Climate Change, Forest Fire Management & Interagency Cooperation in Canada

by

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners. I understand that my thesis may be made electronically available to the public.

Abstract

Climate change has begun to affect the frequency, intensity, and duration of weather related disaster events. This trend may foster a greater probability of encountering 2 or more disaster events simultaneously, increasing the potential to deplete emergency resources. Using Canadian forest fire management as a focal point, this research has determined the extent to which forest fire resource sharing (resources being equipment, fire fighter teams, planes, etc.) has been able to mitigate the impacts of simultaneous forest fire events induced by climate change. Provincial and territorial forest fire management agencies are responsible for forest fire suppression within their jurisdictions, but when fires exceed their suppression capabilities they may request resources from other agencies using resource sharing agreements including: Compact agreements with American States, other international agreements and agreements initiated through the Canadian Interagency Forest Fire Center (CIFFC). If the potential for simultaneous forest fires is neglected, excess fire activity may overwhelm the resource sharing structure.

A historical analysis, 2 case studies, and a survey were employed to uncover information regarding simultaneous forest fires. Moreover, an examination of other resource sharing disciplines was used to uncover new ways of approaching resource sharing issues. The results of this study show that simultaneous fire events have overwhelmed the resource sharing system (during at least two years 1998 and 2003) and that modifications are needed to prepare for the potential increase in forest fire frequency.

Key Words: Simultaneous, Disasters, Forest Fire, Management, Resource Sharing, Emergency Preparedness, CIFFC, Canada

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Dedication

To my amazing family and friends,
for your endless love and support.

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List of Acronyms

CANUS	Canada/United States reciprocal forest fire fighting agreement
CCFM	Canadian Council of Forest Ministers
CCME	Canadian Council of Ministers of the Environment
CIFFC	Canadian Interagency Forest Fire Center
DFAA	Disaster Financial Assistance Arrangements
IPCC	Intergovernmental Panel on Climate Change
MARS	Mutual Aid Resource Sharing agreement
UNISDR	United Nations International Strategy for Disaster Reduction
WUI	Wildland Urban Interface

Chapter 1: Introduction

In coming years the effects of climate change may begin to put pressure on global ecosystems resulting in a higher frequency of natural disasters around the world (Natural Resources Canada, 2007). An evaluation report on Canada's Disaster Financial Assistance Arrangement (DFAA), and a report on weather and climate change created for the Insurance Bureau of Canada, found that the severity and cost of disaster events are also increasing (Public Safety Canada, 2011; The Institute For Catastrophic Loss Reduction, 2012). This trend may increase the probability of encountering disaster events simultaneously, depleting emergency resources faster, obviating existing emergency plans, and disrupting social, environmental, political, and economic structures. Canadian forest fire management is a prime example of such an occurrence. The Canadian Forest Service has even suggested that "as wildland fire activity increases, fire agency suppression efforts will be increasingly strained" (Canadian Forest Service, 2011).

When their own resources and internal sharing capacities are strained, Canadian provincial and territorial forest fire managers most commonly turn to the Canadian Interagency Forest Fire Center (CIFFC) to borrow personnel and equipment, but resources are also shared through bilateral agreements (Compact agreements) between provinces and neighboring US states. This resource sharing system functions best when not all regions are under stress concurrently. For instance, when clusters of forest fires occur simultaneously across the country, the number of resource requests increases and puts strain on the resource sharing system. Yearly forest fire reports from CIFFC have documented situations where all available resources were being used and some resource requests could not be filled (Canadian Interagency Forest Fire Center, 1995; Johnston, 1998, 2002, 2003). The inability

to obtain additional fire suppression resources during simultaneous forest fire events may stifle the ability of an agency to suppress fires effectively, increasing the risk to public safety, property and the environment.

This level of resource strain has only been endured infrequently. However, warmer, drier climates brought on by climate change could increase the potential for greater fire occurrence and more intense fire behavior (Lui, Stanturf, & Goodrick, 2010). If the number of forest fire events increases, there will be a greater chance of encountering forest fires concurrently. Thus the question remains, will Canada's resource sharing system be sufficient to meet the resource sharing needs of all Canadian agencies during simultaneous fire events?

Research regarding simultaneous disaster events has received little attention, mostly because existing research has focused on the effects of climate change on particular disaster events individually (Cardona, Perez, Pulwarty, Schipper, & Sinh, 2012). Recent literature is only now beginning to consider the effects of simultaneous disaster events (Cardona, et al., 2012). In forest fire management, simultaneous fire events have been deemed a contributing factor to the increasing severity and impact of forest fires (Flannigan, Logan, Amiro, Skinner, & Stocks, 2005). However, to the best of my knowledge, from the literature consulted for this study, no research has been done to explore the effects of simultaneous forest fires on Canada's resource sharing capacity. In fact, resource sharing on the whole has been identified by the Wildland Fire Management Working Group as a research gap within forest fire management (R. McAlpine, personal communication, January 5, 2011).

1.1 Problem Statement & Purpose

The effectiveness of fire suppression efforts hinges on each agency's ability to locate and dispatch sufficient resources to forest fires as necessary. Although resource issues are felt

regionally in the provinces and territories, resource sharing issues stretch far beyond any one agency, affecting all of Canada. Therefore, this research required a national scope to explore how simultaneous forest fire events affect Canada's forest fire resource management system. This study intended to answer:

1. How well have existing forest fire resource sharing agreements been able to mitigate the impacts of simultaneous forest fire events in Canada?
2. Will current forest fire resource sharing practices be able to cope with an increase in resource requests if simultaneous forest fire events increase as a result of climate change?

To answer these questions, a series of research methods were used to collect specific information regarding simultaneous forest fire events and resource sharing. A historical analysis of the information available was used to determine in what years these events overwhelmed[1] the resource sharing system. Case studies were then conducted to provide an in depth analysis of 2 of these years. The information collected was useful, but more specific information was necessary to fully grasp the severity of these events. To fill in the gaps, a survey was distributed to provincial and territorial fire managers inviting them to share their opinions and experiences regarding simultaneous events and resource sharing. With all angles of fire management explored, I began researching other resource sharing disciplines (for example inter-library resource loaning) to extract recommendations that could also be applied to forest fire management. This supplemental analysis provided a new perspective to addressing resource sharing issues.

[1] In this study, a resource sharing system is said to be 'overwhelmed', if there are no more resources available to share and that resource requests are not being filled.

Collectively these research methods were used to form conclusions regarding the effect of simultaneous forest fire events. Overall, the intent of this study was to aid Canadian forest fire management agencies in becoming more resilient to the effects of climate change by exposing the true potential for harm concerning simultaneous forest fires.

1.2 Expected Results and Significance

I expected to confirm that simultaneous regional fire outbreaks have had, and will continue to have, a strong negative impact on the effectiveness of Canadian forest fire resource sharing capabilities by examining results uncovered by the historical analysis, case studies, and survey. This research intended to reduce Canada's risk of becoming overwhelmed by multiple forest fire events. Expected results present an opportunity to adapt current methods to better reflect our changing environment.

1.3 Structure of the Thesis

Further chapters include a detailed literature review where current concepts and theories concerning forest fire resource management and climate change are explained, followed by a research methods chapter, outlining specific means of data collection, sampling strategies, and analyses. Then, results from the historical analysis, case study, and supplemental analysis are discussed. Results from the survey are used to justify the relevance of the recommendations extracted from other resource sharing disciplines and can be found in the supplemental analysis section of the results chapter. Implications of the research, conclusions, limitations, and recommendations are discussed in the final chapter.

Chapter 2: Literature Review

2.1 Disasters and Climate Change

A disaster is an event that disrupts a society, impacting its infrastructure, economy, environment and population (United Nations International Strategy for Disaster Reduction, 2007). These events often exceed the ability of a community or region to cope using their own resources (UNISDR, 2007). The timing and severity of a disaster will determine the level of sustained impact. The potential for disaster is derived from a hazard, which can arise from a variety of dangerous phenomenon, human activities, or substances (UNISDR, 2007). The level of risk associated with these events comes from the likelihood of a hazard taking place and the potential for it to result in negative consequences (UNISDR, 2007).

The Annual Disaster Statistical Review of 2007 confirmed an upward trend in the occurrence of natural disasters (Scheuren, le Polain de Waroux, Below, Guha-Sapir, & Ponserre, 2007)**.** While this trend is mainly attributed to an increase in disaster reporting and increased population in hazardous areas, researchers also consider climate change to be a contributing factor (Scheuren, et al., 2007). Since then, the 2011 Annual Disaster Statistical Review has been published demonstrating an increase in the number of victims and in economic losses as a result of disaster events (Guha-Sapir, Vos, Below, Ponserre, 2012). According to the Intergovernmental Panel on Climate Change (IPCC), the impacts of climate change will alter the severity, frequency, and spatial distribution of extreme climactic events (IPCC, 2007). Furthermore, the Panel's 2007 projections suggest an increase in the frequency of droughts, floods, and heat waves (IPCC, 2007). The resultant impacts of this increase are expected to amplify adverse effects on health, food production, and infrastructure, making communities even more vulnerable (IPCC, 2007).

As more climate change evidence is observed, risk alleviation will become a greater priority (Bardsley, 2010). Some communities have attempted to increase their resilience to disasters by implementing more stringent land development regulations or by improving engineering standards throughout the built environment. However, uncertainties surrounding the severity and timing of the effects of climate change (e.g. temperature change, sea level rise, etc) make it difficult to prepare for the future (Bardsley, 2010).

