviour in a broader range of forest fuel types and diurnal variability, ii) the effects of fuel treatments, such as mechanical thinning, iii) the potential for fire brands to breach fuel breaks or to be transported moderate to longer distances.[28] The NG-CFFDRS' development was focused on the principles of modularity, ease of use and interpretation, physically realistic and logical model forms, and internally consistent systems and subsystems.[28] The development of the modernized NG-CFFDRS introduces a powerful new tool for fire managers to more accurately predict and forecast fire behaviour in a larger range of fuel types. The new version of the FWI system includes grassland and peatland specific moisture codes and weather inputs (shown in Figure 1.3), thus allowing for more accurate predictions in these fuel types.[28] Due to the novelty of the system and the lack of broad adoption at this time, this literature review excludes detailed descriptions of all of the new components involved in the NG-CFFDRS.

Figure 1.3 Table shows NG-CFFDRS FWI System.[29]



Fire Regimes

Fire regimes are one of the primary drivers contributing to varying approaches to wildfire management.[30,31] "Fire regimes are the kind of fire activity or pattern of fires that generally characterize a given area over a given time period."[32] In Canada, fire regimes are characterized by fire frequency, size, seasonality, intensity, type (ground, surface, crown), severity, annual area burned and cause.[33,34] There is strong connectivity between these factors, such as severity and size or seasonality and cause. The causes of wildfire ignition in Canada are split roughly equally between lightning and human ignition.[35] Lightning is responsible for a larger portion of summer ignition, while human ignition accounts for most wildfire starts in the spring and fall.[32] Lightning fires make up about 90% of the area burned due to its proliferation in northern wilderness areas that are more difficult to access and have fewer values at risk.[3,34] Fire regimes are one of the key factors influencing differences in wildfire management strategy and tactics.[36,37] Depending on the fire regimes they contend with, agencies may have different seasonal peak fire loads.[30,34]

Climate Change

Weather is a key factor in determining the severity of fire behaviour, making anthropogenic climate change a crucial component of the challenges Canadian wildfire management faces.[32] Coogan et al. [38] identify that climate change impacts on fire weather will be behind the most important impacts on future fire regimes. Climate and fire weather are strongly linked as fire weather is the result of short-term changes in the atmosphere, with climate driving long-term weather patterns in specific regions.[38] Factors determined by weather, such as temperature, wind, precipitation and atmospheric moisture, are highly influential on wildfire activity.[38] Climate can influence vegetation (fuels) through long-term trends in fire weather, as weather directly influences fuel moisture content.[38] Increases in fire occurrence, intensity, fuel consumption, area burned, and fire season length in many forested ecosystems across Canada are likely the results of climate-change-influenced effects on fire regimes.[38] Flannigan et al. [12] suggest that fire management agencies' suppression capacity will be severely challenged over the current century by climate-change-induced changes in fire regime and wildfire activity. Podur and Wotton[39] propose that the traditional approaches to fire suppression are reaching a point of diminishing returns in terms of economic and physical effectiveness.

In the context of incipient wildfires, there is evidence to suggest that climate change will increase the proportion of wildfires escaping initial attack due to increased wildfire intensity.[11] This change in intensity is expected to be characterized by an increased likelihood of unmanageable crown fires.[11] The effects of climate change are likely to affect forest types across Canada.[40] McAlpine and Hirsch[41] suggested that a doubling of resources would be required to match the impact of a 15% increase in fire occurrence. Overall, climate change is projected to increase incipient response complexity, further reinforcing the need for structured and dynamic analysis processes.

Over the last three years, Canada has recorded its two worst wildfire seasons on record (2023 and 2025) in terms of hectares burned.[42] The 2023 wildfire season can be attributed to record setting weather.[4] The 2023 wildfire season began with an early snowmelt and record-breaking heat, and culminated with a record-breaking burning day on September 22nd. [4] This resulted in a fire season spanning seven months.[4] The record-breaking 2023 fire season is due in large part, to multi-annual drought conditions and extreme fire weather which, in turn, induced extreme fire behaviour.[4] Agencies across Canada faced overwhelming fire loads simultaneously causing a breakdown in the resource sharing agreements that make fire management in Canada feasible.[4] This trend has continued through the 2024 and 2025 wildfire seasons, while not record-breaking, these seasons have challenged the capacity of wildfire management in Canada, necessitating the import of international resources.

Contemporary Fire Management in Selected Agencies

Canada functions as a federal union of provinces, having become a sovereign nation through a process called Confederation. It has a federal government recognized by its constitution and ten provinces and three territories. Canadian fire management is responsible for the protection of crown land, which makes up roughly 89% of the country.[43] Fire management in Canada is the responsibility of Provincial and Territorial governments.[16] This literature review focuses on the jurisdictions involved within this study: Alberta, Ontario, Parks Canada, and Yukon.

Since their inception, wildfire management agencies in this study have evolved to organizations with a range of responsibilities that include but are not limited to fire suppression.[9,16] Alberta Wildfire is a single hazard standalone wildfire management organization.[9,16] Ontario's Aviation, Forest Fire and Emergency Services Branch (AFFES) is responsible for protecting people, property, and communities from natural hazards through emergency response to fire, flood, and soil erosion.[16] Parks Canada's is responsible for the protection of nationally significant examples of Canada's natural and cultural heritage, which includes fire management as part of its mandate.[44] Yukon Territory Wildland Fire Management Branch, and the Yukon Territory Emergency Management Organization are within the same ministry.[16]

Wildfire management in Canada has a spectrum of approaches, characterized by zonation or no zonation, and full response or risk-based appropriate response.[16] Risk based appropriate response supports full response options when deemed suitable. These approaches are the result of agency-specific priorities, philosophies, and organizational constraints.[9,43]

Risk-based appropriate response is a decision-making approach that occurs on a wildfire-by-wildfire basis, where wildfire management efforts are commensurate with policy and desired objectives.[16] This approach allows for the use of multiple response types (full, modified, or monitored) over time to simultaneously manage multiple objectives with the ability to pivot should conditions change.[16] This includes the option of whether to deploy initial attack resources to a fire.[16]

Response types differ in the kinds of objectives that they seek to achieve. "Full response refers to aggressive initial attack on a wildfire until it is under control."[16] Modified response involves using a combination of suppression tactics, including both direct and indirect attack, to contain a wildfire within a maximum allowable perimeter.[16,45] Modified response often includes monitoring to manage fire activity.[45] The overall intent is to achieve positive ecological, or resource management objectives while minimizing social and economic disruptions.[45] Containment objectives are based on assessments of the wildfire environment (fuel, weather, topography) and wildfire behaviour potential, opportunities to contain the wildfire within the objective are then identified.[16] Modified response wildfires are assessed to decide whether the fire has suitable conditions for this approach with regular assessments through the fires lifecycle.[16] Modified response might look like direct attack on one flank of the fire, indirect attack using aerial ignition on another, and "let it burn" or monitoring for the other flanks. [16] Modified and monitored responses are often intended to allow agencies to attain land management objectives while reducing impacts to values at risk and costs.[16] Monitored response fires are observed and assessed to determine if suppression will be required. [45] They do not have perimeter containment objectives. [16]

Canadian Interagency Forest Fire Centre (CIFFC)

The variety of approaches to wildfire management and the necessity of interoperability in Canada requires an organization to support interagency work.[9] The Canadian Interagency Forest Fire Centre (CIFFC) was established in 1982, filling an important institutional void by providing a national focus and voice for the provincial fire agencies.[9] CIFFC does not impact the research conducted in this study as they do not conduct incipient wildfire analysis. However, their role as a central hub for inter-agency work means they are uniquely positioned to support interagency knowledge transfer. CIFFC is a not-for-profit organization owned and operated by Canada's fire agencies; they empowered provinces at the federal level without imposing policies.[9] In the Centre's early days, CIFFC had two key agreements that held the system together: the Canadian Interagency Resource Sharing Agreement (CIRSA) and the Canada-US Reciprocal Forest Fire Fighting Accord (CURFFFA).[9] CIRSA was renamed "the Mutual Aid and Resource Sharing"

(MARS) agreement, but the goal of resource sharing remained unchanged. The MARS agreement is the backbone of the contemporary Canadian fire management system as it enables the transfer of crews, gear, and planes that gives agencies the national support required during big fire seasons.[9]

CIFFC allows individual agencies to staff based upon their annual needs, not on the potential requirements a big season might call for. The Centre facilitates not only the sharing of personnel but also aircraft, lengths of hose, and pumps.[46]

Throughout the fire season CIFFC coordinates resource sharing nationally and internationally.[47] They also deliver a daily "situation report," which compiles data from all member agencies to create a national fire situation report.[47] When agencies' fire season's peak simultaneously, CIFFC brings in duty officers from provincial agencies to cope with the increased requirements.[43] Duty officers are responsible for big-picture coordination and strategic direction rather than doing the bookkeeping required to efficiently conduct resource exchanges.[43] CIFFC is an organizational embodiment of Canadian wildfire management's central pillar: interoperability.

Agency Response

Each jurisdiction in this study has specific conditions that their agencies operate within. Response strategies are driven by these conditions. Incipient wildfire analysis in each agency is influenced by these overarching conditions. These conditions are important to address as they shape the unique characteristics that from the context of analysis and management in each jurisdiction.

Table 1.1 Table shows strategies, response priorities, and responsibilities of agencies. Table adapted from Tymstra et al.'s "Wildfire management in Canada: Review, challenges and opportunities."[16]

Agency	**Mandated area of responsibility & length of fire season**	**Response Priorities (Policy)**	**Strategy (approach)**
Alberta	Legislated Forest Protection Area; other public and federal lands through Fire Control	1. Human life 2. Communities and associated infrastructure to support communities	Initial attack all wildfires before they exceed 2 ha in size but if unsuccessful, use an

	Agreements. Wildfire suppression provided on federal lands through agreements. Fire season: March 1–October 31	3. Major environmental and economic values 4. Other values	appropriate response approach guided by a wildfire analysis strategy or approved wildfire management plan. Zonation: None other than as identified in approved wildfire management plans.
Ontario	All crown land including unincorporated townships; other public and federal lands through Fire Control Agreements. Fire season: April 1–October 31	1. Human life and safety 2. Property losses 3. Economic and societal disruptions	Appropriate response: Each wildfire is assessed and an appropriate response made based on the situation. This approach supports the ecological role of fire, and use of fire to attain resource management objectives. Zonation: None
Parks Canada	All National Park and Historic Park lands. Fire season: Varied	No formal list of priorities; wildfires are prioritized based on values-at-risk.	Zonation: 1. Intensive Zone (Full Response) 2. Intermediate Zone (Appropriate Response) 3. Extensive Zone (Modified and Monitored Response)
Yukon	All territorial lands outside Whitehorse city limits; federal lands excluded. Fire season: April 1–September 30	1. Life 2. Property 3. Communities	Protect life, property, and communities while also maintaining the ecological role of fire. The appropriate response is based on zonation:

			1. Critical Fire Management Zone 2. Full Fire Management Zone 3. Strategic Fire Management Zone 4. Transitional Fire Management Zone 5. Wilderness Fire Management Zone

Preparedness Levels

Preparedness levels are numerical rankings done at both the provincial and national level. They are based on the significance of wildfire activity, resource capability and the potential for new significant wildfires. Preparedness levels are influenced in part by the data gathered through incipient wildfire analysis. Wildfire analysis documents contribute to measurements of resource levels, current fire load and agency's ability to respond to CIFFC resource requests. Provincial preparedness levels may influence the response capabilities an agency has and constrain response options. Determination of preparedness levels have wide ranging effects on the Canadian wildfire system since they dictate if and when agencies require out of jurisdiction support.[16]

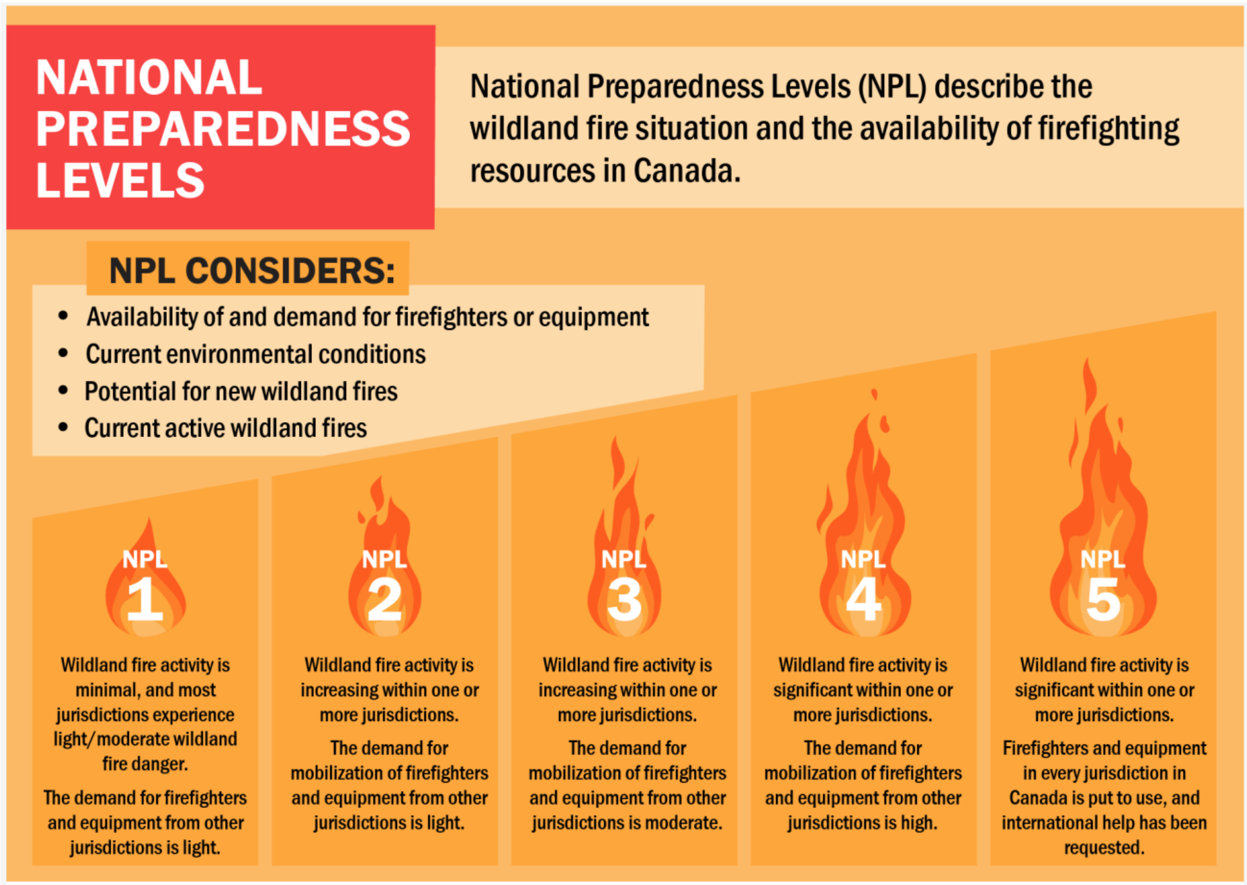
Provincial Preparedness Levels

Figure 1.4 Provincial Preparedness Levels Criteria used by CIFFC to determine Provincial Preparedness Levels.[48]

	Level 1	Level 2	Level 3	Level 4	Level 5
Agency Fire Danger	Low	Moderate	High	Very High	Extreme
Current Fire Load	Low	Moderate	High	Very High	Extreme
Anticipated Fire Load (7 Days)	Low	Moderate	High	Very High	Extreme
Agency Resource Levels	Adequate	Adequate	Some Assistance	Assistance Required	Inadequate
Agency's Ability to Respond to CIFFC Resource Requests	Excellent	Good	Moderate	Poor	No Ability

National Preparedness Levels

Figure 1.5 Figure shows Canadian Interagency Forest Fire Centre (CIFFC) criteria for national preparedness levels. [49]



Emergency Management Principles

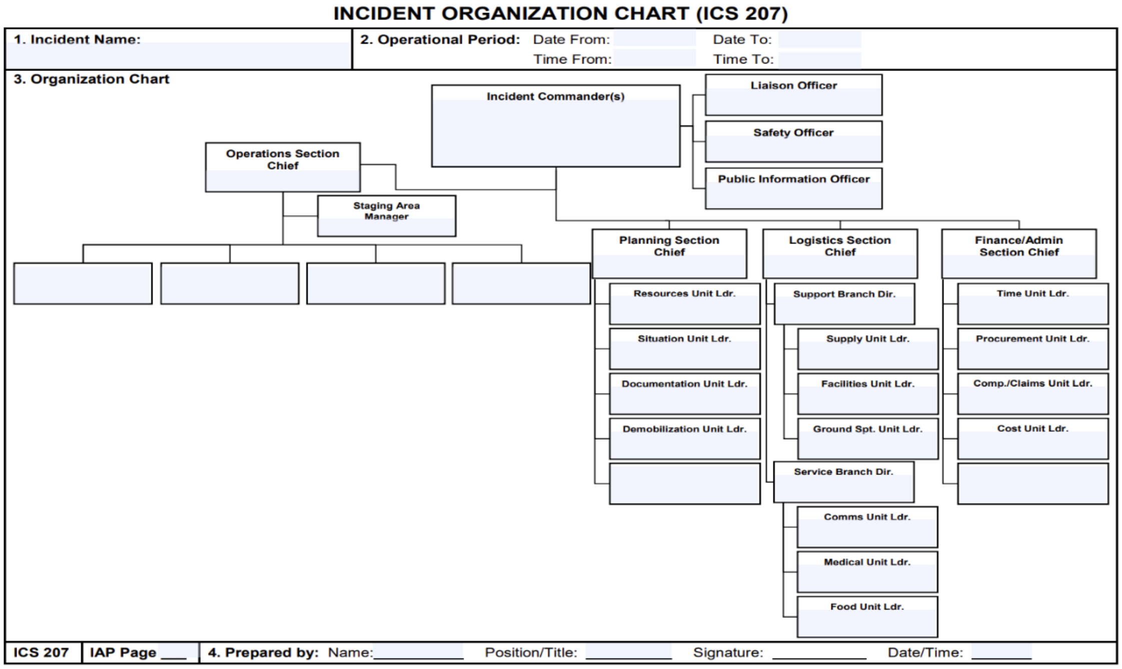
Emergency Management Flow

Wildfire management generally falls into five integrated phases of emergency management: prevention and mitigation, preparedness, response, recovery, and review.[50] The prevention and mitigation phase aims to adapt to, eliminate or reduce the risks of fire to protect lives, property, the environment, and the economy.[50] Mitigation refers to reducing wildfire impacts when they occur, and prevention refers to the prevention of wildfires. [16] Preparedness in wildfire management are the steps taken to create a state of readiness to appropriately manage wildfire ignitions and their potential consequences. [16] Response refers to the actions taken to manage a wildfire once it does occur.[16] The recovery phase includes any actions taken to repair or rebuild after a wildfire incident. [16] In the history of Canadian wildfire management, significant change has often come through a review process after catastrophic fires or fire seasons. [9] Tymstra et al. [16] suggest including review as a separate phase of wildfire management to create a built-in space for systemic change.

Incident Command System (ICS)

Developed in 1968 by fire chiefs in California, the incident command system (ICS) reflects the management hierarchy of the United States navy.[51] Its purpose is to standardize terminology and to centralize the hierarchy of command across jurisdictions for a variety of incidents including both natural disasters and events.[52] The ICS has five major management areas: command, operations, planning, logistics and finance, shown in (see Figure 1.6).[52] Within the ICS there are five levels of incidents with “Type 5” as the smallest and “Type 1” as the largest or most complex.[52] Incident commanders (IC) need to be certified to oversee more complex events, for example fire complexes with multiple fires are often staffed by a higher-level IC who is responsible for the entire complex.[52] Consolidating command functions under one IC makes operations on a fire complex more efficient.[52] In Canada, when fires encroach on municipalities or regions with multiple jurisdictions, the ICS can be applied to create a “unified command” where senior members from multiple agencies share decision- making powers through a single Incident Action Plan with shared objectives.

Figure 1.6 Incident Command System (ICS) Organizational Chart.[53]



Every wildfire jurisdiction in Canada operates within the ICS framework, as mandated by CIFFC in 2002.[51] This framework provides the common ground for the interoperability between agencies that characterizes fire management in Canada. The ICS is employed across the country, which allows for efficient collaboration between both wildfire agencies and other emergency services.[51]

Risk Management

Risk management is a critical component for all forms of emergency management. In 2015, Canada endorsed the United Nations (UN) "Sendai Framework for Disaster Risk Reduction (2015-2030).[54] The Sendai framework is focuses on local actions and the prevention of new risks as much as reducing existing risks; it also clearly defines risk as inclusive of all natural, human caused and technological risks but excludes those related to conflict.[55] Canada has three primary objectives for this framework: i) "to work in an integrated manner to reduce risk, vulnerability and impacts of natural and non-natural disasters to Canadians, ii) provide a coordinating mechanism for disaster risk reduction across sectors, and iii) to support stakeholders with relevant knowledge and information." [54] The Sendai framework can be understood as a societywide approach to risk management that aims to strengthen community resilience and encompass a wide range of stakeholders.[55]

Risk in fire management can be defined as the likelihood and the potential impact of a wildfire.[11] Likelihood is the probability of wildfire occurrence.[56] Johnston et al. [11] define likelihood as the calculation of expected fire behaviour and the potential for a fire at a particular location. Time period and spatial extent must also be considered when calculating likelihood.[11] Impacts are the consequences of a wildfire: determination of impacts is subject to worldviews, cultural values and perceptions, since outcomes will not have consistent effects on individuals.[57–60] Impacts can take many forms, from positive impacts like ecological restoration to negative ones such as evacuations or loss of employment.[61,62] Johnston et al. [11] calculate impacts based on the following, the values being considered and their susceptibility, the exposure of values to fire behaviour that may impact those values, a valuation of the change experienced to determine the impacts.

Wildfire management is in essence management of the risk posed by wildfires. The CFFDRS represents the mainstay of early risk management efforts in Canada, and it continues to inform daily fire operations.[11] Thompson et al.[63] define risk as the effect of uncertainty on objectives. Uncertainty plays a key role in decision-making before and during wildfire operations since both the risk of wildland fire and wildland fire itself are complex and dynamic processes.[11]

Another important aspect of risk management is the hazard to firefighters. The risk presented by fire is mitigated through the use of “LACES,” an acronym that stands for “lookout, anchor points, communication, escape routes, safety zones.” By ensuring the sanctity of each component of LACES throughout operations, firefighters engage in regular and dynamic risk mitigation. However, fire itself is rarely the greatest risk for Canadian firefighters; most fatalities fall into one of two categories: i) dangerous trees, ii) travel to or from incidents in aircraft or vehicles.[43] These risks are difficult to mitigate due in large part to their infrequency and variability. Fire managers in Canada maintain a low risk tolerance when it comes to positioning fire crews, preferring to simply not action a fire rather than to place crews in a vulnerable position.[43] This universal approach characterizes fire management in Canada and is one of the key components of a system that relies on interoperability between agencies.

Resource Allocation

A fundamental uncertainty in wildfire management is the allocation of a finite number of resources in a dynamic setting.[64] Resource allocation occurs on the same timescale as a wildfire incident, applying further pressure on appropriate use of resources.[64] Resource allocation is characterized by trade-offs. One of the main trade-offs is between managing a current fire and the potential for further ignitions, all while operating under uncertainty regarding both the success of suppression and the severity of future fires.[43,65] Fire managers must often rely on their expertise to allocate resources where they deem to be the most effective. One of the principles employed is the pre-positioning of resources in locations to maximize their flexibility.[43]

There is a significant body of research focusing on quantitative models seeking to answer where, when, and how resources should be allocated.[64–66] These models seek to remove the reliance on tacit expertise.[43] However, these models struggle to contend with the complexity of the resource allocation task; and currently fire managers typically use these models as decision to support systems decision making and, not as the decision makers themselves.[43] There is no accepted standard or best practice in Canadian wildfire management, leading to significant variance in approaches between jurisdictions. This variance is an outcome of agencies contending with different management priorities, resource capabilities, and landscapes. The lack of standardized approach to resource allocation is not incidental, rather, it is a reflection of the individuality of each agency's operational realities.

Incipient Response Planning and Wildfire Analysis

As described in the earlier portions of this literature review, wildfire management in Canada has undergone a series of iterations. Wildfire analysis in particular has been forced to evolve as contemporary fire management faces far more complex decision making.[9–11] For incipient wildfires this complexity has resulted in advancements in analysis too. One of the many advancements is the use of formalized analysis systems to support response planning. These systems play an integral role in wildfire agencies' decision making. Analysis represents the first phase of incipient response planning, where situational information on the fire environment is synthesized. There is little research examining this analysis in the wildfire management domain.

Incipient Wildfire Response

The initial portion of the incipient stage represents a key moment for wildfire management. Wildfire agencies have long recognized that the best window for successfully suppressing a wildfire occurs in the initial portion of the incipient stage.[9] These wildfires are smaller and therefore easier and more cost effective to suppress. However, to have effective incipient wildfire response requires pre-planning, rapid detection, and appropriate resource allocation is required. Canadian agencies excel at fighting smaller wildfires. But the 4% of fire that exceeded 200 hectares between 1990 and 2016 encompassed approximately 97% of the hectares burned.[3] This clearly illustrates the crucial nature of the incipient stage. Canadian fire agencies employ rapid detection and aggressive initial attack, often including aerial support to maximize resource effectiveness in the incipient stage.

There are nine key considerations for a successful initial attack: fire type; intensity; and the size when the resources arrive; the time of the resource arrival after ignition; the type and number of resources deployed; the and local conditions such as slope; the, fuel type; and water accessibility.[67] However, the fire weather and the fire environment are the most influential factors when considering the success of an initial attack success from a strategic planning perspective.[68] For real time operations, fire size and fire weather are the top two characteristics determining the success of an initial attack.[69] Incipient wildfire analysis aims to capture these key considerations and synthesize them for decision making.

Incipient Response Planning in Other Fields

There is a significant amount of research on incipient response planning and analysis in other emergency management fields, such as emergency medical services (EMS), fire departments and non-wildfire natural disasters. One of the key differences between wildfire and other sectors of emergency management is the need for a dynamic analysis process.

In the EMS field, pre-hospital triage of patients involves choosing between basic life support (BLS) resources and advanced life support (ALS).[70] Patient outcomes are influenced by appropriate resource dispatch, however, like the wildfire environment it can be difficult to assess the scene prior to resources arriving.[71] Sporer, Youngblood, and Rodriguez's[72] work shows that triage systems aim to provide improved resource dispatches however, results are inconsistent depending on the "code" received. These triage systems use codes to differentiate between types of injuries to send appropriate resources.[72] Codes function in a similar manner to the information received as part of wildfire analysis as subsequent decisions are based upon this early analysis and choices at this juncture strongly influence outcomes.[72] It's important to acknowledge this description is not fully representative of EMS incident analysis. The many factors involving patient care exceed the boundaries of this literature review. However, both EMS incidents and incipient wildfires share the need for analysis to support ideal outcomes. The major difference for incipient wildfire analysis is the dynamic and varied effect of weather and the fire environment on individual fires.

The bulk of the incipient response research in the fire department sector of emergency management is focused on fire station location and resource allocation.[73] The most applicable research for this literature review is Simpson's [73] research on modelling residential structure fire response using a "hyper project" to account for the dynamic task structure, time sensitivity, and external pacing function typical of fire response. Simpson's [73] study aims to address the operational level of the fire response system rather than higher level planning issues. Their research exists within a large body of work that examines incipient response planning in the structural fire sector, driven primarily by modelling. Incipient wildfire response has many shared characteristics with fire department fire response; however, the spatially dynamic nature of wildfires and the difficulty in predicting the effects of weather presents a major bifurcation in planning requirements between the two fields. These fundamental differences explain the need for structured analysis as a key phase of response during incipient wildfires.

Incipient natural disaster response planning faces many problems analogous with wildfire management. At their core, both management systems are faced with decision making under uncertainty and time pressure, and both must meet urgent and developing incidents with appropriate resources. The field of research investigating natural disaster response is well developed; however, research into planning for incipient response is relatively understudied.[74] Alexander [74] summarizes the state and growth of natural disaster response planning research, highlighting how planning is critical to effective response.[74] Their research shows that the field has undergone significant professionalization, a trend that must continue to match rising complexity and the impacts of natural disasters.[74] Looking towards the future, Alexander points to the leveraging of technology and modelling to create dynamically supported response plans that can react to changing situations. [74] Research on risk analysis methods for natural disasters is covered in Sun et al.'s [75] review on the topic. They identify that analysis methods focus on one of three characteristics of natural disaster risk: uncertainty analysis methods, disadvantage analysis methods and future analysis methods.[75] Each method has its strengths and weaknesses, however, fire management agencies approach to risk analysis can be seen as encompassing aspects of each method. Incipient wildfire analysis documents aim to address uncertainties, disadvantages, and collect data that supports future analysis.

The rise of technology has led to modelling being at the forefront of emergency response planning across fields. Kamyabina et al.'s [76] literature review into optimization models for natural disasters aims to look at research that considers operational decisions. Their work identifies a need for models that are capable of integrating multiple critical decisions.[76] Additionally they call for models to incorporate more dynamic capabilities for better real time use.[76]

Canadian wildfire management is no exception regarding the growing body of research investigating models and how they can be to leveraged for incident response. Quantitative modelling is being used to help solve the problem of incipient wildfire response. The models most suited for this literature review are those focused on predicting the success of initial attack efforts.

Wildfire Initial Attack Modelling

Studies on modelling for initial attack (IA) or incipient response focus on the factors contributing to successful containment. Research has typically sought to model suppression effectiveness across broad temporal and spatial scales, using historical fire data paired with supplemental weather observations and geographic feature data.[77] Korkola et al.'s [77] comparative analysis of wildfire IA modelling strategies in Ontario found that despite the breadth of studies identifying predictors of IA success, comparing, and inferring across these studies is difficult due to inconsistent definitions of IA success. They also refer to the differing modelling methodologies themselves as a source of inconsistency.[77] Wheatley et al. [69,78] are behind a growing body of research that uses modelling on decision-making and suppression effectiveness of air attack use in Ontario. This research paired historical fire data with modelling techniques to determine airtanker resourcing choices and probability of IA success.[69,78] Their work identified fire size at the outset of IA, fire weather conditions, observed fire behaviour prior to IA, volatility of fuel type and general fire cause as factors strongly related to successful containment with air attack.[69] These conditions are tightly linked to the types of data gathered during incipient wildfire analysis. As modelling research evolves, there is opportunity for modelling to become a more vital component of planning for incipient wildfire response. However, it is unlikely that modelling will be capable of replacing analysis as the initial phase of response. Accurate modelling depends on quality data inputs. In the incipient wildfire context, this relies on analysis documents. Modelling currently supports decisions through fire projections, particularly during high fire load surges. However, it does not replace the analysis phase as a crucial data gathering exercise that sets the table for subsequent response planning and improved modelling for a specific fire.

Research Objectives

Research on incipient wildfire response in Canada has mostly been focused on factors contributing to successful containment, such as Wheatley et al.'s [69,78] research on modelling decision-making and suppression success of air attack in Ontario. Tymstra et al.'s [16] comparative research on wildfire response planning is the only contribution that compares Canadian approaches to wildfire management. To my knowledge, there is no peer-reviewed research published on incipient wildfire analysis processes in Canada. Additionally, to my knowledge there is no research related to incipient wildfire analysis in other "fire powers" such as the USA or Australia.

My research aims to address this gap in knowledge by revealing the analytic processes employed by Alberta Wildfire, Ontario Aviation, Forest Fire and Emergency Services, Parks Canada Fire Management, and Yukon Wildland Fire Management during incipient wildfire analysis. This will be accomplished through two lenses: first, by analyzing the degree to which agencies use CFFDRS parameters in their fire reporting and analysis documentation; and second, by investigating which analytical functions drive the analysis and what aspects of fire, the fire environment, and fire management ecosystems are represented in each agencies' approach. It is important to show how agencies analyze incipient wildfires, is important due to the fundamental reliance on interoperability among these wildfire agencies in Canada. Identifying differences in the analysis approaches and use of terminology use may support improved interagency operations, and also adoption of alternate tools and processes by individual agencies.

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Chapter 2: Data and Methods

Data

Data Sources

The data for this study consists of three types of documents: initial fire reports, wildfire analysis documents, and procedural "how to" documents used by select Canadian wildfire management agencies. Documents were obtained directly from the respective wildfire agencies. The agencies participating in this study are Alberta Wildfire; Ontario's Aviation, Forest Fire and Emergency Services (AFFES); Parks Canada; Fire Management, and Yukon Wildland Fire Management. Agencies were asked to provide documents they use for or pertaining to incipient wildfire analysis. The resulting suite of documents reflects organizationally sanctioned wildfire analysis structures rather than informal descriptions or incident-specific analysis. Documents provided represent internally organized definitions and operationalizations of wildfire analysis.

The data collection occurred in the fall of 2024. Each agency submitted their documents before 2025. To the best of my knowledge, these documents are still actively in use.

Table 2.1 Table shows data collection dates for agencies.