Climate change scenarios will need to be updated frequently so that government policies can be created or altered to better suit changing conditions (Adger, Arnell, & Tompkins, 2005). Fundamental strategies for creating a climate change resistant system include mitigation, which focuses on carbon emission reduction; and adaptation, which attempts to prevent avoidable impacts (Fussel & Klein, 2002). Early implementation of mitigation strategies will maximize the opportunity to reduce future risks and impacts (Williamson & Johnston, 2009). However, since damage to our environment has already been done, adaptation is necessary to prepare for the changes that are already in motion (Parry, et al., 2001).

Disasters would still occur even without the worsening effects of climate change. In order to protect people from disasters, 4 stages of emergency management have been developed: mitigation, preparedness, response, and recovery (Wang, Tepfenhart, & Rosca, 2009). Mitigation refers to prevention or reduction of a hazard[2]. Preparedness comes from the development of clear procedures and plans of action to be used during and after the event. Response includes the mobilization of first responders and resources to the affected areas.

[2] Note the distinction between disaster mitigation and climate change mitigation. Disaster mitigation is intended to prevent hazards from developing into disasters, while climate change mitigation is meant to reduce green house gas emissions.

The final stage, recovery, involves helping those affected and rebuilding that which was destroyed.

Responding to or recovering from disasters requires specific resources. Required resources can range from heavy land-based equipment, to consumables such as sand bags, to light equipment like shovels or protective gear, to human resources or laborers. The scale and type of disaster will determine the amount of damage that ensues and the kinds of resources needed in response. Low intensity or small scale events typically require fewer resources than large scale destructive disasters, which can strain the resources and funding available for response and recovery (The World Bank Hazard Mitigation Unit, 2006; Rottkemper, Fischer, Blecken, & Danne, 2011).

Resources become all the more unavailable when disaster events happen simultaneously. It is more common to encounter small scale or low intensity events simultaneously because they happen more frequently. However, there have been instances in the past where large disasters have occurred simultaneously. For example, the Global Red Cross Network responded to five nearly simultaneous disasters in the Asia-Pacific region in 2009 including: a typhoon in the Philippines, Vietnam, Cambodia and Laos (Sept. 26); an earthquake and subsequent tsunami in the Pacific Islands of Samoa (Sept. 29); an earthquake in Padang, Indonesia (Sept. 30); and another earthquake in Jambi, Indonesia (Oct. 1) (American Red Cross, 2009). Since these disasters happened within days of one another, personnel, equipment, and money for response and recovery were in high demand, increasing the pressure to find and distribute resources from depleting stocks. With climate change further altering our capacity to effectively manage natural disasters (Public Safety Canada, 2003) it will become increasingly difficult to manage disaster situations effectively.

2.2 Climate Change and Forest Fires

Forest fires can shape our landscapes, change biological cycles, alter ecological compositions, risk human safety, and reduce the economic potential of a forest (Flannigan, Stocks, & Wotton, 2000). They are also the most economically damaging of all climatological disasters (Scheuren, et al., 2007). In order to prepare for climate change and explore simultaneous forest fire events, forest fire management was deemed the focal point of this study.

Several researchers have predicted that, by the end of the century, climate change will have made significant impacts on temperature and precipitation levels, increasing the risk of wildfires (Flannigan, et al., 2000; Lui, et al., 2010). Furthermore, factors affecting fire intensity (e.g. wind and dry fuel loads) have been aggravated by climate change conditions (UNISDR, 2007). The duration of the fire seasons and total area burned are also expected to be affected (Lui, et al., 2010). Others predict greater variability in the amount of fire, estimating that some areas will experience more forest fire, while others will see a decrease (Flannigan, et al., 2000). It is expected that these changes will produce unknown assemblages of species (Flannigan, et al., 2000) and alter the structure of the forest (Hessburg, Agee, Franklin, 2005). Changing the ecological aspects of these areas will make it more challenging to predict how forest fires will spread within these areas.

Successful forest fire management and organization can be achieved with careful and detailed planning in advance of an event (Chandler, Cheney, Thomas, Trabaud, & Williams, 1983). Seasonal severity ratings and fire weather indexes can help estimate the difficulty of control and the level of fire danger based on seasonal means and fuel types (Flannigan, et al., 2000). The types of systems, and the ways in which they are used to manage forest fires,

varies by country and even by region. Every country will experience climate change differently and will deal with forest fire management and suppression in its own way. Problems arise when extreme conditions exhaust fire suppression resources, lowering the success rate of initial fire suppression attacks. As conditions worsen, the world will look to leaders in forest fire management like Canada, the United States, and Australia, for guidance.

2.3 Forest Fires and Climate Change in Canada

Warming trends in the Northern hemisphere began in the 1850s. After a cooling period between the 1940s and the 1970s, warming trends began to accelerate, and have since become a worldwide issue (Girardin & Mudelsee, 2008). The Canadian Council of Forest Ministers (CCFM) warned that global warming will increase fire activity (Canadian Council of Forest Ministers, 2005). Indeed, the number of fires in Canada has increased steadily since the 1960s, while the area burned has tripled since 1980 (Simard, 1996). Analysis of General Circulation Models from 2 different sources show how changing weather conditions may contribute to a greater area burned in Canada. Much of this increase is thought to be as a result of climate change (Gillett, Weaver, Zwiers, & Flannigan, 2004; Flannigan, Logan, Amiro, Skinner, & Stocks, 2005). Moreover, Simard's preliminary research suggests, "longer fire seasons, more severe fire weather[3], and earlier season start-up, particularly in Western Canada" can be expected (Simard, 1996, p. vii). The number of forest fires is also expected to be above long term averages, impacting the forest industry, community protection, recreational activity, and overall carbon budgeting (Girardin & Mudelsee, 2008). Furthermore, it has been suggested that climate change may have accelerated the unprecedented epidemic of the mountain pine beetle in Western Canada, causing significant

[3] Fire weather forecasts provide information to determine fire danger and fire behavior by combining the initial spread index and the buildup index.

damage to forests and making them more susceptible to fire (Williamson, et al., 2009). Overall, the research has suggested that the effects of climate change have (and will continue to) increase the frequency and severity of forest fires.

Purchasing more fire suppression resources has been suggested as a method to cope with the increased amount of fire (Girardin & Mudelsee, 2008). Contrarily, it has been argued that increasing fire suppression expenditures would lead to decreasing marginal returns (Flannigan, Stocks, Turetsky, & Wotton, 2009). Furthermore, even if more resources were puchased, approximately 50% of Canada's permanent fire management staff is due to retire between 2006 and 2016 (Simard, 1996), leaving fewer staff to manage the added resources effectively. This problem has been identified by the fire management community and efforts are being made to find solutions (Natural Resources Canada, 2007).

Fire management, "is not an end in itself, but is only a means to reduce the land manager's risk of loss due to fire damage and increase benefit from proper use of fire" (Chandler, et al., 1983). It is critical to consider all confounding effects that could reduce or intensify the effects of climate change on forest fire conditions (Flannigan, et al., 2009). Researchers predict a gradual reassessment of priorities will be used to decrease the total number of suppression resources needed (Flannigan, et al., 2009). Since fires provide a regeneration process that reduces debris and allows for new growth (UNISDR, 2007), remote areas are being left to burn naturally as a method of reducing the need for fire suppression and encouraging natural ecological functions (Flannigan, et al., 2000). However, if a patch of forest is likely to experience fire and is in close proximity to a populated area, priorities change, and rather than leaving it to burn naturally, prescribed burning could be used. This method of fire management is done by cordoning off an area that is already likely to burn and

burning it under optimal weather conditions under the supervision of trained professionals. Ideally, by allowing a greater number of natural fires and increasing the number of prescribed fires, there will be fewer fires that escaped fire suppression[4] left to manage.

Regardless of the various strategies used to manage fire, fire suppression will remain necessary. While Canada's current fire management practices have proven invaluable, some researchers believe that agencies will not likely be able to maintain current levels of effective suppression (Hirsch & Fuglem, 2006). Agencies need to find a way to cope with the effects of climate change because "waiting for evidence [of climate change] virtually guarantees failure" (Canadian Forest Services, 1997, p. vii).

2.4 Forest Fire Management & Resource Sharing in Canada

In 1867 the British North America Act defined natural resources as a provincial jurisdiction. Organized fire protection in Canada emerged as a provincial/territorial or 'agency' responsibility in the 1930s following a series of devastating fires (Flannigan, et al., 2009). Each agency dictates its own fire management plan to best suits its geographical location, budget, and fire suppression needs. Agencies are also responsible for collecting weather information and producing a fire-weather index for their jurisdiction. In contrast, the federal government is responsible for forest fire research, managing fire on federal lands, and regulating various international and interagency matters (Simard, 1996). The demand for both provincial and federal level fire management has increased as Canada's population and industry have grown. Through growth and innovation from the 1930s to now, Canada has established itself as a world leader in forest management (Flannigan, et al., 2009).

[4] When a fire surpasses the suppression capabilities of an initial attack it becomes an 'escaped fire' and requires more extensive suppression.

Forest fire suppression ("fire fighting") is a necessary fire management strategy, with the primary purpose to safeguard the lives of people who are threatened by fire and their properties (Chandler, et al., 1983). These efforts are directed by each agency's forest fire manager who makes critical decisions based on professional experience and outputs from information systems (Wotton, 2009). Information technology has substantially improved fire weather tracking and predictions, daily monitoring of local level fire events, and seasonal monitoring of national fire events, resulting in more effective and efficient decision making (Lee, et al., 2002). For example, the Canadian Forest Fire Danger Rating System is a non-spatial system that provides a scientific framework for forest fire danger rating (Lee, et al., 2002). Other spatial applications, like the Canadian National Forest Fire Management Information System, produce daily wildland fire conditions (Lee, et al., 2002). The Canadian Forest Fire Weather Index uses daily satellite imagery to determine "hotspots" throughout Canada (Martell, Drysdale, Doan, & Boychuk, 1984). These aids allow for better recognition of patterns within the fire data (Lee, et al., 2002). All of this information is collected in a data-warehouse from which information can be shared between various forest knowledge domains including, policy, forest management, fire science, ecosystem health, global change and economics (Lee, et al., 2002).

When forest fires start within a municipality, municipal and volunteer fire departments use their own resources to suppress them (Hirsch & Fuglem, 2006). Unfortunately the number of fires suppressed by local fire departments in Canada is not accounted for in national reporting (Hirsch & Fuglem, 2006). Their contribution is believed to be significant (Hirsch & Fuglem, 2006); however, when a fire exceeds the capability of a municipality, it requests provincial assistance to supplement resource needs.

On a broader scale, inter-provincial/territorial resource sharing options have proven to be invaluable regarding fire suppression during extreme fire events (Simard, 1996). The Canadian Interagency Forest Fire Center (CIFFC) is a non-profit organization established in 1983 to facilitate forest fire resource sharing amongst provinces and territories in Canada using the Mutual Aid Resource Sharing (MARS) agreement (CIFFC, 2007). CIFFC has also established resource sharing with the United States through the Canada/United States Reciprocal Forest Fire Fighting Agreement (CANUS) (CIFFC, 2007). Natural Resources Canada has described CIFFC's relevance as being "irrefutable," as it is one of the few cost effective ways for individual agencies to obtain the resources they need when their own resource stocks are insufficient (Natural Resources Canada, 2007). Two-thirds of CIFFC's funding comes from participating agencies while the federal government contributes one-third of the total budget up to $200,000, limiting the budget to $600,000 (CIFFC, 2007; Natural Resources Canada, 2007). Average annual expenditures from the 2001-2005 fire seasons were well over the maximum budget at $618,000 (Natural Resources Canada, 2007). Furthermore, the number of resource requests submitted to CIFFC has increased from 50 in 1997, to 150 in 2003 and up to 250 in 2008 (CIFFC, 2008). With the onset or acceleration of climate change, the fire situation could worsen and put more pressure on existing budgets. In an attempt to ameliorate problems within the resource sharing system, CIFFC initiated national equipment and training standards to facilitate more efficient resource sharing (Canadian Forest Services, 1997). CIFFC also began tracking unfulfilled resource requests in 2006 to evaluate the condition of the sharing structure (Natural Resources Canada, 2007).

In addition to CIFFC's national sharing regime, most provinces also share forest fire resources with neighboring American States using Compact agreements. These agreements

permit resource sharing between countries without jurisdictional debate. There are currently three compacts in effect: the Northeastern, Northwestern, and Great Lakes Compacts (Sackinger, 2005). These compacts have an advantage over the MARS and CANUS agreements because the Provinces and States can request resources immediately, without going through CIFFC's procedures (Sackinger, 2005). Table 1 explains each Compact agreement, outlining its partners, history, and goals.

Table 1: Compact Agreement summary

Partners	History	Goals
Northwestern Compact		
Alberta, British Columbia, the North West Territories Saskatchewan, Yukon, Alaska, Idaho, Montana, Oregon, and Washington	The Northwest Wildland Fire Protection Agreement was ratified and signed by each member agency in 1998.	Assist in preventing forest fires, training, pre-suppression, suppression, and controlling wildland fires in all partnering agencies. For initial attacks, operating plans may be developed to determine the closest forces available. This agreement does not override existing cooperatives e.g. MARS or CANUS (NWFP, 2012).
Northeastern Compact		
Maine, New Hampshire, Vermont, New York, Massachusetts, Connecticut, Rhode Island, Quebec, New Brunswick, Newfound Land, and Nova Scotia	In 1947 ravaging fires in New England created a cause for concern regarding suppression resources. Two years later, the US Congress passed and Act to allow for a regional compact to be created to prevent and control Northeaster forest fires. Seven states joined between 1949 and 1950. Quebec joined in 1969, New Brunswick in 1970, and Nova Scotia in 1996 (NFFPC, 2012).	The Northeastern Compact has established procedures to facilitate resource sharing between all member agencies. Fire related information and updates to technology are also shared. The Compact has a central agency that coordinates necessary services and develops forest fire plans (NFFPC, 2012).
Great Lakes Compact		
Michigan, Minnesota, Wisconsin, Ontario, and Manitoba	In 1983, fire managers from the Great Lakes came together to discuss mutual concerns and needs. In September 1989, Ontario, Michigan, Minnesota and Wisconsin signed the first agreement and the Great Lakes Forest Fire Compact was officially established. Manitoba requested to become a member in 1998 (GLFFC, 2012).	The Great Lakes compact promotes the sharing of ideas, new technology, tools, personnel and resources. Specific exchange proposals include: goals and objectives, identification of the sending and receiving agencies, and identification of specific resources, teams or individuals to participate. Upon completion of each exchange, a report is prepared to review lessons learned (GLFFC, 2012).

For both CIFFC and the Compact agreements, agencies are not obligated to share resources with one another. If they choose to share, agencies can also recall their resources from other agencies, as needed (Sackinger, 2005). The purpose of all forest fire resource

sharing agreements is the same: to assist in the prevention, preparedness, and control of wildland fires between member agencies. However, each agreement differs in terms of sharing boundaries, financing and membership requirements (Sackinger, 2005). It is essential that each agency has enough resources for routine and above average fire loads. The more an agency relies on outside sources, the more strain there will be on the resource sharing system. This excess strain could lead to an increased number of escaped fires and result in higher fire suppression costs (Simard, 1996).

In addition to resource sharing between Canadian and US agencies, other means of sharing resources outside of North America have been used in times of great desperation. Canada's only other international agreement is between British Columbia and the State of Victoria, Australia, which was signed in 2006 (Forest Service British Columbia, 2011). However, it is anticipated that with increased fire suppression needs, more agencies will be looking to partner with other international sources with countries who's fire seasons are opposite to that of Canada, particularly those in the southern hemisphere. If climate change causes dramatic implications for forest fire occurrence, it will be imperative that Canada tests its global collaborative strengths.

Cooperation and commitment have become central ideals within Canadian forest fire management. These ideals have transformed local fire management issues into national and even international fire management issues. Agreements made through CIFFC, with Compact partners, and through other international means will only become more important as climate change begins to alter Canada's fire regime.

2.5 Political & Social Aspects of Forest Fire Management

Canada is a forest nation with a forestry industry intimately linked with its cultural, economic, and social development (UNISDR, 2007). As the world's largest exporter of forest products, Canada received $20 billion in trade in 2008, contributing to 1.9% of the GDP, and creating employment for over 270 000 people (Canadian Council of Forest Ministers, 2009). Fire accounts for a quarter of Canada's forest management costs and burns about as much wood annually as is harvested (Simard, 1996). Communities that are supported by Canada's forestry industry, people who choose a rural lifestyle, and aboriginal people for whom this forest is home, are particularly vulnerable to the effects of forest fire (CCFM, 2009).

Efforts have been made nationally to formulate common goals and principles to enhance wildland fire management. The Canadian Council of Forest Ministers (CCFM) established the Canadian Wildland Fire Strategy to unify efforts towards fighting fires nationally (Hirsch & Fuglem, 2006). The biggest challenge identified by this strategy has been initiating collective responsibility while maintaining the autonomy and diversity of individual provinces and territories (Hirsch & Fuglem, 2006). The federal government does not have the power to impose solutions on provincial and territorial fire management agencies. Therefore, if even 1 of the 13 fire management agencies opposed an idea, nothing can be changed.

From a societal perspective, the increase in forest fires will likely cause greater risk to people and property (Flannigan, et al., 2000). The Wildland Urban Interface[5] (WUI) is a growing concern and a major driver of suppression costs (Sackinger, 2005). With sprawling development and increased population, more people are living on the edge of fire prone

[5] The Wildland Urban Interface is the area in which forested lands coincide with developed areas.

areas, making a larger portion of the population vulnerable to the devastating effects of forest fires (CCFM, 2005). Indeed, demographic trends show that people will continue to seek development opportunities in these areas, suggesting that this issue will only worsen over time (Sackinger, 2005). Fire in these areas will increase the loss of property and infrastructure and threaten more community evacuations. Moreover, fires can also have a negative effect on people's health, for instance, smoke inhalation can cause respiratory problems (Flannigan, et al., 2000).

Even though many Canadians associate their cultural identity with forests or forestry, the number of people who have experience or knowledge regarding forests and the dangers of forest fire is quite low. Knowing the correct protocol to follow during a forest fire can, and has, reduced the risk to people living in fire prone areas. Programs like FireSmart, teach the public how to prepare their homes for upcoming fire seasons. For example, the program demonstrates the importance of clearing leaves and other debris from around their properties so as to diminish the amount of fire fuels near homes (FireSmart Canada, 2012). The benefits of the FireSmart program include: reducing the risk of fire endangering homes, improving property value, facilitating community relationships with local fire staff, and offering peace of mind (FireSmart Canada, 2012). If properly disseminated, these kinds of programs can easily translate into positive action (Martin, Raish, & Kent, 2008).