Data Collection Date	Alberta: October 23rd, 2024
	Ontario: April 12, 2024
	Parks Canada; November 1st, 2024
	Yukon: December 3rd, 2024

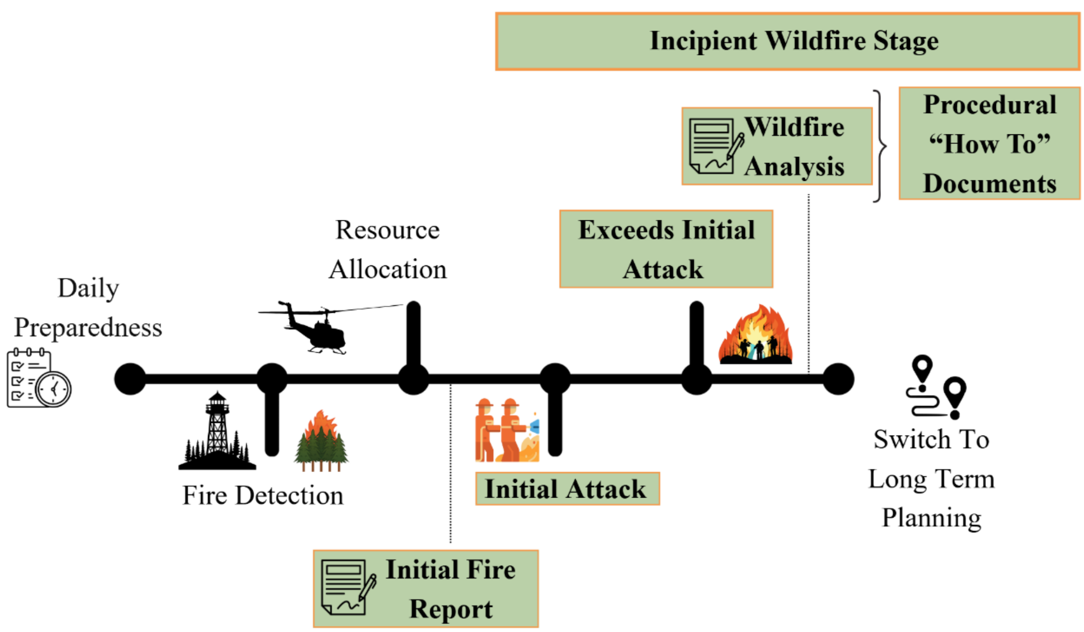
Document Types

The corpus includes a range of document formats, characterized by their heterogeneity. These include structured forms, checklists, flowcharts, procedural "how to" documents, standard operating procedures (SOPs), and structured analytic tools, such as excel spreadsheet-based workbooks reflecting the diversity of analytic approaches used in incipient wildfire analysis. Where spreadsheets or PDFs could not be imported into qualitative analysis, software screenshots were taken and processed using optical character recognition (OCR). The documents used in this study fall into three broad types: initial fire reports, wildfire analysis documents, and procedural “how to” documents. Further descriptions on each document type are provided below.

Scope of the Data: Incipient Wildfire Analysis

Across the agencies examined there are similarities in the structure of their responses. Figure 2.1 depicts how the research conducted in this study fits within the daily activities of wildfire management agencies. The elements bolded within the figure identify the boundaries of incipient wildfire analysis and the associated documents. In the context of this study the incipient wildfire stage is defined as the period from initial fire assessment to long term planning. Long term planning is either a timescale longer than seventy-two hours or an incoming incident management team (IMT) taking control of the fire. Fires that receive a monitored or modified response still fall within this stage as the incipient wildfire analysis process shapes the short-term planning of these fires.

Figure 2.1 Research boundaries and associated documents



For each agency, all three document types were solicited, though some agencies did not have all three. The document corpus was grouped into three functional categories based on use during incipient wildfire management.

1. Initial fire reports (IFRs)

2. Wildfire analysis forms (WFAs)

3. Procedural "how to" documents

Initial fire reports (IFRs) are fillable documents that are most often completed by initial attack crew leaders. These reports capture early -stage situational assessments, typically used to analyze fire characteristics, locations, values at risk, and immediate operational considerations. IFRs are the first documented assessments of a fire. They are usually completed by someone lower in the organizational hierarchy, with the focus being on technical details. Naming for IFRs varies from agency to agency. For the purposes of this study, these documents will all be referred to as "IFRs" going forward. Agency names for IFRs are as follows:

- Alberta: Initial Fire Assessment Message
- Ontario: FAR-Scouting Report
- Parks Canada: Initial Fire report
- Yukon: Initial Fire Report

Wildfire analysis forms (WFAs) are the second analysis document completed. These are fillable documents that engage a formal follow-up assessment which is triggered when incipient wildfires exceed routine initial attack efforts. The exact requirements for this escalation in assessment varies between agencies but all of the examined agencies engaged in similar follow-up processes. These documents support expanded assessments and analyses of incipient wildfires, including risk representation, response framing, and strategic direction. WFAs are the second analysis document completed. Typically, WFAs are completed by someone with more training or experience than those completing IFRs. WFAs focus on assessing the factors that may influence idealized responses and strategic directions. Naming the WFAs differs between agencies; however, for the purposes of this study they will all be referred to as "WFAs". Agency names for WFAs are as follows:

- Alberta: FP-51: Wildfire Analysis and Strategy (WAS)
- Ontario: Fire Appropriate Response (FAR) Excel Workbook

All worksheets were included with the except for the worksheet titled "photo log" due to the lack of data for analysis. The included worksheets are:

  - Field evaluation
  - Assets and values
  - Interim plan
  - Risk worksheet
  - Response plan worksheets

- Parks Canada: Wildfire analysis (WFA)
- Yukon: Wildfire analysis (WFA)

Procedural how-to documents deliver guidelines for appropriate use of the WFA documents and identify broader agency-level thinking that drives assessments processes. Procedural documents offer a glimpse into the idealized version of planning, response, and analysis, rather than necessarily reflecting on what is actually done during a response. Procedural documents were not treated as evidence of practice, serving instead as representations of intended analytic structure and logic.

- Alberta: FP210: Wildfire analysis and strategy (WAS) instructions
- Ontario: Wildland fire appropriate response (FAR) guide
- Parks Canada: N/A
- Yukon: Wildland fire analysis (WFA) how-to-guide

These document types differ in purpose, depth, and form, but all are integral to incipient wildfire analysis. All were therefore analyzed using the same coding framework. This approach allowed for comparisons of how analytic representation evolves across document types while preserving a consistent analytic lens. Presentation of the results for the WFAs and “how-to” documents were combined as the “how-to” documents are directly related to the WFAs and provide descriptions of intended use.

The included documents aim to support situational awareness, representations of values at risk, assessments of wildfire risk, evaluations of operational feasibility, and framing of response options and strategic directions. They also act as documentation and record keeping forms and representations of organizational structure and authority. Documents intended for extended incident management, pre-and post-incident responses, and overall responses were excluded. Documents intended for extended incident management are typically used by incident management teams or after the seventy-two-hour mark. Only documents directly pertaining to incipient wildfire analysis were included.

Methods

Research Design

This study is exploratory in nature, employing both inductive and deductive qualitative content analysis. Deductive content analysis involves using pre-determined frameworks to identify relevant features, while inductive analysis generates frameworks from the data itself. This study compares how select Canadian wildfire management agencies represent incipient wildfire analysis through organizational documents. This study is non-evaluative and does not assess decision the quality of the decisions, operational outcomes, agency effectiveness, or the analysis quality. The focus is on how the analysis is structured, represented, and articulated. Both approaches to the content analysis approaches were applied to the three document categories mentioned

Analytic Orientation: Terminology as Analytic Data

The terminology was seen as a key component for this study due to the requirement of interoperability among wildfire agencies in Canada. Across all analytic domains, attention was paid to the terms, categories, and labels used. The terminological choices were examined for how they structured the analytic work within the documents and were highlighted when they diverged. Particular focus on the terminology was devoted to descriptions of fire characteristics and responses that could affect inter-agency operations.

Through the inductive portion of the analysis, differences in terminology were treated as analytically meaningful since they contributed to shaping the representation and the framing. However, these differences are identified, but they did not serve as analytic frameworks for code creation. Rather, the terminology drove the study's deductive analysis component and was treated as the basis for its code creation for the deductive analysis, with the CFFDRS serving as the framework for the terminology.

Units of Analysis

For the purposes of this study, the unit of analysis was defined as the smallest self-contained segment of text or structured content that performed a coherent analytical function. Units were not restricted to individual sentences or lines of text; they could consist of entire tables, checklists, flowcharts, or structured form sections when analytic meaning was distributed across components.

Units were delineated based on their analytic role rather than their form or textual length. By avoiding strict line-by-line coding, the analytic logic in the structured tools was preserved, thus preventing fragmentation of meaning.

Analytic Workflow and Software

Qualitative coding was conducted in NVivo 15.[1] Initial coding was performed at the unit level. Subcodes were exported to Excel to facilitate sorting and aggregation. Further consolidation and refinement were done in Excel before re-importing the revised coding structure to NVivo.

Deductive Content Analysis (DCA): Fire Characteristics and Terminology Used

Deductive content analysis was conducted to examine which fire characteristics were being assessed in the analysis process and which terminology or metrics were being used. This analysis used the Canadian Forest Fire Danger Rating System (CFFDRS) as a framework to create three pre-defined categories all under the overarching category of fire characteristics. The purpose of this analysis was to identify the roles of the CFFDRS in describing the fire characteristics, and not to evaluate agency use of the system.

Stage 1: Identification of Relevant Units

The documents were read closely, seeking to identify references to fire characteristics. For the purposes of this study, fire characteristics were defined as characteristics relevant to the physical condition of the fire. These characteristics included but were not limited to weather, fire behaviour, fuels, and topography. Units elucidated during inductive content analysis were then reviewed to identify those containing references to fire characteristics.

Stage 2: Application of Deductive Categories

Each relevant unit was coded into one of three pre-defined deductive categories:

1. Direct use of CFFDRS terminology: terms or metrics that were taken verbatim from the CFFDRS (e.g., named indices, formal inputs and outputs like relative humidity or wind direction).

2. Terminology or concepts clearly transposed or inspired from the CFFDRS: terms, metrics, or concepts that describe similar characteristics to those from the CFFDRS but that use different terminology or metrics (e.g., fire rank with qualitative descriptions; the rate of spread described as slow, moderate, or fast; the fuel types defined such as "conifer" or "deciduous"; wind speeds with ranges such as: 0-5km/h).

3. Non-CFFDRS fire characteristic descriptors included: terms or metrics that are not clearly inspired or transposed by the CFFDRS but that still assess fire characteristics (e.g., position on slope, adjacent fuels, spread potential, smoke description)

Stage 3: Deductive Coding in NVivo

Relevant units were identified and coded directly in NVivo. Each unit was coded once into the most appropriate category. Once the coding was complete, the individual codes were reviewed to ensure internal consistency. The classification system did not encounter any ambiguity that resisted coding, and no new categories were introduced. The deductive analysis was conducted in parallel with, but analytically distinct from the inductive content analysis.

Inductive Content Analysis (ICA)

Inductive content analysis (ICA) was conducted to identify how incipient wildfire analysis is represented across organizational documents. The analysis was a structured, multistage, and iterative process.

Stage 1: Familiarization and Unit Identification

All documents were read closely and in full prior to coding. At this stage, units of analysis were identified. Units were delineated when a segment of text or structured content performed a discrete analytic function (e.g., table identifying values at risk). Unit boundaries were adjusted where necessary to preserve analytic coherence.

Stage 2: Initial Open Coding

Units were coded inductively in NVivo. A new code was created when a unit performed an analytic function that was not adequately captured by an existing code. Codes were defined by the analytic role the unit played, and not by the terminology used. Where the terminology varied but the analytic function was consistent, the units were coded together. Memos were attached to codes that held cases of shared functions with different terminology.

Stage 3: Constant Comparison and Code Refinement

As the coding progressed, related codes were grouped into higher-order domains as part of a constant comparison process across the corpus. Overlapping or closely related subcodes were temporarily preserved to retain inductive sensitivity. Coding continued until no new subcodes emerged, and existing subcodes required no further revision, indicating analytic saturation.

Stage 4: Subcode Aggregation Using Excel

Following the initial coding, the full coding schema was exported from NVivo into Excel. Excel was used as it provides a more efficient environment for systematically sorting, comparing, and aggregating subcodes, based on the domains shared analytic functions. This helped ensure that granularity, differences, and redundancy were addressed. No coding was done in Excel. This step facilitated code sorting and aggregation decisions. Justifications were recorded for aggregation and consolidation decisions. Prior to aggregation there were thirteen distinct analytic functions found. Aggregation grouped functions that held shared purpose.

Stage 5: Reconstruction and Domain Formation

The revised subcode structure developed in Excel was manually recreated in NVivo. Subcodes were merged, nested, or retained as child codes when appropriate. Higher order domains were constructed by grouping subcodes that represented recurring analytic functions within incipient wildfire analysis. ChatGPT 5.2 was used as a support tool to aid in higher-order domain title refinement. ChatGPT's contribution towards analytic work was the refinement of the domain title: "organizational structure and administrative control." Domain boundaries were evaluated for internal coherence, cross agency applicability, and stability. Domains were considered stable when no further subcodes were generated, and subcode assignments to domains no longer required revision.

Handling Overlap, Ambiguity and Boundary Decisions

Each unit of analysis was coded to a single best fit subcode to maintain analytic clarity. When a unit could fit into multiple subcodes, placement was determined based on the dominant analytic function featured.

Boundary cases such as distinctions between procedural how- to content and analytic content were identified. The document type did not alter the structure; inclusion or exclusion decisions were justified based on their analytic role.

Coding Criteria and Definitions

Higher order domains were created based on their analytic function. These domains needed to meet certain conditions:

- Represents a distinct analytic function in incipient wildfire analysis

- Have a function that appears across multiple jurisdictions
- Have a function that cannot be collapsed into another without losing analytic clarity

Six domains were revealed through inductive analysis (bottom-up reasoning). Each of the six domains represents a distinct analytic function accomplished through incipient wildfire analysis. Deductive analysis (top-down reasoning) contributes an additional domain, bringing the total to seven. Representation of the domains is not spread evenly among documents or agencies. The seven domains are as follows:

1. Spatial References
2. Fire Characteristics
3. Values at Risk Identification and Representation
4. Operational Capacity and Constraints
5. Risk Representation and Management
6. Response and Strategic Direction
7. Organizational Structure and Administrative Control

Domain Description

Spatial References

Spatial references refer to descriptions or analytic processes involved in situational awareness. These representations establish the fire's location and the physical context surrounding it. Mapping products are included within this domain.

Fire Characteristics

Fire characteristics encompass all descriptions about the physical state associated with an existing fire. This domain captures elements related to a fire’s growth and its behaviour.

Values at Risk (VAR) Identification and Representation

Value at risk (VAR) provides a reference through which potential fire impacts are understood, framed, measured, and managed. Narratives, lists, excel worksheets, and checkboxes identifying and representing values at risk make up this domain.

Risk Representation and Management

Risk representation and management are consistently linked to the anticipated impacts on the VAR. In the context of this study, risk representation and management translates incident-specific information into a basis for response framing. The elements included address risk both explicitly and implicitly with the intent of framing the response options. Implicit representations of risk occur through linkages with the VAR and the response outcomes.

Operational Capacity and Constraints

The operational capacity and constraints are representations of the feasibility of suppression and the constraints on response. The elements that might constrain the response options are included here. This domain captures the resource availability, access, and competing fire priorities.

Response and Strategic Direction

The response and strategic direction are heavily influenced through the agency response logic and pre-structuring mechanisms. However, in the context of this study, the focus was placed on the analytic processes occurring through the incipient wildfire analysis phase. The elements in this domain included management strategies, objective definitions, and justifications of operational actions.

Organizational Structure and Administrative Control

This domain captures three primary administrative and organizational structure functions. These functions are frameworks that give the documents organizational structure and administrative control. Elements such as conditions for reanalysis, roles, consultations, approval chains, and administrative tracking are included.

Limitations on Scope of Analysis

This study did not evaluate operational success, decision correctness, agency effectiveness, or assessment quality. Its findings are limited to how incipient wildfire analysis is represented through organizational documents, terminology, and analytic structures. The conclusions are descriptive and comparative rather than normative or prescriptive.

Literature Cited

1. Lumivero. NVivo [Internet]. [cited 2026 Apr 4]. Available from: https://lumivero.com/products/nvivo/

Chapter 3: Results

Context

The analysis process begins when resources arrive on site and an IFR is completed. Before delving into IFRs, certain contextual knowledge is required to appropriately understand how IFRs fit into each agencies approach to wildfire management.

Pre-IFR Structuring Mechanisms

Across the agencies examined, IFR assessments form the basis for individual fire situational awareness. Though not explicitly stated, the documents imply that all wildfires will be assessed. However, it would be wrong to assume that this act of assessment occurs in a vacuum. Agencies have mechanisms that alter decision making to varying extents prior to resources even reaching the fire. It's crucial to acknowledge these mechanisms even if they themselves do not pertain directly to the analysis of incipient wildfires. They act as overarching mechanisms that affect the entire flow of analysis options, and crucially, pre-identify the range of acceptable responses.

Table 3.1 Agencies pre-IFR mechanisms that shape initial attack response options.