2.6 Simultaneous Forest Fires

The severity and impact of a forest fire is dependent on a number of factors including: the type of landscape, the amount and type of fuel, timing, suppression priorities, the location of fires, type of ignition, weather, and presence or absence of simultaneous fires (Flannigan, Logan, Amiro, Skinner, & Stocks, 2005). Simultaneous fires present a uniquely stressful

situation due to the combination of limited resources and multiple resource requests which diminishes available resource stocks. Management of simultaneous fires requires precise orchestration of rapidly changing and contending demands (Laufer, Denker, & Shenhar, 1996). Unfortunately, given the extent of fluctuation in fire activity throughout Canadian regions, organization and pre-placement of resources can be difficult (CCFM, 2005). CIFFC daily national fire situation reports help by determining the level of response required throughout the country (Table 2). Level IV indicates that 2 or more regions require mobilization of resources. Level V indicates that several regions face major events that have the potential to exhaust national resources (Natural Resources Canada, 2007).

Table 2: National Preparedness Levels

	Level 1	**Level 2**	**Level 3**	**Level 4**	**Level 5**
Agency Fire Hazard	Low	Low-Moderate	Moderate - High	High - Extreme	Extreme
Current Fire Load	Low	Low-Moderate	Moderate – High	High	High - Extreme
Anticipated Load (7 Days)	Low	Moderate	High	High - Heavy	Heavy
Agency Resource Levels	Adequate	Adequate	Some Assistance	Assistance Required	Inadequate
CIFFC request for Mutual Aid; Response Level	Excellent	Good	Moderate - Poor	Poor – nil	nil
Potential for international assistance	nil	nil	nil	Increasing	Consideration

(After: Natural Resources Canada, 2007)

Levels IV and V are reached regularly in a typical fire season (Natural Resources Canada, 2007). CIFFC personnel have indeed admitted that, during times of high fire activity across the country, requests for additional resources go unfilled (Natural Resources Canada, 2007). With the increasing strain on resource sharing, the continuing effects of climate change, and the rising challenges within the WUI, it can be assumed that resource sharing pressures will continue to grow and that instances of unfilled resource requests will become more common.

2.7 Chapter Summary

Canadian fire management has been largely successful because of its ability to share fire suppression resources. Resource sharing is a good way of limiting the costs of fire suppression in individual agencies, but it has limitations. Over the years the number of resource requests made by individual agencies has increased (CIFFC, 2008), suggesting that agencies are becoming more dependent on external resources. Sharing resources will no longer be effective if there are not enough resources available to meet incoming requests. Although Canada has dealt with unfilled requests in the past, Canadian fire management is not yet accustomed to encountering these events more consistently.

Research throughout the remainder of this study was developed using the concepts and knowledge accumulated in this chapter. Without a clear understanding of the issues at hand, it would have been difficult to further explore this issue. The following chapters set out to examine the effects of simultaneous forest fire events.

Chapter 3: Methodology

3.1 Research Design

The research methods used in this study were designed to analyze how agencies have contended with simultaneous forest fires in the past and how resource sharing practices could be modified to cope with the threat of climate change. Two main challenges emerged from the research: 1. The scope of the issue stretches beyond the borders of any one fire management agency, so it was necessary to take on a national perspective; and 2. Specific resource request information regarding filled and unfilled requests only started being collected by CIFFC in 2006 (Natural Resources Canada, 2007). To overcome these challenges several different research methods were employed in an attempt to triangulate the results from each method. Approaching the main issues from multiple angles provided many perspectives of the same issue, ensuring that the topic had been explored in its entirety. The following three research methods were combined to explore issues of simultaneous forest fire:

Historical Analysis: Using fire statistics and the resource sharing information available, a historical analysis was completed to confirm whether simultaneous forest fire events have hindered the effectiveness of Canada's forest fire resource sharing system in the past.

Case Studies: Two years were identified by the historical analysis in which resource sharing was significantly affected by simultaneous forest fires. Two case studies set out to explore how other extreme events or disasters (floods, storms, pandemics, etc.) might have further aggravated the resource sharing process.

Survey: A survey was circulated to all Canadian fire managers responsible for provincial or territorial fire management to obtain their perspectives on the following:

- Climate change
- Simultaneous forest fire events
- Resource sharing procedures
- Potential modification to the resource sharing system

3.2 Historical Data Collection

Identifying Simultaneous Forest Fires

Inductive analysis is an approach that uses detailed readings to derive themes through interpretations made by the researcher (Thomas, 2006). In using this method, theory emerges from the data; as opposed to deductive analysis where data are used to test a theory (Thomas, 2006). For this analysis, inductive coding was used to extract critical information from CIFFC's yearly fire reports. These reports provide a rough description of the year's events, including details about when resources were shared and between whom they were shared. The purpose of extracting this information was to investigate instances when: national resources were low and resource requests were not readily available; or, when stocks were depleted and could not meet the national demand. Low or insufficient stocks indicated that the resource sharing system was under significant stress. A fire event was deemed "simultaneous" if more than one agency was requesting external resources at the same time.

Detailed chronological information regarding resource requests and distribution was intermittent throughout the yearly reports: exact dates were rare. In some instances only weeks of the month were revealed, such as, "during the third week of August". To confirm

the information found in the yearly reports, dates were compared with those found in weekly reports (1998-2011) from the Natural Resources Canada website. Disparities between yearly and weekly reports highlighted any inconstancies. With a more accurate assessment of the timing of resource sharing it was easier to identify instances of simultaneous events.

Coding & Information Collection

Inductive coding uses a series of categories and codes to collect information from qualitative sources (Thomas, 2006). Categories are used to explain key characteristics of what is being searched (Thomas, 2006). Once categories are established, codes (or key words) are assigned to better illustrate the critical issues under study (Thomas, 2006). The challenge is determining appropriate codes. The reader may already have key words in mind, but each code chosen likely has similar words or phrases that can mean the same thing. Only by reading the text initially can these synonyms be identified and included in the list of codes. It is also important to read the text carefully because there are often other codes that the reader may not have thought to include initially.

All CIFFC yearly reports from 1993 to 2009 were studied to identify codes that would highlight instances when the resource sharing system was under stress. Five categories were created (e.g. unfilled, supply, sharing, agreements, and North America) to focus the search for codes. After careful consideration of the language used in the reports, each category was assigned a list of codes. For example, "Compact agreements" was a code under the "Resource Sharing Agreements" category.

To ensure accuracy, a computer word search function was used to highlight each code within the reports. Highlighted words were counted and examined to verify that each word was being used in the right context. Tallies of each code were compiled to determine which

codes were identified in which years (Appendix A). It was assumed that the years with the highest number of key words had experienced a higher level of resource sharing stress than years with fewer key words.

The coding process was able to clearly identify 4 years in which simultaneous events caused significant stress within the resource sharing system, namely 1998, 2002, 2003, and 2006. However, inherent biases embedded in the coding process still required attention. Electing to use one category or one key word over another, for example, could have been a source of bias. There was also a chance that some key words or phrases were overlooked by the researcher. As such, a 'data triangulation' method was employed to eliminate biases by comparing results from the inductive coding process with other forest fire and resource sharing information. The purpose of the data triangulation process was to find out whether the 4 years identified in the coding process were accurate.

Each variable used for data triangulation needed to bring forth information that would further indicate which years had the worst fire season in order to be deemed applicable for this comparison (Table 3). Also, it was necessary to have a consistent time frame so that the new information could be compared with the results from the coding process, so the data collected was limited to years between 1998 and 2009[6]. Information was then ranked to identify the worst fire years. Given that each variable had its own unique characteristics, it was expected that top ranked years for each variable would not be completely consistent.

[6] CIFFC yearly reports were available from 1993 to 2009. Weekly reports from Natural Resources Canada were available from 1998 to 2011. Thus the available range of dates for all data sets considered was 1998-2009.

Table 3: Variables for data triangulation process

Variable/Source/ Years available	How the information applies	How the information was ranked
Number of resources mobilized, Natural Resources Canada website, 1998-2011	The higher the number of mobilized resources, the more stress there will likely be on the resource sharing system.	The information was organized in graphs by week. The three years with the highest number of resources mobilized in a given week were deemed significant.
Number of agencies mobilized (sending & receiving), Natural Resources Canada website, 1998-2011	The more agencies being mobilized, the more stress the sharing system has to endure. This information is also evidence that agencies have experienced simultaneous forest fires because there are several instances where more than one agency is requesting external aid.	Any years that had 11 agencies sending or 7 agencies receiving resources from other agencies (in one week) were deemed significant.
Area Burned (ha), National Forestry Database, 1970-2010	A higher than average area burned is a sign of stress indicating there may not have been enough resources to suppress the fires sustained.	The three years with the highest total area burned within a given year were deemed significant.
Number of fires, National Forestry Database, 1970-2010	More fires often equate to increased stress on an agency's suppression resources and could identify years when simultaneous forest fires were more likely to occur.	The three years with the highest total number of fires to start in a given year were deemed significant.
Property loss, National Forestry Database, 1970-2010	Forest fires do not always result in property loss but this information provides an indication of the severity of fire damage.	The three years with the highest amount ($) of property damage were deemed significant.
Fire management budget, B. Stocks unpublished document, 1970-2009	Years with high variable costs suggest there was a large event that required a high amount of fire suppression.	The three years with the highest budgets were deemed significant.

Once all the variables were ranked, results were complied into a table to facilitate a comparison of all the forest fire variables assembled. Table 4 clearly identifies which 2 years experienced the highest level of resource sharing stress as a result of simultaneous forest fires. These 2 years were selected for case study analysis.

Table 4: Comparison of forest fire variables

	Inductive Coding Results	Number of Resources Mobilized	Number of Agencies Mobilized		Area Burned	Number of Fires	Property Loss	Variable Budget	Tally
			Sending	Receiving					
1998	x	x	x	x	x	x		x	7
1999				x			x		2
2000									0
2001									0
2002	x				x				2
2003	x	x	x	x		x	x	x	7
2004			x		x				2
2005									0
2006	x			x		x			3
2007									0
2008							x		1
2009		x						x	2

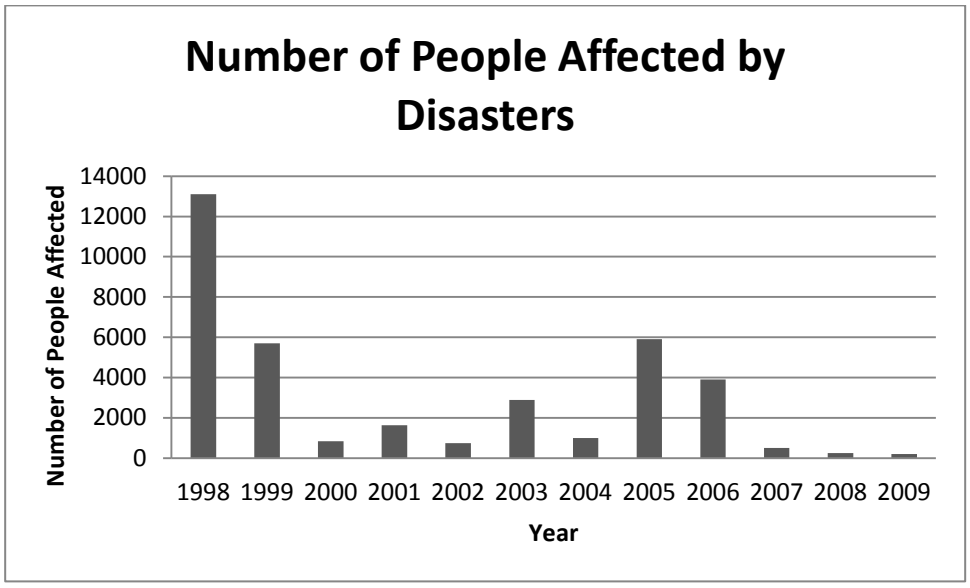
3.3 Case Studies

Case studies are used when there is little or no control over the event in question and when the goal is to determine how or why something happened (Yin, 2003). The historical analysis identified 1998 and 2003 as the 2 years most affected by simultaneous forest fires, making them the most suitable choice for case study analysis. The purpose of the case study was to examine more factors (other than those examined in the historical analysis) that might have contributed to the increase in stress within the resource sharing system.

Originally the case study analyses focused on the influence of politics, society, the environment, and economics on forest fire resource management. It was hypothesized that a better understanding of these aspects could reveal additional stressors that might have exacerbated the stress of coping with simultaneous forest fire events. Had solid evidence been discovered that suggested these factors had contributed to increased stress it could have opened up new avenues for future research.

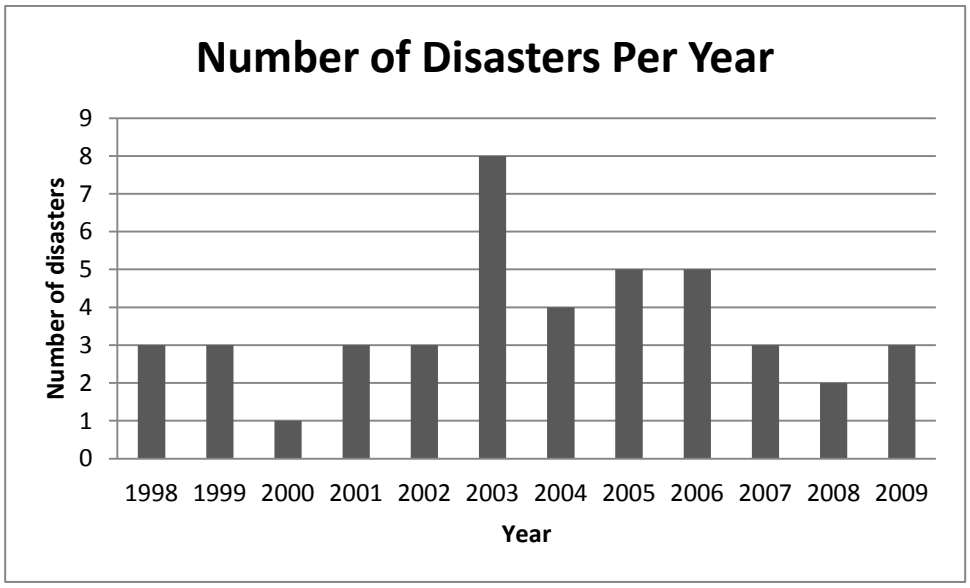
After a preliminary investigation of both years it was determined that the scope of the search was too broad and that most aspects revealed very few significant stressors. As a result, I focused the case studies on the one factor that stood out: other crisis or disaster events. Each of the 2 years experienced a number of disaster events (other than forest fires) in Canada that were identified in the international disaster database run by the Center for Research on the Epidemiology of Disasters (See Appendix B for CRED disaster selection criteria). In order to be sure that this level of disaster occurrence was not common in all years, I searched the disaster database for all the events that happened between 1998 and 2009 (inclusive). Looking at the number of people affected by each disaster and the total number of disasters per year, it was obvious that the events of 1998 had affected the highest number of people, and that 2003 had encountered more disasters than any other year (Figures 1 & 2). From this analysis, a new hypothesis emerged: disaster events, other than forest fires, drained nationally available emergency management resources and financial support, adding to the stress of forest fire resource sharing in both case study years.

Figure 1: Number of people in Canada affected by disasters between 1998 and 2009 (CRED)



(Data extracted from EM-DAT: The OFDA/CRED International Disaster Database – www.emdat.be – Université catholique de Louvain – Brussels – Belgium)

Figure 2: Number of disasters per year between 1998 and 2009 in Canada (CRED)



(Data extracted from EM-DAT: The OFDA/CRED International Disaster Database – www.emdat.be – Université catholique de Louvain – Brussels – Belgium)

The investigation

For each case study year, a list of crisis or disaster events was compiled and the details of each event were examined. An event that disrupts a society, impacting its infrastructure, economy, environment and population constitutes a disaster. The timing, severity, and outcome of each event were noted. The 2 factors under consideration (resource sharing and financial support) were then investigated to find any parallels between these events and the forest fire events of that year.

From a resource sharing perspective, the intent was to find out whether resources needed during one event were strained or unavailable because they were being used for other events. From a financial perspective, the intent was to determine if the financial support given to one event meant that there was less money available to cope with other crisis or disaster events within the same year. The overall intent of this case study was to establish potential stressors that could have negatively affected the forest fire resource sharing system. If the hypothesis was correct, these types of events could be monitored more closely to signal when the resource sharing system might be hindered in the future.

3.4 Survey

Details regarding resource sharing and simultaneous forest fire events are not typically discussed in agency reports, research papers, or in the news. Therefore, it was necessary to obtain information about these subjects directly from all provincial and territorial fire management agencies. The information collected was used to clarify dates, times and severity of simultaneous events, and to indicate how each agency dealt with the increased strain on their resources.

Sample Size & Population

Few people have the requisite knowledge of forest fire resource management to respond to this survey. As a result, purposive sampling was used to recruit suitable participants. It was assumed that people with the highest level of responsibility also held the most seniority, and thus the most knowledge regarding forest fire management. The population for the survey was to include the head forest fire manager from each Canadian province and territory[7]. These 12 individuals have the most control over critical decision making regarding forest fire suppression. Understanding their position on the subject is invaluable to a clear explication of the situation, and is necessary for developing appropriate modifications to the resource sharing system.

To ensure equal representation, participation was limited to one fire manager from each of the 12 agencies. Adding further participants to the study would have increased the potential for an uneven representation (for example if a province prone to fire had one respondent and a province with very little fire had five respondents, the results would have been skewed).

Survey Type

Several survey options were considered, including phone, web-based, and emailed surveys. In the interest of time, cost and simplicity, emailed surveys were chosen. This type of survey was easy to distribute and recover from respondents, especially considering the small sample size. The structure of the survey gave participants the time to complete it at

[7] Nunavut does not experience enough forest fire activity to warrant a fire management program. Parks Canada is also considered its own agency but because their lands are federally owned and so dispersed, they were not included in this analysis.

their own pace, allowing them to look up information if they needed to. The fill-able Microsoft Word form was attached to an email which could then be opened, completed by the managers, and returned to me via email.

Survey Creation

The purpose of the survey was to collect information that was not available in the literature or reports. A question web[8] was created to brainstorm missing information (Appendix C). The results of this exercise yielded a list of questions that needed to be answered by the survey. This list of questions was refined after a discussion with the Director of CIFFC. With his guidance, a more comprehensive set of survey questions was assembled.