Agencies	**Pre-IFR Mechanism**
Alberta	N/A - Initial attack on all wildfires, unless an approved wildfire management plan states otherwise
Ontario	N/A - Each fire is treated with the "appropriate response".
Parks Canada	Zonation system identifying response options based on fire location (individualized by each park) Final response type is made based on risks and benefits identified.
Yukon	Zonation systems dictating response options based on fire location. Seasonal and danger-

	based changes apply to the "Transitional Zone"

An important consideration to acknowledge is that the entirety of incipient wildfire analysis could be appropriately summarized as a risk management process with response representing mitigation efforts. At its core wildfire management is the management of the risk posed by wildfires.[11] The documents analyzed in this study can be accurately seen as steps of a risk management process to analyze fires and determine adequate risk mitigation. Across jurisdictions this is driven by an impacts-based risk logic, with all agencies seeking to reduce the potential negative impacts of wildfire. Each agency examined has underlying response or mitigation logics that shape their management approaches and their incipient wildfire documents. It's important to address these response logics prior to presentation of the results chapter as these logics have wide-ranging effects.

Central Response Logic

The central response logics for Alberta and Ontario were drawn directly from the primary materials in the corpus. Parks Canada and Yukon's central response logic's were drawn from sources outside the primary corpus. Parks Canada's central response logic was drawn from two separate standard operating procedure documents: the fire directive document and the national fire restoration target performance document. Yukon's response logic was drawn from the fire management zones directive document. Both Parks Canada and Yukon's documents were excluded from the primary corpus of this study since they did not pertain directly to incipient wildfire analysis.

Alberta

Alberta's central response logic is driven by standard operating procedures (SOPs) stating that all wildfires within forest protection areas will receive an initial attack response. Initial suppression action needs to be initiated before an incipient wildfire exceeds two hectares with the suppression objective of containing wildfire spread by 1000 h MDT the following morning.

Ontario

Response in Ontario is shaped by the "fire appropriate response" (FAR) logic. FAR is a comprehensive assessment process covering incidents from initial report to extinguishment. Every fire is assessed and receives what is determined to be the most appropriate response. Appropriate responses are intended to produce the best outcome given the competing desires to:

- Reduce the negative impacts of fire
- Manage the costs of wildland fire management strategies
- Facilitate the positive impacts of fire

Parks Canada

Parks Canada is responsible for forty-eight national parks across Canada. Each Park has certain individualized aspects of their response logic. However, response across all parks is intended to:

- Restore and maintain ecological integrity and cultural landscapes
- Minimize wildfire risk

The "National Fire Restoration Target" requires all larger parks to target an area burned over a twenty-year period equal to at least 20% of the historical burn area based on the reference fire cycle of the park. This can be achieved through both prescribed fire and managed wildfires.

Yukon

Yukon's response strategy logic is founded upon their zonation system named the "fire management zones directive". Through a consultative process with land owners, stakeholders, interest groups and the public, a system of fire management zones has been established. The zones function as a prioritization system:

- Critical fire management zone
- Full fire management zone
- Strategic fire management zone – the strategic zone may convert to wilderness zone status as of July 15th annually. Conversion is based upon fire load, drought conditions and forecasted weather.

- Transitional fire management zone – the transitional zone may convert to wilderness zone status as of July 15th annually. Conversion is based upon the same factors as the strategic management zone.
- Wilderness fire management zone

Summary

While each agency features a distinct underlying logic to their response approach, all seek to reduce the negative impacts of fire. The inner workings of each agency's approach to structuring response are explored through the results chapters.

Domain Analysis

IFRs act as situational awareness anchors, recording the most relevant factors for fire management. While this study is focused on incipient wildfire analysis, the agencies in this study are focused on the management of wildfire across the totality of their respective jurisdictions. This is important to acknowledge as incipient wildfire analysis is only relevant within this wider picture in mind. IFRs function as the initial input of information for agencies to make decisions not only for incipient wildfires but across the landscape.

While all seven domains are represented in IFRs the analytic focus is primarily on six domains. Amongst these domains the analytic focus is not spread evenly. These domains serve to resolve uncertainties all fire agencies contend with. The domains each seek to answer questions:

- Spatial references – where is the fire?
- Fire characteristics – what is the fire doing?
- Values at risk identification and representation – is there anything we value near it?
- Operational capacity and constraints – is there anything preventing us from idealized response?
- Risk representation and management - how can we prevent the fire from impacting things we value?
- Response and strategic direction – what are we going to do about it?

- Organizational structure and administrative control

The final domain of organizational structure and administrative control serves a role in IFRs, however, it does not contribute to the analytic process other than influencing the capacity and capability to address to effectively conduct the analysis.

Spatial References

Across agencies, spatial references in the context of IFRs are used to establish specific and accurate locations of incipient wildfires. This represents a foundational component of establishing overall situational awareness. Spatial references influence subsequent analytic functions by establishing where a fire is burning. Spatial references are particularly important for Parks Canada and Yukon since these agencies have a response system driven by zonation, emphasizing the importance of accurate location data.

Unique Characteristics

Alberta's IFR seeks to determine land ownership as part of location confirmation. The IFR uses the terminology "point of origin" as a request for the fire location. Ontario has an agency-specific mapping system known as "basemap". This system is used as one of several spatial references to determine the fire location. Both Yukon and Ontario use "location geographic" on their IFRs. Location geographic refers to an identifiable geographic feature such as a named lake or river.

Table 3.2 Spatial references recorded on agencies' IFRs

Alberta	Point of Origin: legal subdivision (LSD) coordinates + latitude and longitude
	Origin: land ownership determination: Provincial, private, other
Ontario	Location UTM:
	Location geographic:
	Basemap_, Block_, Sub-block_
Parks Canada	UTM
	Latitude – Longitude

Yukon	Fire response zone
	Location (format hdd°mm.mmm’): Latitude - longitude
	Geographic location

Fire Characteristics

Fire characteristics are one of the most important factors determining representations of risk and response direction. Agencies share a mostly conceptually analogous approach to analyzing fire characteristics with the data predominantly recorded during IFR assessments. Across agencies there are four primary categories of fire characteristics driving analysis; weather, fuels, topography, and fire behaviour. This section delves into the specific data fields in each agency's IFR describing fire characteristics.

Table 3.3 Table shows legend for subsequent fire characteristics tables.

CFFDRS	**Bolded**
Transposed or ported concepts	*Italicized*
Non-CFFDRS	Normal text

Alberta

50% of fire characteristics recorded on Alberta’s IFR are direct CFFDRS components. Fire characteristics on the IFR represent 23% of the data gathered. These characteristics are weather, fuels, topography, and fire behaviour.

Table 3.4 Fire characteristics recorded on Alberta’s IFR

Fire Characteristics	Data Recorded
Weather	**Temperature, relative humidity, wind direction and speed**

Weather over fire	CB Dry, CB wet, clear, cloudy, rain showers
Fuels	**List of FBP fuel types**
Topography	Position on slope
Fire behaviour - type	*Ground,* **surface**, *crown*
Fire behaviour – rate of spread	**@_m/min (meters/min)**
Smoke description	Narrative description from assessor in "comments"
Size	Size:___ha

Ontario

Ontario dedicates 50% of their data requests on the IFR to recording fire characteristics, making it the agency with the largest proportion. 50% of the fire characteristics are described using terms verbatim from the CFFDRS. Ontario is the only agency to use intensity class in their IFR. A notable omission is the absence of descriptions or requests for weather data.

Table 3.5 Fire characteristics recorded on Ontario's IFR

Fire Characteristics	Data Recorded
Topography	*Narrative assessment*
Fuels	**List of FBP fuel types – includes curing and conifer percentages**
Fire behaviour -intensity class	**Checkbox one through six**

Fire behaviour -rate of spread	*Smoldering, creeping, running, torching, crowing* - **@_m/min**
Fire Behaviour – Direction of spread	Checkbox with cardinal directions
Fire behavior - spread potential	Checkbox: limited or unlimited with cardinal directions Limited category includes: By___ meters from fire
Fire behaviour -spotting	***Yes/no, number of spot fires, distance from fire***
Smoke description	Narrative description from assessor in "comments"

Parks Canada

41% of the Parks Canada IFR is dedicated to recording fire characteristics. Several of the fire characteristics recorded by Parks Canada have both ported and direct CFFDRS components within the same data request.

Table 3.6 Fire characteristics recorded on Parks Canada's IFR

Fire Characteristics	Data Recorded
Topography - slope	*Checkboxes with ranges of slope degrees (e.g., 6 ° to 17°)*
Topography – aspect	**Check box with cardinal directions**

Topography – position on slope	Checkboxes: lower third, middle third, upper third, top + elevation__ (m or ft)
Fuels	*Checkboxes with ported from CFFDRS fuel types: grass _% cured, brush, deciduous__ (height, meters), coniferous__ (height, meters), __% canopy closure, __% downed wood +* __ **FBP fuel type**
Fuels - adjacent	*Checkboxes with ported from CFFDRS fuel types: grass _% cured, brush, deciduous__ (height, meters), coniferous__ (height, meters), __% canopy closure, __% downed wood + __* ***FBP fuel type***
Fire behaviour – fire rank	*Checkboxes: Smoldering ground fire, low vigor surface, moderate vigor surface, high vigor surface, active crown fire, blow up*
Fire behavior – rate of spread	*Slow, moderate, fast +* **__m/min**
Weather - wind	*Checkboxes with wind speed ranges (e.g., 2 to 11 kph) + cardinal direction*
Smoke description	Checkboxes: diffuse, wind driven, convection, color: __

Yukon

Yukon shares many similarities with Parks Canada in their recording of fire characteristics. 36% of the form is related to this task. However, Yukon almost exclusively uses ported and non-CFFDRS concepts to describe fire characteristics.

Table 3.7 Fire characteristics recorded on Yukon's IFR

Fire Characteristics	Data Recorded

Weather - wind	*Checkboxes with wind speed ranges (6-11km/h)* + **direction**
Topography - slope	*Checkboxes with qualitative descriptions: Flat/rolling, moderate, steep, extreme*
Topography – aspect	**Checkboxes: N/A, Facing__**
Topography – position on slope	Checkboxes: lower 1/3, middle 1/3, upper 1/3, top
Fuels	*Checkboxes with ported from CFFDRS fuel types:* __ **FBP fuel type +** *grass, brush, deciduous, slash, open conifer, closed conifer, mixed wood, old burn, other*
Fuels - adjacent	*Checkboxes with ported from CFFDRS fuel types:* __ ***FBP fuel type*** **+** *grass, brush, deciduous, slash, open conifer, closed conifer, mixed wood, old burn, other*
Fire behaviour – fire rank	*Checkboxes: Smoldering, creeping, running surface, torching, crowning, blow up*
Smoke description	Checkboxes for (Smoke Colour): White, grey, black
Size	Checkbox: Spot < 0.1 ha, 0.1 ha – 1.5 ha, 1.6 ha – 5 ha, 5 ha, _________ ha

Values at Risk Identification (VAR) and Representation

Identification of VAR provides an essential reference for understandings of potential fire impacts. VAR represent one of the most analytically impactful domains since they establish the lens through which the consequences of fire impacts are conceptualized. Despite the small number of requests for VAR information on IFRs, they have enormous influence on subsequent analysis. Across agencies representations of VAR differ slightly in form, however, they retain the analytic role in driving risk management and response orientation. The basic analytic intent of identifying what VAR exists and a coarse assessment of the extent to which they are at risk remains consistent. Parks Canada explicitly identifies "firefighter safety" as a value at risk which is a significant departure from the conceptualization of values at risk shown in the other agencies IFR.

Table 3.8 Values at risk inputs recorded on agencies

Alberta	Unstructured fillable text: Values at risk______
Ontario	Combination of text and checkbox: Values (<2km) ___ m to the N, E, W, S + Threatened, not threatened, saved, lost
Parks Canada	Checkboxes: firefighter safety, people, facilities, powerlines etc., other___
Yukon	Checkboxes and fillable text for distance and direction: Human life, infrastructure/private property, commercial/cultural/historic/natural, other Distance____, direction____

Operational Capacity and Constraints

In the context of IFR documents, operational capacity and constraints are primarily represented through the lens of short-term suppression feasibility. All agencies identify additional feasibility filters for immediate suppression represented through resource requests or requirements, accessibility for ground crews to the fire, and availability of water for suppression. These items constrain potential response options.

Table 3.9 Operational capacity and constraint inputs recorded on agencies' IFRs

Alberta	Requirements, remarks, control difficulties: ________
Unstructured text	Water sources: _____
Ontario	Pumping distance: _____m
Checkboxes	Access: Helicopter, fixed wing, road, boat, other___
Parks Canada	Water: None, adjacent, ____meters to fire, ____ direction from fire
Checkboxes + text/distances	Access: Road__km, boat__km, float plane_, helispot__km, ___direction from fire
Yukon	Access: Road__m, helispot__m. Hover exit__, other__, direction__
Checkboxes + text/distances	Available water: N/A, adjacent, ___m, direction___

Risk Representation and Management

IFRs do not explicitly manage risk. They function as tools used to establish a baseline context of risk posed by the fire. Yukon is unique among the agencies examined as they explicitly seek to identify probability of success on their IFR, rated as: low, moderate or high. No other agencies examined have explicit representations of risk probabilities on their IFRs. However, Alberta and Parks Canada explicitly address risk to firefighters. Alberta does this through a checkbox confirming that “LACES” are in place for initial suppression action. Parks Canada achieves this through their VAR checkbox. Ontario assesses impacts through analysis of threat to VAR. Probability, however, is not assessed in this analysis.

Despite the minimal data inputs on the IFR, risk representation and management was included as a key domain due to the innate nature of wildfire management being a risk management process. All the data gathered in the IFR factor into a larger picture of risk management at the landscape level. It would be inaccurate to leave out risk representation and management at the IFR level since it represents a foundational process in wildfire management.

Table 3.10 Risk representation and management inputs recorded on agencies' IFRs

Alberta	Checkbox confirming "LACES" are in place
Ontario	VAR: Threatened, not threatened, saved, lost
Parks Canada	Checkbox in VAR portion of form: "firefighter safety"
Yukon	Probability of success checkbox: low, moderate, high

Response and Strategic Direction

The intent of IFRs as situational assessment documents means they do not articulate response and strategic direction. At this level of assessment, pre-structuring mechanisms and constraints identified are the primary drivers of response. Specific suppression details are not included as part of an IFR. Instead, response and strategic direction at the IFR level of analysis are at the discretion of the individuals involved. Yukon is the only agency to explicitly articulate an intended response on their IFR. The other agencies examined treat response and strategic direction implicitly.

Response and strategic direction were included as a key domain despite the lack of data inputs on the IFR due to the integral nature of response as an outcome in wildfire management. All the other gathered data facilitates response decisions. These decisions are tailored to the individual context of the incipient wildfires being assessed. The lack of explicit response and strategic direction representations on IFRs reflects the inherent uncertainty embedded within wildfire management. Thus, retaining the ability to individualize response based on pre-structuring mechanisms and the data recorded in the other key domains.

Table 3.11 Response and strategic direction inputs recorded on agencies' IFRs

Alberta	Implicit response and strategic direction decision making
Ontario	Implicit response and strategic direction decision making

Parks Canada	Implicit response and strategic direction decision making
Yukon	Recommended action: Full response, modified response, monitor

Organizational Structure and Administrative Control

All agencies use IFRs as recordkeeping documents and mechanisms to preserve continuity, accountability, and administrative tracking. All agencies seek to record dates and times associated with the IFR. There are some unique features in IFRs across the corpus that are not achieving any analytic functions. Alberta and Ontario both seek to record cause determination. Alberta devotes a significant portion of their IFR to cause determination and land ownership, including a trigger to call for a fire investigator. Parks Canada and Alberta both seek to record the control status of the fire. Parks Canada also records times for commencement of firefighting and changes in control status.

Summary of Key Domains

Seven domains are represented in IFR documents; however, organizational structure and administrative control does not accomplish any analytic function. The other six domains represent the key analytic functions of IFR documents. Together they shape response direction and identify baseline risk and feasibility conditions. Assessments of fire characteristics represent the most frequent domain on IFRs across agencies. This frequency is due to the dynamic nature of wildfire behaviour, requiring many types of assessment to create necessary situational awareness.

Wildfire Analysis (WFA) & "How To" Procedural Documents

Context

WFAs are follow-up documents based on the state of an incipient wildfire. Certain contextual knowledge is required to appropriately understand the role WFAs play organizationally.