To evaluate the clarity and content of a survey, researchers often employ pilot studies on a small subsection of their population. Unfortunately, the small sample size of my study precluded this. Instead, CIFFC's Director was able to review the survey, verifying the logic and language used, and eliminating any obvious biases.

In terms of ethical considerations, it was made clear to participants in the recruitment email and comprehensive cover letter (Appendices D & E), that their participation was voluntary and that no personal identifiers would be collected (for example the respondents name, email address, or agency). By completing the survey, it was assumed that the participants had given their consent to use the information provided. Ethics approval was obtained through the Office of Research Ethics at the University of Waterloo. Each participant was sent a thank you message following their submission (Appendix F).

[8] Question webs are used to break down broad questions into subsets of more detailed questions.

Questions

The survey was divided into five sections. In the first section, multiple choice, contingency, open ended, and Likert scale questions were used to gauge opinions on climate change and forest fires. The second section included multiple choice and ranking questions to explain how each agency uses, requests, and shares resources. The third section used multiple choice, multiple choice matrices, and Likert scale questions (with space for commenting) to collect information regarding their agencies standard resource sharing practices. The fourth section assessed the willingness of agencies to modify current fire management practices. Eleven different suggestions were provided in the fourth section (in each case some were very simple, others more complex) to gauge how well each idea might be received if they were recommended by this study. The final section was a space for comments and additional information.

Several question types were used to collect specific information and to keep participants interested. Questions were generally used to gauge participants' perspectives, prompting them to reflect on how their agencies are managed and how modifications to current practices could help mitigate the strains of simultaneous forest fire events on resource sharing.

Distribution, Collection & Analysis

The Director of CIFFC agreed to deliver the survey by email to all 12 fire managers (it was presumed that fire managers would be more inclined to respond to a colleague). Participants were to read the information, fill out the survey on the Word form, save their responses, and email the completed form back to a designated email address. After two or

three reminders via email or phone call, 11 of the 12 fire managers responded to the survey. The manager that did not respond was from a small jurisdiction. Each survey received was saved to a computer with all personal identifiers removed.

Analysis was completed using descriptive statistics and cross tabulation analysis techniques. Different methods of analysis were used for each of the question types included. With such a small sample size, the use of inferential statistical analysis was very constrained.

3.5 Supplementary Information

Phone calls and email communication were used in various instances throughout this study. This method of information collection was necessary because some knowledge was not available in the literature. Whenever this method was employed, a citation was used to note that the source of information had been obtained through 'personal communication'.

Each of the individuals contacted was qualified to answer the questions. Each individual was informed that the information they provided might be used for the purpose of this study.

3.6 Summary

The historical analysis, case studies, and survey were chosen to verify that simultaneous forest fires have indeed contributed to the stress of forest fire resource management. The combination of these three methods highlighted critical issues within the resource sharing system. Collectively, the results of these approaches demonstrated past and present methods of coping with simultaneous forest fires and have provided insight into what can be expect in the future.

Chapter 4: Case Studies

The purpose of these case studies was to determine the extent to which other crisis or disaster events of 1998 and 2003 influenced the effectiveness of forest fire resource management during simultaneous fire events. This was an opportunity to assess sources of resource sharing stress (other than those directly incurred by forest fires) that had never been explored before. The rationale was that if new sources of stress were discovered, there might also be new ways of improving the forest fire resource sharing system.

Two hypotheses were made: 1. Crisis or disaster events drained federal emergency resources, including military personnel; and 2. These events had also strained federal financial support available to help cover the costs of emergency events. Archived situation reports from CIFFC, newspaper articles, journals, government reports, budgetary documents and parliamentary proceedings were used to assemble evidence about each hypothesis.

Within this chapter, a description of each fire season has been provided as background, followed by a short discussion of the similarities between the 2 years. Next, tables listing the crisis and disaster events from both the years were provided, followed by a discussion of the findings from each hypothesis.

4.1 Background 1998

This year was the strongest El Nino year (1997-1998) in recent history with low over-winter precipitation combined with record breaking temperatures of 2.5^{o} C above normal (Environment Canada, 2011). The weather created high drought conditions for British Columbia, Alberta, Saskatchewan, Manitoba, northwestern Ontario, half of the North West Territories and the Yukon Territories (Johnston, 1998). In the early spring, drought

conditions produced large amounts of dry vegetation, which often act as fuel for forest fires. Starting in early spring, the fire season triggered a high level of interagency resource mobilization (Johnston, 1998). Fires that would normally have been suppressed were escaping initial attack and escalating into major fire situations. Because fire crews were typically hired later in May, there were few crews available this early (Natural Resources Canada, 2012). Thus, from the beginning of the season, the resource sharing system was stressed.

The remainder of the fire season saw multiple fire events scattered throughout the country. In May, Alberta, Saskatchewan, and Ontario were all requesting external resources from CIFFC and in June, requests were also coming from the Yukon Territories (Natural Resources Canada, 2012). In July and August, numerous requests for resources were being issued by all agencies west of Ontario (Johnston, 1998). On August 12th, it was reported that "almost all Canadian suppression resources [were] now committed and significant amounts of US equipment [were] being mobilized to Canada" (Natural Resources Canada, 2012). CIFFC's 1998 fire situation report described instances where: requests for resources could not be filled; simultaneous requests for resources from several agencies put considerable stress on the resource-sharing system; and agencies had to wait for resources to become available (Johnston, 1998). The steady need for resources throughout the country made this fire season a record breaking year for the total number of resources mobilized throughout the fire seasons.

4.2 Background 2003

This was a moderate El-Nino year (2002-2003). In the first half of May, resources were mobilized to Ontario and Manitoba, mostly from Saskatchewan. The second half of May brought national resource mobilization efforts to fires in Quebec, Nova Scotia, and Saskatchewan (Johnston, 2003). A large number of lightning strikes in June caused a peak in resource requests from Ontario and Manitoba but national resources were fully committed, and these requests were not all filled (Johnston, 2003). The situation escalated further on July 20th, when the number and intensity of fires increased in British Columbia, Manitoba, the North West Territories, and Alberta, creating competition between agencies for available resources (Johnston, 2003). At this point, US states were unable to lend any of their resources to Canada because they were also experiencing numerous fire outbreaks. In late July, and well into August, the fire situation in the west "put a tremendous strain on the nation's resources" (Johnston, 2003, p. 3). As the situation worsened, national resource pools dried up and resource requests could not be met (Johnston, 2003). By the end of August, resources borrowed by British Columbia from Ontario, Saskatchewan, and Manitoba were being called back to help with fire situations at home (Johnston, 2003). On August 23rd, the fires in British Columbia escalated destroying 200 homes and requiring 30,000 people to evacuate (Johnston, 2003).

4.3 Similarities

There are similarities between the 1998 and 2003 fire seasons. For instance, the 2003 fire season had the highest forest fire management expenditures (between 1970 and 2009) at $1,130,375,000, followed closely by 1998 at $1,099,750,000 (in 2009$) (B. Stocks, personal

communication, 2012, from unpublished data). A state of emergency was declared in British Columbia as a result of the forest fire situations in both years. As a result, the military was asked to help manage these crises. Three hundred troops were brought into the Salmon Arm area of British Columbia (Johnston, 1998), and 1000 line personnel[9] were sent to Kelowna, British Columbia (Johnston, 2003). The fires became easier to control once precipitation and cooler weather materialized in these areas. Precipitation in areas outside British Columbia and the resulting low fire risk conditions helped free up resources from other agencies that could then be relocated to British Columbia.

4.4 Additional Crisis & Disaster Events

Table 5: Noteworthy Crisis and Disaster Events of 1998

Disaster or Crisis	Where?	What happened?
Ice Storm	Eastern ON, Southern QC, the Maritimes, and adjacent American States	A massive ice storm caused 3 million people to be without power in January. This was the largest insurance payout in Canadian history (Environment Canada, 2011).

Table 6: Noteworthy Crisis and Disaster Events of 2003

Disaster or Crisis	Where?	What happened?
Mad Cow Disease (Bovine Spongiform Encepalopathy, BSE)	Canada (mainly Alberta)	In January, this disease significantly hindered Canadian beef exports (CNN, 2003).
Severe Acute Respiratory Syndrome (SARS)	Canada (mainly Toronto)	In March, SARS came to Toronto making Canada the worst affected country outside of Asia. In total, 58 cases of SARS were seen in Canada, resulting in 6 deaths (BBC News, 2003).
Power Blackout	Southern Ontario & some American States	In the midst of extreme fire conditions, on August 14th, the biggest power outage in North American history hit Southern Ontario and some American cities (BBC News, 2012).

[9] Fire line personnel use shovels, rakes, chainsaws, etc., to clear a line of vegetation to create a fire break.

Hurricane Juan	Nova Scotia and Prince Edward Island	Just after forest fire fighters gained control of the fires in September, Hurricane Juan hit the east coast. The event was the most powerful and damaging of its kind to ever come to Canada (Environment Canada, 2009).

4.5 Hypothesis 1: Resource Strain

In 1998 and 2003 Canadian fire management agencies struggled to obtain the resources they needed. British Columbia, in particular, was in the direst need due to its WUI fires. In both years, national resource stocks were used up and the military was called in to assist. Thankfully military personnel were ready and willing to participate in suppression activities; without their assistance the outcomes may have been much worse.