Escalation Criteria

WFAs are the second document used for analysis. Agencies have varying criteria for assessment escalation from IFR to WFA. Across agencies, these escalation criteria can be met immediately upon IFR assessment. However, the specific criteria differ between agencies, based in part on the pre-assessment mechanisms at play. Suppression success, fire characteristics, fire location and values at risk analysis done in the IFR may also induce an assessment escalation prior to these primary criteria. The primary assessment escalation criteria are shown in Table 3.12

Table 3.12 Agency differences in primary assessment escalation criteria

Agencies	**Primary Assessment Escalation Criteria**
Alberta	Fire is over two hectares or remains out of control 10am the following day. If containment is anticipated in the near future a WFA is not necessary.
Ontario	Fire is over four hectares or remains out of control at 12pm the following day
Parks Canada	Fire remains out of control 24 hours after ignition
Yukon	Dependent on which zone the fire falls within and regional fire load

Intent of Wildfire Analysis Documents

Most agencies explicitly state the intended purpose of their WFA documents. Across agencies procedural "how to" documents and WFA documents work together to comprehensively describe the WFA process as a whole. Therefore, both document types are featured in this chapter.

Alberta

Stated intent: N/A

Three documents are included:

1. Wildfire Analysis and Strategy (WAS)
2. Instructions for Completion of the Wildfire Analysis and Strategy
3. Wildfire Management Strategy and Planning – Flow Chart

Ontario

Stated intent: “The FAR assessment is a comprehensive planning process workbook that collects and evaluates information, develops near, short, and long-term plans and direction. It provides analysis of risks and benefits to support appropriate response decision making.”

Two primary documents are included:

1. Select workbooks from Fire Appropriate Response (FAR Excel) Workbook:

- Field Evaluation
- Assets and Values
- Interim Plan
- Risk Worksheet:

Based in part on the risk representation identified through the risk worksheet a response path is decided. Only the workbook corresponding to the response option chosen is completed. There are three response options:

- Full Response Plan
- Monitor Plan
- Modified Plan

2. Wildland Fire Appropriate Response (FAR) Guide

Ontario's FAR workbook has a sequential process that is unique among the agencies examined. All of the analytical functions other WFAs achieve are embedded in a series of workbooks. Analysis of domains can be spread across more than one workbook.

Parks Canada

Stated intent: the fire analysis will:

- Describe the fire situation
- Describe current and expected fire behaviour
- Recognize values at risk
- Establish objectives and constraints for the management of the fire
- Identify costs of proposed fire management options
- Document and approve the decisions.

Two documents are included:

1. Wildfire Analysis (WFA)
2. SOP Analysis of Wildfires

Yukon

Stated intent: The WFA is used to:

- To provide the necessary situational awareness and assessment of risk posed by a specific wildland fire.
- Establish clear objectives, and identify operational considerations, to manage the fire.
- Provide a uniformly understood approval process to managing the fire.

Two documents are included:

1. Wildland Fire Analysis (WFA)
2. Wildland Fire Analysis (WFA) How-To-Guide

Embedded in the how to guide there are instructions for an escalated WFA process known as the WFA 2. Functions appearing in the WFA 2 process are included in analysis. The WFA2 is an important component of Yukon's WFA process. It is intended to provide a deep analysis of a specific wildfire supporting fire prioritization and development of more in depth understanding of response options. The WFA 2 is unique among agencies examined since it is entirely accomplished through narrative text. There is significant freedom for the assessor to focus on the aspects deemed most important to the specific fire.

Domain Analysis

WFAs are holistic follow-up assessment documents for wildfires that meet escalation criteria. WFAs most basic intent is to determine response direction, through assessment of the projected impacts of a fire and the constraints affecting idealized response. WFAs contain all seven domains identified, but the analytic process is driven by six domains. However, the analytic emphasis on each domain differs significantly from the IFR since WFAs are intended to produce response decisions as well as conduct analysis on the wildfire environment.

- Spatial references
- Fire characteristics
- Values at risk identification and representation
- Response and strategic direction
- Operational capacity and constraints
- Risk representation and management
- Organizational structure and administrative control

Fire Characteristics

WFAs expand on the fire characteristic data recorded with attention also given to future considerations rather than the immediate nature of IFR assessments. Across agencies there are four categories of fire characteristics that drive analysis; weather, fuels, topography, and fire behaviour. This section delves into the specifics of each agency's approach to describing fire characteristics and identifies which deductive category they fall in to.

Alberta

Alberta's WFA engages in significant expansion upon the fire characteristics recorded by the IFR. However, the focus remains on weather, fuels, topography, and fire behaviour (type). The main differences in the WFA are the level of details associated with the data recorded and analyzed.

Table 3.13 Fire characteristics recorded on Alberta's WFA

Fire Characteristics	**Analytic Inputs and Outputs**
Present weather	**Wind direction and speed, temperature, relative humidity,** CBs present(y/n)
Forecasted weather (three-day outlook)	Big picture weather including fronts and regional trends
Fire Weather	**Temperature, relative humidity, wind direction and speed, precipitation**
Fuels	*Unstructured narrative assessment*
Fuels – FBP map	**Map showing FBP fuel types**
Topography	Unstructured narrative assessment
Topography - map	Request for topographical map
Fire behaviour – observed perimeter fire behaviour	*Quantitative assessment of percentage of perimeter showing crowning, candling, surface, smoldering, obscured by smoke + assessment of spotting distance*
Fire behaviour – Narrative assessment	***Narrative assessment of fire behaviour, including analysis of fire behavior in specific fuel types***
Fire behaviour forecast - "general"	**Quantitative FWI indices: FFMC, DMC, DC, ISI, BUI, FWI.**

Fire behaviour - "specific"	**Rate of spread, fire intensity class and fire type descriptions associated with primary fuel types on fire (e.g., C2-16m/min-class 6-crown fire)**

Ontario

Ontario assesses fire characteristics in two separate workbooks. This assessment is done in a sequential process with "field evaluation" first, followed by a response work sheet. Since all three response work sheets assess the same fire characteristics, they will not be separated.

Field Evaluation Worksheet

Table 3.14 Fire characteristics recorded on Ontario's "Field Evaluation Worksheet" as part of Ontario's WFA process

Surrounding Fuels	*Dominant fuel types: cardinal direction*
	Horizontal arrangement: continuous vs separated
	Disturbance: % dead/damaged
	Spread potential: limited vs unlimited
	Limitations: comment box

Response Worksheets

All of the inputs and outputs shown below can be loaded from already produced weather and FWI readings from the nearest weather station.

Table 3.15 Fire characteristics recorded on Ontario's "Response Worksheet" as part of Ontario's WFA process

Fire Characteristics	**Analytic Inputs and Outputs**

Weather – current weather	**Structured table of current weather: temperature, relative humidity, wind direction and speed, precipitation**
Weather – forecasted weather with dates	**Structured table of forecasted weather: temperature, relative humidity, wind direction and speed, precipitation**
Fire behaviour – current indices	**Quantitative FWI indices: FFMC, DMC, DC, ISI, BUI, FWI**
Fire behaviour – forecasted indices	**Quantitative FWI indices: FFMC, DMC, DC, ISI, BUI, FWI**

Parks Canada

Parks Canada primarily uses unstructured narratives at the WFA level to describe fire characteristics. The WFA represents a significant expansion upon the IFR, increasing in detail for both the individual characteristics and the temporal spread of the characteristics.

Table 3.16 Fire characteristics recorded in Parks Canada's WFA process

Fire Characteristics	**Analytic Inputs and Outputs**
Weather - Present weather	Unstructured narrative description of current and antecedent weather.
Weather – current fire weather	**Wind direction and speed, temperature, relative humidity**

Weather: – short-term forecast (three-to-five-day outlook)	Unstructured narrative summary of forecasted weather
Weather: – long-term forecast (5+ day outlook)	Unstructured narrative summary of forecasted weather
Weather – weather warnings or significant weather events	Unstructured narrative summary of forecasted weather warnings and events (e.g., frontal passage, wind event)
Fuels	*Unstructured narrative assessment*
Fuels – Adjacent fuel types	*Unstructured narrative assessment*
Fuels – map	*Prompt for fuels map*
Topography	Unstructured narrative assessment with explicit inclusion of adjacent topography
Topography - map	Request for topographical map
Fire behaviour – observed perimeter fire behaviour	*Quantitative assessment of percentage of perimeter showing crowning, candling, surface, smoldering, obscured by smoke + assessment of spotting distance*
Fire behaviour – Narrative assessment	*Narrative assessment of fire behaviour, including analysis of fire behavior in specific fuel types*
Fire behaviour - current indices	**Quantitative FWI indices: FFMC, DMC, DC, ISI, BUI, FWI**
Fire behaviour	*Unstructured narrative description of observed fire behaviour to date*
Fire behaviour - map	Fire projection map

*Fire behavior – anticipated fire growth (short term – 3 days_*	*Unstructured narrative description of anticipated fire growth: size, spread, duration*
Fire behavior – anticipated fire growth (long term – 5+ days)	*Unstructured narrative description of anticipated fire growth: size, spread, duration*
Fire Behaviour – Complexity rating chart	*Fuels/fire behaviour category in complexity rating chart.*

Yukon

Yukon does not include any further assessment of fire characteristics in their WFA 1. Expansion of fire characteristics occurs at the WFA 2 level. The fire characteristics identified within the WFA 2 are all potential section headings, written at the discretion of the assessor. Yukon is the only agency to explicitly consider the effects of seasonality on fire characteristics. The characteristics listed below are taken from Yukon's procedural "how to" document.

Table 3.17 Fire characteristics recorded in Yukon's WFA process

Seasonality	Length of daylight
	Time remaining in fire season
	Foliar moisture considerations
Fuels	***Applicability of forest vegetation to the FBP fuel types***
	Fire history
	Stressed or unnatural / diseased fuels
Weather	*Forecasted conditions*
	Spot forecast or other

	Windrose
	Representative weather station
	On site fuel moisture codes
Topography	Description of relevant topography

Spatial References

Across agencies, spatial references are one of the most consistently represented domains. Spatial references in the context of WFAs refer to the variety of mapping products either suggested or required by agencies. These products enhance awareness of potential impacts and represent key analytic tools across agencies. WFAs seek to expand on the basic situational awareness collected within the IFR to understand spatial conditions influencing response choices and outcomes. Yukon is the only agency that does not use a large variety of maps as part of their WFA process. The map types shown below are those explicitly prompted for. All agencies except Yukon state that more map types can be called for should the assessor require.

Table 3.18 Map types used or prompted for as part of agencies' WFA process

Agency	**Map Types Used/Prompted For**
Alberta	Detailed operations map, overview maps, FBP fuel type map (additional maps can be called for)
Ontario	VAR maps, perimeter maps, plan map (additional maps can be called upon)
Parks Canada	VAR maps, fuel types, fire management zonation, operational boundaries (additional maps can be called for)
Yukon	Zonation maps Fire growth projection maps only required in WFA 2.

Table 3.19 Fire growth model types used or prompted for as part of agencies' WFA process

Fire Growth Model *All agencies prompt for fire growth maps*	Alberta: Prometheus
	Ontario: Fire STARR
	Parks Canada: Not specified
	Yukon: Not specified

Risk Representation and Management – Values at Risk Identification and Representation

The domains of risk representation and management and values at risk identification and representation have been merged since their analytical functions are embedded together in the WFA process. WFAs expand on VAR identification done in IFRs by linking them explicitly to impacts, likelihoods, and risk conceptualization. Across agencies, risk is represented as anticipated impacts to values at risk. VAR serve as an analytic anchor in this process shaping conceptualizations of risk. VAR provide the lens through which impacts are understood. Fire characteristics provide the basis for likelihood and severity understanding. In the context of the WFA linking these domains together is crucial.

Alberta

Alberta treats risk primarily implicitly. Their documents do not define or include risk explicitly at any point. However, there is significant attention given to VAR and potential impacts based on their proximity to the fire. The risk posed by fire is primarily represented through fire characteristics. A fundamental objective of the WFA is to identify and frame appropriate response.

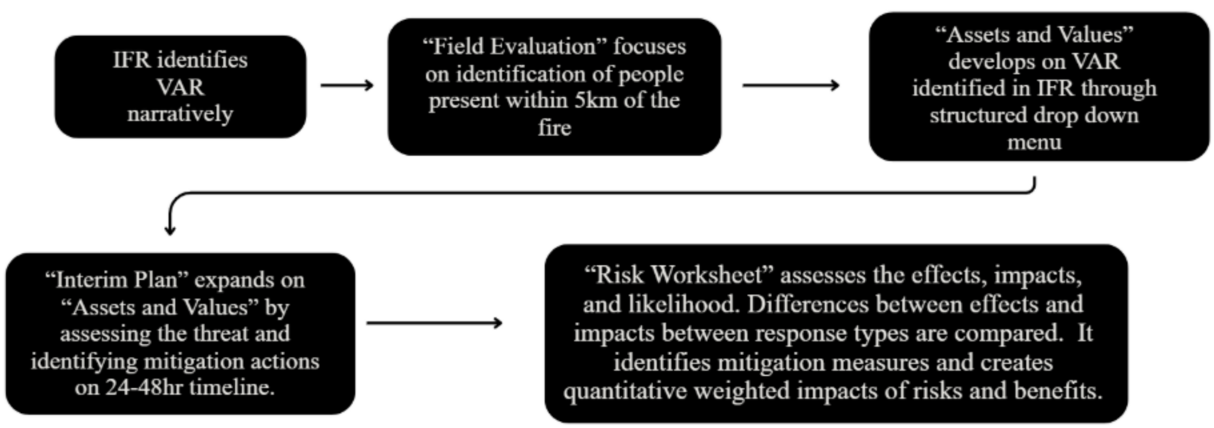
The WFA expands on the VAR identification done in the IFR. VAR are categorized based upon which of the provincial priorities they sit within. The provincial priorities are explicitly stated. Further representations of VAR are done through unstructured narrative text that couples VAR with potential impacts from fire behaviour. Notably, Alberta does not engage in any specific risk assessment, rating, or narrative.

Ontario

Ontario defines risk as "negative impact times the likelihood. Risk literally means likelihood-weighted negative impact or the arithmetic average loss, if the situation was repeated many times." Ontario treats risk in a very structured and explicit manner through a series of excel workbooks. The risk representation process is broken into four components.

Ontario's approach to risk is sequential and highly structured, culminating with quantitative outputs in their risk worksheet. The risk representation and management process in the FAR workbooks provides a thorough and structured assessment. Due to its complexity and granularity a simple flowchart (Figure 3.1) is used to capture the main elements. Screenshots of the risk representation and management process are more appropriate for capturing how it functions. Screenshots are shown in Appendices A through F.

Figure 3.1 Ontario's sequential risk assessment as part of WFA process



Parks Canada

Parks Canada does not define risk in the documents examined, however, risk is explicitly represented and managed in their WFA. Risk is addressed through two narrative text boxes using a checklist as a decision support tool. Values at risk are explicitly linked to the overall risk assessment. Parks Canada also explicitly considers potential positive effects of fire on ecosystems.

Table 3.20 Risk representation and management inputs recorded as part of Parks Canada's WFA process

Values at risk: uses checklist as list of potential values
Overall Risk Assessment: provide a comprehensive risk assessment discussion of all potential risks using checklist
Checklist of elements potentially at risk: broad categories are: firefighter health & safety, public health & safety, local/regional fire situation, infrastructure, neighboring lands, ecological/cultural integrity, economics, social.

The checklist of elements at risk above only includes the broad categories. Each has four or more subcategories.

Yukon

Yukon defines risk as: product of the probability of an event occurring and the consequences. Over 50% of the Yukon WFA is dedicated to capturing potential impacts on values at risk. This assessment is based on presence vs absence. Comment boxes are used to emphasize factors or values assessed as carrying greater importance. Risk assessment is blended with situational awareness in Yukon's WFA. The WFA assesses risk through six criteria:

1. Public Health and Safety
2. Regional / Yukon fire situation
3. Infrastructure
4. Land Ownership
5. Social / Economic considerations
6. Ecological Values.

Each of these six criteria has several subcategories embedded within.

The WFA 2 expands further on risk assessment by explicitly attributing probability and consequence to identified impact. The identification of specific risks has already been accomplished through the first level of the WFA.

Operational Capacity and Constraints

Operational capacity and constraints are representations of the feasibility conditions that shape incipient wildfire management choices. In the context of WFA documents, these representations assess factors that influence response framing, fire prioritization, and planning. Across agencies, the primary feasibility conditions represented are capacity constraints in the form of resource availability, and competing priorities. WFAs aim to integrate these constraints into response framing. Across agencies, WFAs are an important component in assessing overall agency fire load. Agency-wide fire load can act as a significant constraint on available response options by constraining resources. All agencies explicitly address resource capacity as a primary constraining factor.

Alberta

Alberta primarily treats constraints implicitly through the lens of resource availability. Their procedural documents reinforce the relationship between resources required or requested and the feasibility of objective completion. On the WFA, this is represented implicitly through linking resources requested with strategic planning. Should the resources not be available to achieve the strategic objectives, it is assumed the strategic plan will need to be adjusted. Within the strategic planning flowchart, it is mentioned that provincial wildfire priorities (fire load) may constrain available resources, however, it leaves decision making to the discretion of the Alberta Wildfire Coordination Center (AWCC).

Ontario

Ontario analyzes constraints implicitly through the lens of resource requests and availability. Resource requests are embedded within the worksheets of the FAR process. The relationship between resources and strategic planning is explicitly shown through the sequential process. The "interim plan" worksheet is required within two hours of recognition that a fire is exceeding initial attack capabilities. The interim plan develops a twenty-four-to-forty-eight-hour plan that is important for provincial priority setting. This worksheet identifies resources required to achieve the desired mitigation strategy; it is assumed that the strategic plan must be adjusted should these needs not be met.

The subsequent response plan worksheets also identify resources required to achieve mitigation strategies. It is assumed that the plan need adjustment should the required resources be unavailable.

Within the follow- up response plan worksheets there is explicit linking of assessments to fire loads. This is achieved by assigning wildfires a regional priority and a district which can be either numerical or qualitative (low, moderate, high). Assessors are asked to make this choice based on the current fire load. The priority setting component supports broader decision making.

Parks Canada

Parks Canada explicitly analyzes operational capacity and constraints within their WFA. This analysis features a multi-pronged approach with several categories of feasibility filters addressed. The most unique feature of Parks Canada's approach to analyzing capacity and constraints is the quantitative complexity matrix that encapsulates a wide variety of factors and outputs a numeric rating, matrix shown in Appendix G. Parks Canada addresses fire load explicitly through identification of competing priorities and available local resources.

Table 3.21 Operational capacity and constraint inputs recorded as part of Parks Canada WFA process

Competing Priorities – Local / Regional Fire Situation	Text describing the local and regional fire situation
Resources – text descriptions	Resources required
	Park/field unit resources available
	Import resources required
Tactical Complexity – quantitative rating scale	Elements included in numeric rating guide: Safety, threats to boundaries, fuels/fire behaviour, objectives, management organization, improvements to be protected, ecological cultural & social values to be protected, air quality values to be protected,

	logistics, political concerns, tactical operations, interagency consultation

Yukon

Yukon primarily represents operational capacity and constraints through the lens of resource availability and competing priorities. Yukon maintains initial attack readiness as a priority over suppression of fires that have exceeded IA. There is explicit linking through both the procedural document and the WFA of requested resource availability and objective success feasibility. The WFA also identifies several unique capacity and constraints related to both resources and feasibility of resource use. One of the primary functions of the Yukon's WFA is to support fire load management through efficient use of resources.

Table 3.22 Operational capacity and constraint inputs recorded as part of Parks Canada WFA process

Competing Priorities - Responding to this fire may compromise initial attack	Checkbox Yes/No
Competing Priorities – Resources from outside of region required	Yes / No
Resources	Resources from outside region are required
	Required resources are not available

Response and Strategic Direction

Response and strategic direction represent the ultimate objective of WFA processes across all agencies examined. All other domains feed into this final outcome by providing the contextual grounding necessary for response decision making.

Across all agencies examined response and strategic direction are represented as analytic outputs of incipient wildfire analysis. These outputs establish intended management strategies, define objectives, and specify conditions for response change or re-assessment. They function as analytic products that justify subsequent operational action under uncertainty.

Alberta

Alberta's WFA treats response and strategic direction through two separate narrative text boxes. First, objectives are developed, then specific strategies are developed to achieve the objectives. Embedded within strategies are resource requests tailored to the specific strategy. The WFA suggests developing multiple strategic options with different suppression methods and resource requests.

Table 3.23 Response and strategic direction inputs recorded as part of Alberta's WFA process

Develop Objectives	One-to-two-line narrative describing what the objective is
Develop Strategy	What is the plan to achieve the objective? What suppression methods will be used?
Develop Strategy - Resources	Indication of resources currently utilized. What resources are required to meet the objectives using the identified strategy.

Ontario

Ontario's FAR process analyzes response and strategic direction through structured and sequential excel workbooks. The tables presented below are in sequential order, "full response plan" and "managed response plan" are response alternatives. Before either of these plans are engaged it is necessary to complete the risk worksheet to fully understand the constraints affecting response.

Interim Plan

The "interim plan" is required within two hours of recognition that fire has escaped control or an opportunity for a managed response exists. The interim plan provides a twenty-four-to-forty-eight-hour response direction.

Table 3.24 Response and strategic direction inputs recorded in Ontario's "Interim Plan Worksheet" as part of Ontario's WFA process

Strategic direction	Managed vs full response
Tactics	Full response, modified response, monitored response
Tactical direction	Values protection, tanker/bucket support, ignition
Interagency response	Yes/no
Goals and Action Plan	Dropdown menus for goals and fillable comment box for action plan

Full Response Plan

Full response planning supports an incoming IC/IMT during the first three days of transition. The plan is required within twenty-four-to-forty-eight hours after fire confirmation. The response plan outlines the tactics and resources required to mitigate forecasted impacts/risks with an initial action plan to accomplish objectives.

Table 3.25 Response and strategic direction inputs recorded in Ontario's "Full Response Plan Worksheet" as part of Ontario's WFA process

Response plan	Extinguishment or full containment
Interagency response	Yes/no
Impact mitigation/suppression goals	Drop down menus: categories, goals, effects
Action plan	Comment Box

Monitor and Modified (Managed) Response Plan

Managed response planning considers the extent of fire growth that is deemed acceptable known as acceptable burned area (ABA). It identifies mitigation efforts that will be engaged should fire spread beyond the ABA. The plan is required within twenty-four to forty-eight hours after fire confirmation.

Table 3.26 Response and strategic direction inputs recorded in Ontario's "Monitor and Modified Response Plan Worksheets" as part of Ontario's WFA process

Appropriate response objective	Limit area burned (LAB) or allow area burned (AAB)
Tactics	Monitor, asset/value protection, modified suppression
Planning objectives	Drop down menus: menus, category, goals, effects
Trigger points	Drop down menus: trigger point type, purpose, actions
Action plan	Drop down menus: ABA size (hectares), response to ABA being compromised

Parks Canada

Parks Canada analyzes response and strategic direction through a comparative process named "management alternatives." Each of the components shown in Table 3.27 must be filled for management alternative A and B. Once the comparative process is complete the assessor chooses a recommended action. They must explain the rationale and if necessary, and expand the selected objective, strategy, and tactics.

Table 3.27 Response and strategic direction inputs recorded as part of Parks Canada's WFA process

Management Objectives
Strategy
Costs (+/- 20%): Personnel – Aircraft – Equipment
Tactical Complexity – Uses fire complexity rating process and discuss most serious issue

Yukon

Yukon's zonation system results in prescriptive response types based on the location of the fire. However, the WFA still requires the assessor to select a response option. Once the response option is confirmed, objectives are established. Yukon states that objectives should be made using the SMART acronym. (Specific, Measurable, Achievable, Relevant, Time-Oriented (S.M.A.R.T.)). Smart objectives are recorded in narrative text; they intend to establish specific tactical and strategic objectives referencing the fire environment.

Yukon's WFA also specifies a series of operational considerations presented in a checklist format that supports incident-specific response direction.

Table 3.28 Response and strategic direction inputs recorded as part of Yukon's WFA process

Fire growth projection done
Established trigger points

Natural control lines
Appropriate for ignition
Appropriate for heavy equipment
Ongoing Airtanker support

Organizational Structure and Administrative Control

This domain represents multiple important functional components of WFA. These functions do not accomplish any analytical work towards structuring response. There are three primary functions embedded within this domain at the WFA level of analysis.

- Conditions for re-analysis
- Roles, consultations, and approval chains
- Administrative tracking: fire name or number, temporal, and fiscal components

Alberta

Table 3.29 Organizational structure and administrative control inputs recorded as part of Alberta's WFA process

Conditions for re-analysis	Overall strategy change
	Fire spreads beyond predetermined values
	Fire status returns to “out of control” (OC)

Roles, consultations, and approval chains	WAS assessment completed by "assessor", IC2, wildfire operations officer (WOO), wildfire prevention officer (WFPO)
	Approval chains: Wildfire manager -> Provincial fire center
Administrative tracking	WAS records, dates, times, and fire numbers

Ontario

Table 3.30 Organizational structure and administrative control inputs recorded as part of Ontario's WFA process

Conditions for re-analysis:	Not explicitly stated
Roles, consultations, and approval chains: Fire analysis developed in cooperation and recommended for approval by:	Interim Plan: completed by Sector response officer (SRO), in consultation with regional duty officer (RDO)
	Risk assessment: dependent upon complexity and severity of fire: IC1-4, person with advanced fire behaviour training, a fire technician, or a manager in consultation with the land managers

	Modified and monitored response: Depending upon the complexity and severity of the fire the plan is constructed by, or by consulting an IC 1 – 4, individual with Advanced Fire Behaviour or FBAN training (Fire Technician/ Manager) with involvement of the Land Manager(s).
Administrative tracking:	WFA records dates, times, and fire numbers
	Cost estimate embedded in response plan worksheets using cost ranges. (E.g., <$5,000)

Parks Canada

Table 3.31 Organizational structure and administrative control inputs recorded as part of Parks Canada's WFA process

Conditions for re-analysis:	Updated periodically as conditions change – Ex: change in overall strategy
Roles, consultations, and approval chains: Fire analysis developed in cooperation and recommended for approval by:	Park Fire Duty Officer and/or Park Fire Management Officer
	Incident Commander

	Parks Canada National Duty Officer
	Manager of Resource Conservation
	Advisors as required (neighboring land management agencies, etc.)
	Final approval by: Field unit superintendent
Administrative tracking:	WFA records dates, times, and fire numbers
	Cost estimate for personnel, aircraft and equipment (+/-20%)

Yukon

Table 3.32 Organizational structure and administrative control inputs recorded as part of Yukon's WFA process

Conditions for re-analysis:	Request of Yukon duty officer (YDO)
	Inaccurate at 10am Wednesday
	Objectives failed
	Required resources not available

	Assigned resources re-prioritized
	Costs-exceed estimates Significant change in fire danger
Roles, consultations and approval chains:	Typically, a regional duty officer (RDO) completes the WFA. In normal circumstances the RDO is expected to have a dialogue with the YDO
	Final approval comes from YDO
Administrative tracking:	WFA records dates, times, and fire numbers
	Cost estimate is not attached to WFA but is expected within 24 hours of approval.

Summary

All seven of the analytic domains play a role within the WFA process. WFAs primary intent is to synthesize the fire environment into idealized response through analysis of capacity and constraints. Capacity and constraints are informed by resource availability and risk management analysis. Risk assessments are formed around assessments of impacts to VAR. Impacts are founded upon analysis of fire characteristics and spatial references. All agencies rely upon WFAs for fire prioritization decisions. The assessment done in the WFA process is essential for understanding overall fire load.

Chapter 4: Discussion

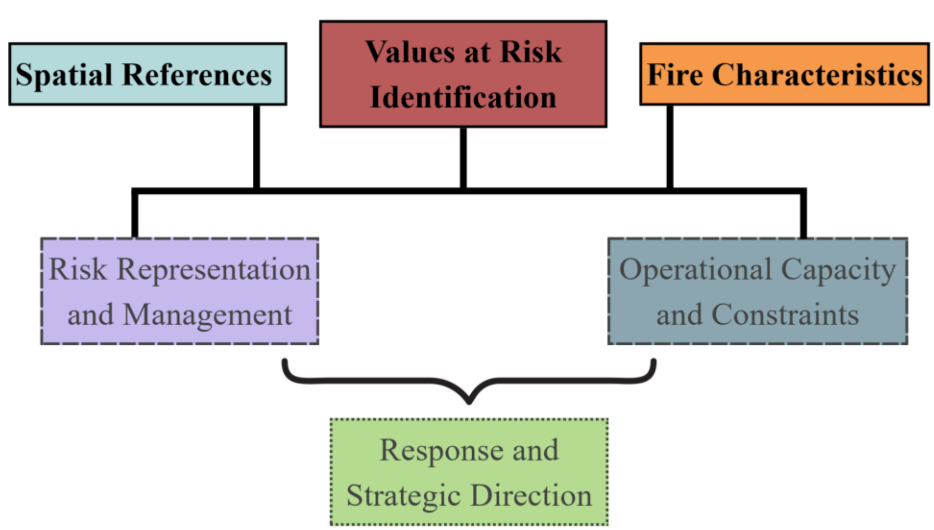
Summary of Key Findings

Despite differences in form, agencies hold shared analytic purpose in structuring how incipient wildfires are made operationally legible. This thesis establishes what constitutes an incipient wildfire in this study by defining the analytic phase and the documentation used to examine it. Specifically, this study begins when resources arrive on site and complete an IFR, forming the baseline for situational awareness. This study ends when long term planning is engaged, represented by either a timescale over seventy-two hours or handover of the fire to an incident management team (IMT). Rather than using the "initial attack (IA) phase" as a boundary, this study uses the IFR threshold since agencies do not share a common definition for the IA phase of response. It's important to recognize that IFR assessments act within a larger framework with pre-IFR structuring mechanisms that shape acceptable responses before personnel arrive at the fire. E.g., zonation systems in Parks Canada and Yukon that pre-identify response options based on fire location, while Ontario's "appropriate response" logic and Alberta's initial attack expectations similarly structure acceptable response pathways.

Across all agencies examined, the underlying purpose of wildfire analysis documents is to attempt to resolve uncertainties and synthesize the fire environment into understandable and time sensitive information usable for operational response. The process of synthesizing the fire environment requires a combination of many analytic functions driven in large part by assessments of fire characteristics and values at risk. This process is also required for wildfires that are receiving a modified or monitored response. With the completion of a WFA signifying the end of the incipient phase. To explain how incipient wildfire analysis documents attempt to resolve uncertainty it is crucial to understand the tightly inter-connected nature of the six key domains involved. IFRs and WFAs both use the same analytic functions; however, emphasis is placed on different analytic functions which alters the domains relationships with each other. These relationships, the domains driving analysis, and differences between agencies are explored below.

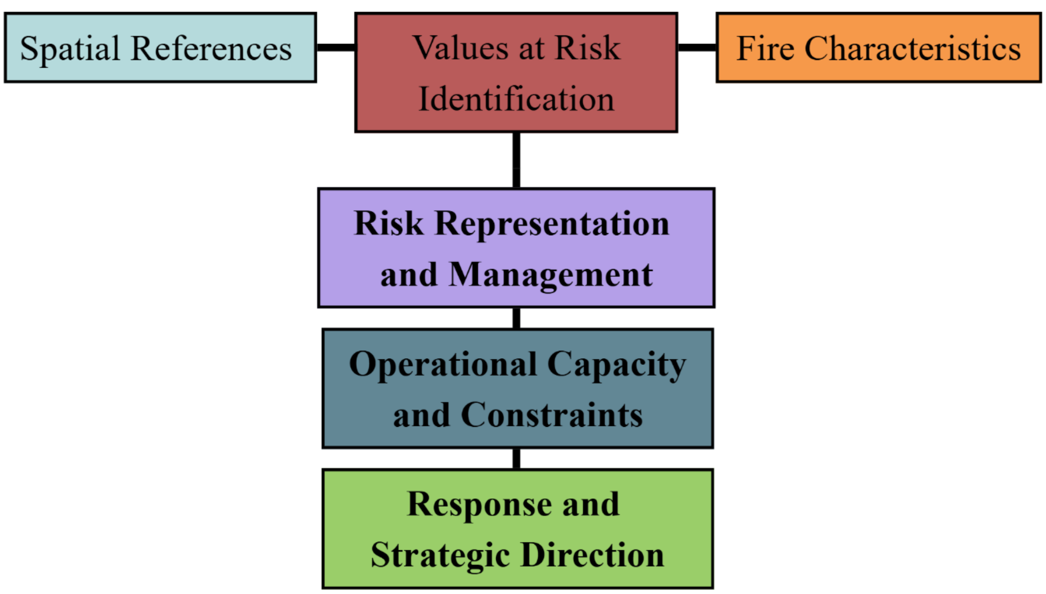
Agencies share a flow of information gathering in their IFRs due to the way they are structured. There is an implicit flow in the ordering of the documents which places certain analytical domains ahead of others. In specific cases the order of domains can be changed which means that the domains are not necessarily hierarchically organized. IFRs have three primary domain fields that drive consecutive analysis and decision making: values at risk identification and representation, spatial references, and fire characteristics. These domains capture situational awareness, forming the foundation for subsequent assessment and decision making. Each of these domain's act as inputs creating the context necessary that enables the other three primary domains analytic clarity. Both the risk representation and management domain and operational capacity and constraints domain are outputs from the situational awareness domains. Risk management decisions regarding values at risk and access to the fire are directly informed by the initial analysis of the fire environment. These two domains also act as inputs as they have synthesized the situational awareness data gathered into information more usable for response decisions. Response and strategic direction is analytically distinct from the others as it represents a final output derived from the analytic work accomplished through the other domains. With the exception of Yukon, response decisions are not reflected on IFRs. These decisions are primarily made through conversation between the initial assessor and a fire manager in the office. The IFR provides a situational awareness baseline for conversation between the two for deciding upon specific tactics and response strategies.