While the Canadian military had obviously proven its utility to Canadian fire management agencies, it also provided assistance in several of the other emergency situations that arose during the 2 case study years. In 1998, military resources were provided to help citizens affected by the ice storm in Ontario and Quebec. In 2003, the power failure of Eastern North America also required assistance from the Canadian forces (Parliament of Canada, 2003). Later that year, the military assisted Nova Scotia when Hurricane Juan hit the coast (Department of Finance Canada, 2006). While the Canadian Forces can be used to alleviate the stress of these domestic operations, this organization is primarily responsible for national security. In February of 2003, the Minister of National Defence, John McCallum, announced that Canada had agreed to provide a battalion group and brigade headquarters for a United Nations mandated mission in Afghanistan starting in the late summer (The Loyal Edmonton Regiment Military Museum, n.d.). Overall, Canadian forces proved to be of great assistance throughout both years.

The resource demands of emergency events in 1998 and 2003 were met with the help of military resources, thus disproving the hypothesis that other disaster and crisis events hindered the ability of forest fire management agencies to obtain additional resource. However, even though the case studies found no evidence to prove that military resources were insufficient to meet the demands of emergency events in 1998 and 2003, the issue of overstretched resources may be encountered in the future. According to a report written for the Canadian Defence and Foreign Affairs Institute, the 2012 deficit reduction plan resulted in a reduction of Department of National Defence operating budgets, by $1.12 billion a year (Perry, 2012). The Chief of the Defence Staff explained that "This means planes will not fly as much, soldiers will train less regularly, and ships will spend less time at sea. As a result, when a future government asks the Canadian Forces to deploy on an operation, it will have fewer high readiness troops prepared to do so than are available today" (Perry, 2012, p. 3). With fewer troops available to help during emergency situations, there may be instances in the future where the military is unable to assist. Furthermore, an evaluation report on Canada's Disaster Financial Assistance Arrangement (DFAA) found that "nationally and internationally, there is an upward trend in the number of major natural catastrophes and the severity and costs of the events are increasing" (Public Safety Canada, 2011, p. 16). Therefore, there may be a greater number of instances that will require military assistance in the future, stretching military resource even further (Young, 2006).

Canadian forest fire management agencies have relied on the military as a vital resource when mutual aid agreements have failed. If in the future the demand for military aid exceeds the number of resources available in the future, there will be no guarantee that fire management agencies will get the help that they request.

4.6 Hypothesis 2: Financial Strain

Forest fire suppression is expensive (Hirsch & Fuglem, 2006). The years with the highest forest fire management expenditures within a 39 year span (1970-2009) were 1998 and 2003 (B. Stocks, personal communication, 2010, from unpublished data). Other disaster and crisis events from those years were also very costly. The ice storm of 1998 was one of the most costly environmental disasters to hit Canada, while Hurricane Juan (2003) was the most costly wind storm in Canadian history (Kovacs, 2006). When the cost of an event exceeds what a province or territory could be reasonably expected to pay, financial assistance is provided through Public Safety Canada's Disaster Financial Assistance Agreement (DFAA) (Public Safety Canada, 2011). Assistance provided through this arrangement is typically used after an event has happened to help pay for recovery (Public Safety Canada, 2011). The following payments were made to provinces through Canada's DFAA: Ontario and Quebec received $665,387,416 to deal with the ice storm of 1998, British Columbia received $141,566,277 to assist with the forest fires of 2003, and Halifax, Nova Scotia and Charlottetown, Prince Edward Island received $30,900,000 to recover from Hurricane Juan in 2003 (Public Safety Canada, 2011).

Emergency events have proven to be taxing on provincial and federal budgets. However, the purpose of this case study was to explore whether or not the sum of disaster or crisis events in 1998 and 2003 drained national financial support to a point where there was less money available for forest fire suppression. The hypothesis was quickly disproven when details regarding the 2003 fire management budgets were discovered in the 2003 Firestorm report. This report was created as a comprehensive review of British Columbia's response to the forest fires of 2003. It explains how fire management budgets are divided into 2

categories: “a preparedness account to prepare facilities, crews, air-craft and staff, and a direct fire account which is not budgeted to any limits, but can be increased in response to the fire driven needs” (Filmon, 2004, p. 57). British Columbia’s provincial fire management budget for 2003 started at $55 million, but after extensive fire suppression, costs grew to $375 million (Filmon, 2004). Therefore, regardless of whether they were able to get federal financial assistance, the Government of British Columbia would have kept spending provincial money until the fires were put out.

The case studies may not have provided evidence to prove that forest fire suppression funding was hindered by the demands of other emergency events; however, overstretched funding for recovery was also a potential issue. The DFAA average annual budget has been $110 million since 2006 (Public Safety Canada, 2012), meaning the financial aid provided to British Columbia, Nova Scotia, and Prince Edward Island in 2003 was approximately $70 million over the DFAA’s allotted budget[10]. When funding requests exceed DFAA budgets, Public Safety Canada seeks additional funds through a request submitted to the Treasury Board of Canada (General Inquiries Department of Public Safety Canada, personal communication, Sept. 12th, 2012). If the Receiver General accepts the request, a contractual obligation is created within the Public Accounts of Canada between the federal government and requesting province(s) (General Inquiries Department of the Treasury Board of Canada Secretariat, personal communications, September 15th, 2012). These obligations accumulate federal government liability (a form of debt). Looking back to 2003, the federal debt was $510.6 billion (Department of Finance Canada, 2003). Therefore, the combination of disaster events in 2003 contributed approximately 1.4% of the federal debt. Although this may not

[10] DFAA funding for the BC forest fires was $141,566,277 and $30,900,000 for Hurricane Juan in 2003.

seem significant, no additions to federal debt are good. Thus, efforts should be made to decrease the number of instances where additional liability is places on the federal government.

Should simultaneous forest fire events become more frequent in years to come, there may be a greater need for recovery funding from the DFAA. Likewise, if the number of disaster events (in general) increases as predicted (Public Safety Canada, 2011) there may be an even greater need for DFAA funding in the future. If Public Safety Canada is unable to increase its DFAA budgets to match the increased need for recovery funding there will be a greater risk of raising government debts.

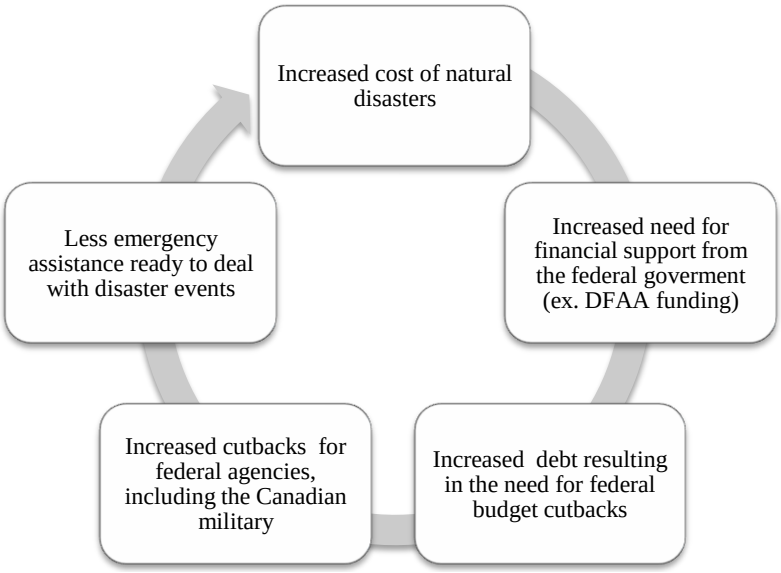
4.7 Conclusions

Although forest fire management was not hindered by other crisis or disaster events in 1998 and 2003, the case study analysis presents 2 problems that could arise in the future if climate predictions hold true and large simultaneous forest fire events become more frequent:

1. Using military services as a last resort for forest fire management may become less reliable if more disasters (not only forest fires) arise simultaneously.
2. If simultaneous disasters become more frequent, the need for recovery will likely increase also. If the financial support requested exceeds Public Safety Canada budgets, more federal debt may be accumulated.

If nothing is done to decrease the dependence on military aid and DFAA funding, the following hypothetical cycle could develop (Figure 3).

Figure 3: Hypothetical cycle of a worsening state



The increasing cost of natural disasters may increase the amount of financial support needed from the federal government, which would then contribute to an increase in the national debt. This, in turn, would increase the need for financial cut backs to pay down the debt. These cutbacks have already reduced military budgets (Perry, 2012) and could be reduced further in the future. Therefore there may be less emergency assistance available, resulting in greater damage and higher costs during disaster events.

Chapter 5: Supplemental Analysis

The natural sciences and engineering have been the dominant themes of forest fire research for many years (Goldammer, 2007). While these themes have produced remarkable findings, it has been suggested that advances in research are better achieved when they are not limited by strict thematic barriers (Merchant, Van der Stede, & Zheng, 2003). With resource management issues coming to the fore, it may be appropriate to widen the research scope and employ more organizational and managerial based research themes. Furthermore, Merchant, et al. (2003) suggest that when research and experience is taken from a single discipline, the developments and insight achieved by other professions are often overlooked. Since forest fire resource management is a newly emerging research topic in forest fire management, it could be valuable to examine issues from a problem-based perspective rather than from a discipline-based perspective. Thus, instead of establishing recommendations for forest fire resource management in isolation, efforts will be made in this section to learn from other resource sharing disciplines.