Figure 4.1 Shows relationships between key domains on IFRs.



Analysis in the WFA is also driven by the same three foundational domains of values at risk identification and representation, spatial references, and fire characteristics. These domains are analyzed in more depth and with a longer timeframe in mind than the IFR. Like the IFR, these three domains act as inputs to provide the context necessary for subsequent decisions. In the WFA, these domains provide the foundation for risk representation and management. Risk management in turn is used as an input for understanding the constraints associated with idealized response. Factors such as unmanageable fire behaviour or proximity to a community may act as constraints when structuring response. Each of these factors may completely alter the range of possibilities available for deciding upon a response and overall strategic direction. Simultaneously, operational capacity must be assessed in the context of fire load and available resources. Resources matching the response needs of a wildfire is a final component that the WFA aims to assess as part of deciding an overall strategic direction. Fire characteristics and spatial references shape the context that these decisions are based on. These two domains dictate what water sources, access points, and resources are reasonable in the context of the fire. Ultimately the final goal for WFAs is to synthesize the fire environment into usable data inputs to structure a response and strategic direction appropriate for the incipient wildfire. This also applies to wildfires that are receiving a monitored or modified response. The WFA captures the conditions that enables these kinds of responses.

Figure 4.2 Shows relationships between key domains on WFAs.



Organizational structure and administrative tracking serve a more important role in the WFA than in the IFR. However, they are not accomplishing a crucial analytic function. Instead, they serve as frameworks for changes in response and structures for consultations and approval chains. While this domain is not a key analysis function, it is a necessary component that supports defendable and repeatable analysis processes.

Across agencies the documents analyzed are not only data capturing tools. They are also organizational representations that act within a broader impacts-based risk management process that supports defendable and repeatable response framing. The IFR and WFA chapters can be understood as sequential stages in a structured analytic pathway: initial representation followed by formalized synthesis into strategic direction. The exploratory and comparative content analysis conducted on incipient wildfire analysis documents showed that the selected agencies involved share many similarities in approach.

Domain Expansion

Operational Capacity and Constraints WFA: Fire Load

Across agencies capacity constraints related to overall fire load are represented both implicitly and explicitly. Fire load is not a component that is directly related to analysis of incipient wildfires; however, it may have a significant effect on operational decisions. It's important to acknowledge that fire load is crucial concept that underlies much of the big picture decision making during incipient wildfires. When agencies are not experiencing large fire loads, decision making is relatively unconstrained with issues relating directly to the wildfire as the primary drivers. However, when agencies are operating under large fire loads, WFAs hold increased importance organizationally since they support prioritization decisions. Fire prioritization is not directly tied to the analysis of incipient wildfire, rather it is an output, expressing the conditions that may require broader agency support. Across agencies there exists a need to balance suppression of wildfires threatening values at risk with the potential for new ignitions. This balance may significantly affect idealized response of an incipient wildfire with the WFA serving as the primary analytical tool to base decisions upon.

Inconsistent Use of CFFDRS

Fire Behaviour Descriptions: IFR

Across agencies examined, a primary analytic function is assessment of fire characteristics, however, CFFDRS use is highly inconsistent. The fire characteristics assessed in IFRs can be broken into four main categories: topography, weather, fuels, and fire behaviour. The only CFFDRS component present through all IFRs is the use of FBP fuel types. Notably, Parks Canada and Yukon do not use the FBP as the primary descriptor of fuel type, rather, the FBP types serve as one option among many.

Describing fire behaviour is a key component of the IFR and of wildfire management in general. All four agencies examined use varying terminology to describe fire behaviour, most notable is the lack of CFFDRS terminology used. The CFFDRS uses fire type (FT) to provide a general description of fire behaviour, FT is based on crown fraction burned (CFB).[26] If the CFB is less than 0.1 (10%) then the fire is a surface fire.[26] If the CFB is 0.9 (90%) or more the fire is a continuous crown fire.[26] If the CFB is between 0.1 and 0.9, the fire is an intermittent crown fire.[26] Alberta is the only agency to use any of the CFFDRS FT terminology. Even then, it is only surface fire that is used. The other agencies employ far more descriptive terminology to describe fire behaviour than the CFFDRS FT with five or more categories covering a broad range of fire activity.

The wide range of terminology used to describe fire behaviour among the agencies examined is a potential source of miscommunication during interagency work. Additionally, it may point to a gap in the capabilities of the CFFDRS to report on current fire conditions. There is certainly opportunity to establish more consistent terminology.

Figure 4.3 Shows differences in CFFDRS and CFFDRS related fire characteristic terminology on IFRs.

IFR Fire Characteristics

Analysis Elements	Alberta	Ontario	Parks Canada	Yukon
Fuels	**Fuel Type:** **FBP Fuel List**	Fuel Type: **(Currently burning,** *directly adjacent)* **FBP Fuel List +** **% conifer in M types** **% curing in O1 types**	Fuels *Grass___% cured* *Brush* *Deciduous___(ht ,m),* *Coniferous___ (ht, m)* *___% Canopy closure* *___% downed wood,* **FBP Fuel Type___**	Burning in Fuels: **FBP fuel type ________** *Grass* *Brush* *Closed conifer* *Deciduous* *Mixed-wood, Slash* *Old burn* *Open conifer,* *Other*
Fire Type/Rank/ Intensity	Fire Type: *Ground,* **Surface,** *Crown*	*Fire ROS:* *Smoldering, Creeping, Running, Torching, Crowning* *Spotting Y/N, # of spot fire + distance* **Fire Intensity Class:** **1,3,4,5,6**	*Fire Rank:* *Smoldering ground fire* *Low vigor surface fire Mod. vigor surface fire Active crown fire* *Blow-up*	*Fire Rank:* *Smoldering* *Creeping* *Running surface* *Torching* *Crowning* *Blow-up*
Rate of Spread	**__M/Min**	Smoldering, Creeping, Running, Torching, Crowning @**__M/min**	*Slow, Moderate, Fast* **___M/min**	Not represented

Figure 4.4 Shows differences in non-CFFDRS and related fire characteristic terminology on IFRs.

IFR Fire Characteristics - Non CFFDRS

Analysis Elements	Alberta	Ontario	Parks Canada	Yukon
Smoke	Narrative assessment	Narrative assessment	Smoke: None Diffuse Wind driven Convection Color___	Smoke Colour: White Grey Black
Adjacent Fuels	Not Represented	Fuel Type: (Currently burning, directly adjacent) FBP Fuel List + % conifer in M types % curing in O1 types	Adjacent Fuels: Grass___% cured Brush Deciduous___(ht ,m), Coniferous___ (ht, m) ___% Canopy closure ___% downed wood, **FBP Fuel Type___**	Adjacent Fuels: **FBP fuel type ________** Grass Brush Closed conifer Deciduous Mixed-wood, Slash Old burn Open conifer, Other
Position on Slope	Pos. on Slope: Bottom Flat Lower 1/3 Middle 1/3 Upper 1/3 Topography: Fill in text box	Topography: Fill in text box	Position on Slope Bottom Lower third Middle third Upper Third Top Elevation___ (m or ft)	Position on Slope: N/A Lower 1/3 Middle 1/3 Upper 1/3 Top

Fire Behaviour Descriptions: WFA

A significant proportion of WFAs are aimed at capturing fire characteristics. Analysis of fire characteristics in WFA occurs at a broader scale both temporally and spatially than the IFR. The CFFDRS is more consistently used at the WFA level in the form of fuel moisture codes and FWI indices. This is likely due to the capability of the CFFDRS to offer predictions of fire behaviour. Additionally, individuals who are completing the WFA are more likely to have higher level fire behaviour training or more operational experience than those completing IFRs. Comparison among agencies descriptions of fire behaviour at the WFA level does not provide useful insights since all agencies use CFFDRS fuel moisture codes in their WFAs to support forecasting fire behaviour.

Decision Support Systems (DSS)

Ontario: Risk Worksheet

Ontario's approach to risk management is filtered through a highly structured decisions support system. The "risk worksheet" within the FAR process supports decision making by addressing likelihoods and impacts in a step-by-step sequential process that outputs quantitative matrices. An important aspect of this process to acknowledge is the inclusion of benefits as a potential impact. Structuring the risk worksheet suggests that fire managers should consider the potential for benefits from natural fire on the landscape. Creating such a structured DSS Ontario enables clarity in the risk conditions that led to response decisions. This clarity is important for creating repeatable and defendable response decisions. Particularly in the context of Ontario's "appropriate response" philosophy, measurable and quantitative risk outputs increase the likelihood that their intended outcomes are achieved.

Parks Canada: Complexity Rating

Parks Canada uses a quantitative complexity rating scale that captures a wide variety of factors that contributes to management complexity. Each factor is weighed differently with safety, threats to boundaries, and fuels and fire behaviour carrying the most significance. Based upon the complexity rating a corresponding IC level is associated. This complexity rating process is a DSS that helps the assessor understand the factors constraining response. Parks Canada aims to achieve benefits from wildfire while also preventing negative impacts. Achieving these contradicting objectives is supported by the complexity rating process.

Key Aspects of Overall Process

Alberta

Table 4.1 Key overall aspects of Alberta's wildfire analysis process.

Pre-structuring mechanism	N/A - Initial attack on all wildfires
Escalation Criteria	Fire is over 2 hectares or remains out of control 10am following day
Stated intent of WFA	No stated intent
Risk Management Process	Implicit and primarily qualitative

Ontario

Table 4.2 Key overall aspects of Ontario's wildfire analysis process.

Pre-structuring mechanism	N/A - Each fire is treated with the "appropriate response".
Escalation Criteria	Fire is over four hectares or remains out of control at 12pm following day
Stated intent of WFA	"The FAR assessment is a comprehensive planning process workbook that collects and evaluates information, develops near, short-, and long-term plans and direction. It provides analysis of risks and benefits to support appropriate response decision making."
Risk Management Process	Explicit and highly structured – considers potential for positive effects

Parks Canada

Table 4.3 Key overall aspects of Parks Canada's wildfire analysis process

Pre-structuring mechanism	Zonation system dictating response options (individualized by each park)
Escalation Criteria	Fire remains out of control 24 hours after ignition
Stated intent of WFA	"The fire analysis will: • Describe the fire situation • Describe current and expected fire behaviour • Recognize values at risk • Establish objectives and constraints for the management of the fire

	• Identify costs of proposed fire management options • Document and approve the decisions.”
Risk Management Process	Explicit – seeks potential positive impacts from fire

Yukon

Table 4.4 Key overall aspects of Yukon’s wildfire analysis process

Pre-structuring mechanism	Zonation systems dictating response options
Escalation Criteria	Dependent on which zone fire falls within and regional fire load
Stated intent of WFA	“The WFA is used to: • To provide the necessary situational awareness and assessment of risk posed by a specific wildland fire. • Establish clear objectives, and identify operational considerations, to manage the fire. • Provide a uniformly understood approval process to managing the fire.”
Risk Management Process	Explicit and qualitative – considers potential for positive impacts

Analysis as a Distinct Phase of Wildfire Management

Analysis represents a distinct component of response. Response decisions are predicated in large part upon the assessments during the analysis phase. Decisions made based on the data collected through analysis determine the strategic direction of response. Historically, analysis has fallen under the umbrella of the response phase. However, this research demonstrates that response is informed through analysis. The domain structure of IFRs and WFAs reflects this. Situational awareness domains precede and enable risk management and response domains in both document types. Analysis is therefore a precondition for response, not a component of it.

Differences in Terminology

While agencies share many similarities in the analytic functions used to assess incipient wildfires, there are significant differences in the terminology that features in their documentation. The frequency of words used in their documentation reveals aspects of how agencies think about wildfire management. The findings support that the differences are concentrated in representation rather than analytic purpose. This distinction is a useful starting point for identifying where interoperability challenges are most likely to emerge.

Alberta

Figure 4.5 Figure shows a word cloud made using Alberta's documents.

Ontario

Figure 4.6 Figure shows a word cloud made using Ontario's documents.

Parks Canada

Figure 4.7 Figure shows a word cloud made using Parks Canada's documents.

Yukon

Figure 4.8 Figure shows a word cloud made using Yukon's documents.

Strengths and Limitations of this Research

Strengths

The strengths of this thesis derive from the alignment between a document-based comparative design and research questions focused on agencies representations of incipient wildfire analysis.

Documents are appropriate as an evidence base to examine how incipient wildfire analysis is organizationally arranged and sanctioned. IFRs, WFAs, and procedural "how to" documents explicitly state what agencies require to be recorded, assessed, and categorized, which aligns with the topic under study.

The agencies involved in this study enable comparison of approaches from different parts of the spectrum of wildfire management in Canada. Inclusion of multiple agencies empowers identification of functions that are stable across jurisdictions and where differences concentrate. The research design supports distinctions between shared analytic purpose and variation in representation, negating treatment of a single agencies form as standard or typical.

Analyzing both IFRs and WFAs allows descriptions of incipient wildfire analysis as a sequential process. This moves from baseline situational awareness to formal synthesis and response framing. Inclusion of procedural "how to" documents strengthens interpretability by showing how governance and analytic synthesis are intended to be operationalized.

Treating terminology and description conventions as analytic objects is a strength of this thesis due to the necessity of interoperability between Canadian wildfire management agencies. This identifies translation points, offering a concrete basis for future work on interagency coordination without assuming operational impacts.

Limitations

The most relevant limitation to this research is that analysis is restricted to documentation. Documentation alone is incapable of capturing the full picture of incipient wildfire analysis. Documents reveal idealized assessment and response planning, not necessarily what occurs in reality. This limitation was partially mitigated through engaging in conversations with agency representatives to ensure documents were understood correctly.

Another important limitation to note is the inductive content analysis was only done by one researcher, which can be considered atypical in a standard inductive content analysis process. This was mitigated by use of iterative checks, clear unit definitions and boundary memos.

Finally, this research only covers incipient wildfire analysis of four wildfire agencies. This negates the possibility of making claims about incipient wildfire analysis in the broader Canadian context. However, the agencies involved in this study represent the spectrum of Canadian response strategies including full suppression, zonation, and appropriate response.

This study relied solely on inductive content analysis of documents. Different methodological approaches would likely produce different insights into incipient wildfire analysis. Interviews or observational methods would allow examination of how documents are used in practice rather than what they contain, and may produce different categorizations of the domains identified here. This approach would have examined the effect of the human dimensions involved with decision making. A study directed towards the human dimension may have yielded different results than document-based research.

Conclusion

Thesis Reorientation

Incipient wildfire analysis is a key component of response planning. This phase structures situational assessment under uncertainty. This study sought to investigate how select wildfire management agencies analyze incipient wildfires. Documents used to analyze incipient wildfires formed the corpus for examination, centered on initial fire reports (IFRs) and wildfire analysis documents (WFAs), alongside supporting procedural "how to" documents that articulate intended analytic workflows. The exploratory and comparative analysis focused on document-based representations and analytic functions not effectiveness or outcomes. The following conclusions draw on that analysis to characterize how incipient wildfire analysis is structured across agencies and what that structure means for response planning in Canada.

Cross Thesis Conclusions

Sequential Process

Across agencies examined, incipient wildfire analysis is represented as a sequential process in which initial situational awareness is established and when required, formalized into synthesis and response framing. This pattern is visible in the IFR-to-WFA sequence analyzed across chapters. The sequential logic of analysis holds true across agencies despite variations in escalation criteria and document style. Understanding incipient wildfire analysis as sequential highlights the role of documents as representational infrastructure. They progressively stabilize what the fire "is" and what response and strategic directions are considered appropriate.

Variations in Terminology

Differences between agencies are concentrated in how analytic content is represented, not in whether analysis occurs. Cross-agency variation in terminology is not evidence of analytical disagreement but identifies where translation work becomes necessary when information moves across jurisdictions. Addressing these differences does not require standardization across agencies. A more practical opportunity is the development of shared reference guides that map equivalent terms across jurisdictions. This would support clearer communication during interagency response without requiring agencies to abandon terminology that is already embedded in their operational culture. An ideal opportunity for implementation of shared reference guides is the provincial briefing out of provinces crews receive during interagency work.

Scope of Conclusions

These conclusions describe how agencies represent incipient wildfire analysis through documentation, not what occurs in operational practice. They are bounded to four agencies and cannot support broader claims about Canadian wildfire management. The findings are therefore best understood as a comparative baseline rather than a generalizable account of how incipient wildfire analysis is conducted across Canada.

Significance for Wildfire Management Knowledge

Wildfire research in the Canadian context is done in many areas but primarily limited to fire ecology, fire behaviour, and wildfire management. There are many underexamined aspects in our understanding of wildfires and wildfire management in Canada. In the context of this study the most important knowledge gap is response planning. Very little attention has been paid to how agencies structure early assessment and how analysis factors into wildfire management and response planning.

This research advances the idea that analysis documents are not simply recordkeeping documents. They are integral to the response system, shaping how information is produced, how uncertainty is addressed, and how response options become describable. The significance of this thesis is that it identifies analysis as a distinct phase of response planning, clarifying how uncertainty reduction and synthesis become the basis for response framing and strategic direction in incipient wildfire contexts. By treating IFRs, WFAs, and procedural "how-to" documents as representational infrastructure, this study clarifies how early response planning is made possible through organizational structuring of knowledge. This creates a basis for research into interoperability and how these structures of knowledge may interact.

Wildfire management in Canada is highly dependent on coordination across agencies, as wildfire seasons continue to become more challenging reliance on cooperation will likely increase.[16] The ability to translate analytic representations among agencies may become a more pressing practical and scholarly concern. This thesis contributes a comparative baseline for describing where variations in terminology emerge in the production of situational awareness and response framing. This baseline can support future research examining how representational differences are navigated, or their influence on cross agency decision making.

Potential Applications

Interagency Coordination and Information Translation

A potential application of this research is to support interagency coordination by making variations in terminology more visible. Crucially, this study does not examine whether representational differences produce misunderstanding or operational friction. Therefore, application is limited to identifying plausible translation points and providing a comparative basis for future evaluation. The findings provide a comparative basis for anticipating where meaning may need to be converted across jurisdictions, particularly where terminology differs. In practice, this could be used as a lightweight translation prompt for briefings and situation reporting.

Training and Professional Development: Clarifying Analytic Expectations

A second potential application is for training and professional development. This thesis does not delve into training in any capacity; therefore, application should be understood as a lens to support conceptual clarity and shared analytic language. Specifically, to clarify what incipient wildfire analysis is expected to accomplish and how it fits within a broader system of fire management. The analytic framework developed in this research may support teaching incipient wildfire analysis as a sequential process intended to produce usable information under time constraints. Instructors and trainees could potentially use the descriptive model to support reflections on what uncertainties are being addressed, how identified constraints might affect response, and where vocabulary choices may require translation when information is shared across agencies.

Future Research Direction

This research represents the first step toward understanding how Canadian wildfire management agencies engage in incipient wildfire analysis as the initial phase of response planning. The immediate next step is expanding documentary comparison to agencies not included in this study, which would support broader claims about Canadian practice. This comparative foundation can then support more in-depth investigation into decision making during incipient wildfires.

Methodological expansion is also an important next step. Combining document analysis with interviews or operational observations would allow researchers to test whether the representational structures identified in this study reflect how analysis actually unfolds during operations.

Closing Statement

Incipient wildfire analysis has historically been treated as part of response rather than as a distinct phase. This thesis establishes that it is analytically separable, structured, representational, and consequential for how response becomes possible. Understanding how agencies organize knowledge under uncertainty is a necessary foundation for improving how that knowledge moves across jurisdictions and informs decisions in the field.

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Appendices

Appendix A

Assets/Values Workbook

ASSETS/VALUES

District Fire #:	"District"		<Enter Fire Number>					
Location: UTM:	Zone:	0	Basemap:	00000	Block:	00	Sub-block:	00

#	Assets/ Values	Location	Threat	Status	Add
1	"Asset/Value"		"Threat"	"Status"	

"Asset/Value"
Human Life
Residence
Subdivision
Cottage/Camp
Trappers Cabin
Lodge/ Outpost Camp
Towers

Appendix B

Interim Response

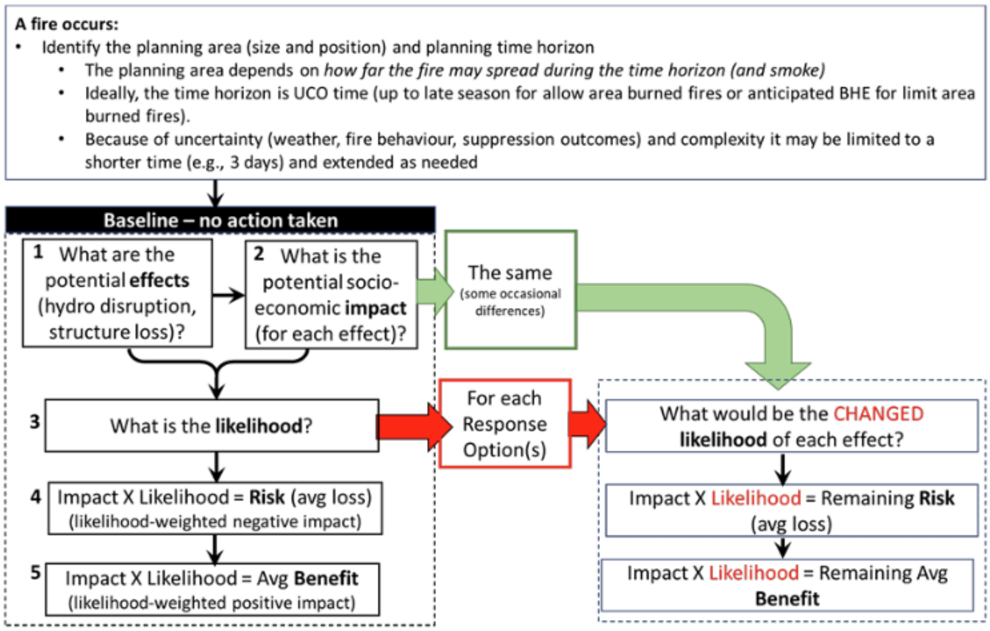
INTERIM RESPONSE PLAN (24-48 hours)

District Fire #:	"District"		<Enter Fire Number>					
Location: UTM:	Zone:	0	Basemap:	00000	Block:	00	Sub-block:	00

#	Asset/Value	Location	Action	Action	Add
1	"Asset/Value"		"Action"	"Actions"	

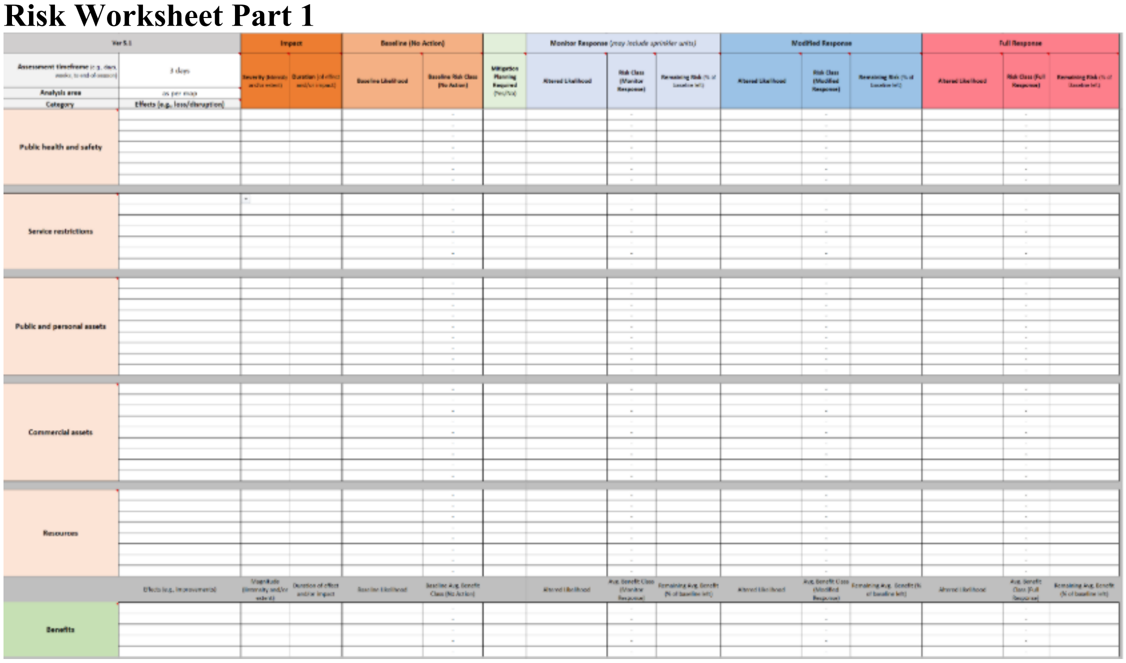
Appendix C

FAR Risk Worksheet How to Guide



Appendix D

Risk Worksheet Part 1



Appendix E

Fire Effects Dropdown Menu List

Category	Effects
Public health and safety	Evacuation
	Smoke exposure
	Injury
	Contamination– dump burning
	Contamination– other (e.g., fume kill, mine reclamation site)
	Contamination– air quality (other than typical wildland smoke)
	Contamination– drinking water
Service restrictions	Airport disruption
	Energy (hydro, natural gas) disruption
	Economic (tourism, business, employment) disruption
	Area closure(s)
	Road disruption
	Railway disruption
	Emergency service disruption
Public assets	Structure(s) damage
	Recreational caches damage
	Cultural assets damage
	Airport infrastructure damage
	Emergency service infrastructure (e.g., hospital) damage
Commercial assets	Equipment damage
	Transmission line (power, phone, fiber optic) damage
	Tower damage
	Pipeline damage
	Wind turbine damage
	Research plots damage
	Structure(s) damage
	Cut wood damage
	Facilities damage
Resources	Cultural heritage site damage
	Water/ wetland contamination
	Timber damage
	Sensitive area impairment
	Sensitive habitat damage
	Wildlife damage
	Wildlife habitat damage
	Other ecological functions damage
Benefits	Hazard fuel reduction (public safety)
	Resource improvements – rehabilitation (e.g., storm, insect or disease damage)
	Resource improvements – other (e.g., stand renewal, habitat diversity)
	Resource improvements – special (e.g., sensitive habitat improvement)
	Natural ecological functioning

Appendix F

Risk Worksheet Part Two

		Class		Class	% Remaining		Class	% Remaining		Class	% Remaining
Summary of Risk	Baseline Risk = Avg Loss (No Action)	Nil	Remaining Risk = Avg Loss (Monitor Response)	Nil	0%	Remaining Risk = Avg Loss (Modified Response)	Nil	0%	Remaining Risk = Avg Loss (Full Response)	Nil	0%
Summary of Avg. Benefit	Baseline Average Benefit (No Action)	Nil	Remaining Average Benefit (Managed Response--Monitor)	Nil	0%	Remaining Average Benefit (Managed Response)	Nil	0%	Remaining Average Benefit (Full Response)	Nil	0%

Appendix G

Parks Canada Complexity Rating

PARKS CANADA WILDLAND FIRE COMPLEXITY RATING PROCESS

The Parks Canada Wildland Fire Complexity Rating Process provides a method to assess the complexity of wildland fires. The analysis incorporates an assigned numeric rating complexity value for specific complexity elements that are weighted in their contribution to overall complexity. The weighted value is multiplied times the numeric rating value to provide a value for that item. Then all values are added to generate the total complexity value. Breakpoint values are provided for low, moderate, high complexity values. The complexity is worksheet is accompanied by a guide to numeric values for each complexity element shown, provided on the following pages.

Complexity element	***Weighting factor***	***Complexity value***	***Total Points***
Safety	**5**		
Threats to Boundaries	**5**		
Fuels and Fire Behavior	**5**		
Objectives	**4**		
Management Organization	**4**		
Improvements	**3**		
Ecological, Cultural, Social Values	**3**		
Air Quality Values	**3**		
Logistics	**3**		
Political Concerns	**2**		
Tactical Operations	**2**		
Interagency Coordination	**1**		
Total complexity points			
Complexity Value Breakpoints:	***Low***	***40 - 90***	
	Moderate	***91 - 140***	
	High	***141 - 200***	

Complexity Rating (circle) (Related ICS Complexity Type)	L (5-4)	M (3)	H (2-1)

Parks Canada Wildland Fire Complexity Rating Worksheet Numeric Rating Guide

COMPLEXITY ELEMENT	GUIDE TO NUMERIC RATING		
	1	3	5
Safety	• Safety issues are easily identifiable & mitigated	• Number of significant issues have been identified • Safety hazards identified on LACES worksheet & mitigated	• Dedicated Safety Officer required • Complex safety issues exist
Threats to Boundaries	• Low threat to boundary • Boundaries naturally defensible • Shared fire management policies on both sides of boundary	• Moderate threat to boundary • Moderate risk of slopover or spot fires • Boundaries need mitigation actions for support to strengthen fuel breaks, lines • No shared policy, but boundary fire management agreements in place	• High threat to boundary • High risk of slopover or spot fires • Mitigation actions necessary to compensate for continuous fuels • No boundary fire management agreements in place
Fuels/Fire Behavior	• Low variability in slope & aspect • Weather uniform & predictable • Surface fuels (grass, needles) only • Grass/shrub, or early seral forest communities • Short duration fire • No drought indicated	• Moderate variability in slope & aspect • Weather variable but predictable • Ladder fuels & torching • Fuel types/loads variable • Dense, tall shrub or mid-seral forest communities • Drought index indicates normal conditions to mod. drought; expected to worsen	• High variability in slope & aspect • Weather variability & difficult to predict • Extreme fire behavior • Fuel types/loads highly variable • Late seral forest communities or long-return interval fire regimes • Altered fire regime, hazardous fuel/stand density conditions • Potentially long duration fire • Drought index indicates severe drought; expected to continue
Objectives	• Maintenance objectives • Prescriptions broad	• Restoration objectives • Reduction of both live & dead fuels	• Restoration objectives in altered fuel situations

	• Easily achieved objectives	• Moderate to substantial changes in two or more strata of vegetation • Objectives judged to be moderate hard to achieve • Objectives may require moderate intense fire behavior	• Precise treatment of fuels & multiple ecological objectives • Major change in structure of 2 or more vegetative strata • Conflicts between objectives & constraints • Requires a high intensity fire or a combination of fire intensities difficult to achieve

COMPLEXITY ELEMENT	**GUIDE TO NUMERIC RATING**		
	1	**3**	**5**
Management Organization	• Span of control held to 3 • Single fire • No external personnel required	• Span of control held to 4 • Multiple fires managed together • Short-term commitment of specialized resources • External Parks Canada Fire Management personnel required	• Span of control greater > 4 • Multiple fires, multiple management teams • Specialized resources needed to accomplish objectives • External personnel required, including interagency personnel
Improvements to be Protected	• No risk to people or property within or adjacent to fire	• Several values to be protected • Mitigation through planning &/or preparations is adequate • Require some commitment of specialized resources	• Numerous values &/or high values to be protected • Severe damage likely without significant commitment of specialized resources with appropriate skill levels
Ecological, Cultural, & Social Values to be Protected	• No risk to ecological, cultural &/or social resources within or adjacent to fire	• Several values to be protected • Mitigation through planning &/or preparations is adequate • Require some commitment of specialized resources	• Numerous values &/or high values to be protected • Severe damage likely without significant commitment of specialized resources with appropriate skill level

Air Quality Values to be Protected	• Few smoke sensitive areas near fire • Smoke produced < 1 burning period • Air quality agencies generally require only initial notification &/or permitting • No potential for scheduling conflicts with cooperators	• Multiple smoke sensitive areas, but smoke impact mitigated in plan • Smoke produced 2-4 burning periods • Daily burning bans are sometimes enacted during the burn season • Infrequent consultation with air quality agencies is needed • Low potential for scheduling conflicts with cooperators	• Multiple smoke sensitive areas with complex mitigation actions required • Health or visibility complaints likely • Smoke produced > 4 burning periods • Multi-day burning bans often enacted during season • Violation of provincial or federal health standards possible • Frequent consultation with air quality agencies is needed • High potential for scheduling conflicts with cooperators

COMPLEXITY ELEMENT	**GUIDE TO NUMERIC RATING**		
	1	**3**	**5**
Logistics	• Easy access • Duration of fire support < 4 days	• Difficult access • Duration of fire support 4-10 days • Logistical position assigned • Anticipated difficulty in obtaining resources	• No vehicle access • Duration of support > 10 days • Multiple logistical positions assigned • Remote camps & support necessary
Political Concerns	• No impact on neighbors or visitors • No controversy • No media interest	• Some impact on neighbors or visitors • Some controversy, but mitigated • Press release issued, but no media activity during operations	• High impact on neighbors or visitors • High internal or external interest & concern • Media present during operations
Tactical Operations	• No ignition or simple ignition patterns • Single ignition method used • Holding requirements minimal	• Multiple firing methods &/or sequences • Use of specialized ignition methods (terra-torch, AID) • Resources required for up to one week	• Complex firing patterns highly dependent upon local conditions • Simultaneous use of multiple firing methods &/or sequences • Simultaneous ground & aerial ignition • Use of heli-torch • Resources required for > 1 week

		• Holding actions to check, direct, or delay fire spread	• Multiple mitigation actions at variable temporal & spatial points identified. Success of actions critical to accomplishment of objectives • Aerial support for mitigation actions desirable/necessary
Interagency Consultation	• Cooperators not involved in operations • No concerns	• Simple joint-jurisdiction fires • Some resource competition for resources • Some concerns	• Complex multi-jurisdictional fires • High competition for resources • High concerns