The purpose of this investigation was to help resolve forest fire the resource sharing issues identified by the survey results (See Appendix G for full survey results). Survey results demonstrated how resource sharing has been affected by simultaneous forest fire events. For example, out of 11 fire managers, 5 said that they had experienced an event where the resources that they requested from an external agency were not available because they were already being used by other agencies to deal with fire suppression. Furthermore, 4 fire managers believe that their ability to suppress fires using only their agency's own resources has been decreasing. This means that these 4 agencies have been increasingly

relying on external agencies, putting excess strain on the resource sharing system. Also, if simultaneous resource requests become more frequent throughout the resource sharing system 7 of 11 fire managers agreed that Canada would need to augment its resource stocks and 6 fire managers believed that their agencies would need to augment their own resource stocks. Unfortunately, only 2 of the 11 responding fire managers think that their agency will be financially stable enough to obtain more suppression resources within the next ten years. One fire manager stated that his/her agency requests additional funds every year to deal with suppression costs. As another manager expressed the problem: "many people are fighting for limited financial resources". Therefore, to convince politicians that an increase in fire management budgets is needed it will be necessary to express exactly how many resources are required. Currently, Canada's resource sharing capacity (including agency resources, Compact partner resources, and other international resources) is unknown but 8 of 11 agencies agreed that determining this information was important. To increase the resilience of the resource sharing system these issues need to be addressed.

The following analysis considers the resource sharing behaviors, organizational structure and information gathering techniques of 5 unique resource sharing activities: 1. Inter-library loaning, 2. Crisis and emergency management, 3. Information tracking for health records and blood bank donations, 4. Transport supply chains, and 5. Confidence in supply chain management. Each example was chosen based on its similarities to forest fire resource sharing (Table 7). Resource sharing recommendations for each of the 5 activities were collected from journal articles, reports, and web sites. Information was extracted from the survey results to define the recommendations that would be most appropriate for forest fire resource management.

The following subsections briefly describe each example, their recommendations for resource sharing and the applicability of those recommendations to forest fire resource management.

Comparisons are not being made to argue which management structure is best but, rather, to illuminate diverse options for organization and management of fire control that might not have been considered in the past.

Table 7: Similarities between forest fire resource sharing and other resource sharing activities

	Forest fire resource management	Inter-library loaning	Resource sharing in crisis & emergency management	Blood bank donation & distribution	Supply Chain Management*
Purpose of sharing resources	To reduce loss of life, damage to property and natural resources, and to reduce suppression costs (Natural Resources Canada, 2007)	To provide patrons with access to materials they would otherwise have traveled for.	To help communities recover from loss of life, injury, and/or damage to property.	To ensure appropriate blood types are available where and when they are needed and to reduce the amount of unused/expired blood.	To ensure the correct products are delivered to the right places, on time, at minimal cost.
Increased demand for resources	Increasing resource demands and the limits of resource sharing are of concern (CFFI, 2008; Natural Resources Canada, 2007).	Increasing demand for materials not available locally overstretch library capabilities (Beaubien et al., 2006).	Demand for emergency resources has been increasing.	Demand for blood products has been increasing (Delen, Erraguntla, Mayer, & Wu, 2009).	Increasing demands can lead to increased complexity and risk within the supply chain (Manuj & Mentzer, 2008).
Increasing cost of sharing	Resource requests have been climbing since 1997 which contributes to higher costs (CIFFC, 2008).	Resources are being shared faster with less financial support (Beaubien et al., 2006).	The more emergency resource being used, the higher the cost.	Budget allocation is the same even though resource demands are increasing (Delen et al., 2009).	
Benefits of efficient resource sharing	Resource sharing agreements reduce the cost of fire suppression and increase the supply of resources for fighting individual fire crises, thereby limiting damage and injury.	Resource sharing is a solution to the financial problems within the academic library community (Kingma, 1997).	The Metro Law Enforcement Council pools knowledge, equipment, and personnel between jurisdictions to expand its resource base (Schnobrich-Davis & Terrill, 2010)	Blood banks track inventory to decrease the amount of blood lost to expiration (Delen et al., 2009).	An efficient supply chain typically translates into more satisfied customers, which may result in better business.

Table 7: Con't	Forest fire resource management	Inter-library loaning	Resource sharing in crisis management	Blood bank donation & distribution	Supply Chain Management*
Having resource sharing options	Agencies carry their own supply but agreements (MARS, CANUS, and the Compacts) provide other sharing options.	Some universities have a variety of networks that allow them to share resources (Beaubien et al., 2006).	Emergency managers can elect to involve a number of different institutions to help (ex. police, hospitals) (Mazzetti et al., 2009).	Partner blood banks share their supply, if there is an excess or a shortage in a specific location (Delen et al., 2009)	Companies retain multiple suppliers in case one of them fails (Manuj & Mentzer, 2008).
Difficulties with information collection	Provinces and Territories collect their own information, but not in a standard format.	Information is not collected uniformly, making evaluation difficult (Beaubien et al., 2006).	Procedural differences between responding institutions make information sharing difficult (Briody & Trotter, 2008).	Information collection at several organizational levels can cause errors and delays (Delen et al., 2009).	Lack of information makes it difficult to predict transit times, creating uncertainty (Rodrigues et al., 2008).
Predicting the need for resources	Predictions are made throughout the fire season to help fire managers distribute resources appropriately.		The location and timing of some disasters can be predicted, but disasters are still difficult to anticipate.		Speculation is used to save time by moving goods in anticipation of future demand (Manuj & Mentzer, 2008).
Geographical dispersion of resource sharing	Provinces and territories can request resource from anywhere in Canada and from other countries.	Libraries transport resource to partnering libraries based on patron requests.	Emergency management resources can be coordinated between several jurisdictions.	The supply in one blood bank may be moved to another if there is a greater demand elsewhere.	Dispersion is inevitable in the supply chain, moving products from A to B (Manuj & Mentzer, 2008).
Unexpected events	Unexpected events put added pressure on resource distribution decisions.	High demands can arise unexpectedly (ex: release of a new best seller).	Emergency events are often unexpected. Fast and efficient response is critical.	The need for blood can increase without warning.	Unexpected events increase complexity within the supply chain.

***Note: "Transportation supply chain management" and "Confidence in supply chain management" have been discussed as one since they both deal with supply chain management.**

5.1 Inter-Library Loaning

Inter-library loaning is a resource exchange service provided by groups of partnering libraries. When resources are unavailable at a patron's home library they can seek out and request resources from partnering libraries. The same concept is used in forest fire resource management whereby agencies request resources from partnering agencies when they do not have enough of their own resources to suppress fires within their jurisdiction. In a typical fire year, 6 of 11 fire managers reported that their agency is able to fulfill 61-80% of the resource requests made to their agency. In a bad fire year, this percent decreases drastically with the majority of agencies only providing 0-20% of the requests.

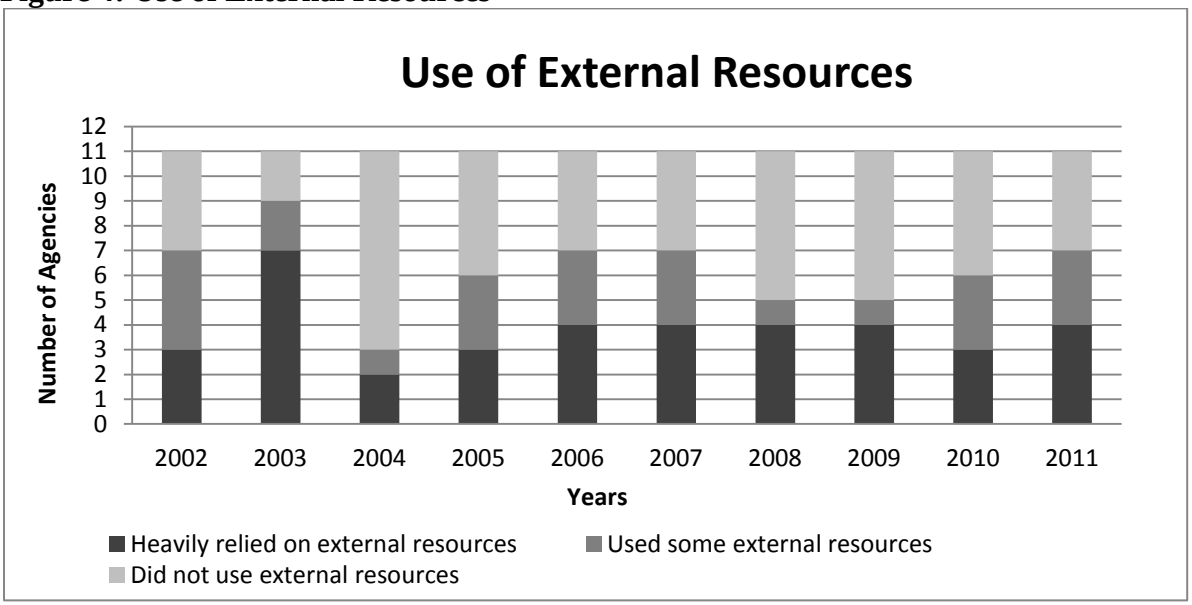
Work has been done within the inter-library loaning community to readjust internal resource sharing processes to enhance the long term stability of sharing operations. Leon, et al. (2003), describe a best practices model for interlibrary borrowing and lending for consortia and local operations. The purpose of which is to improve the delivery of interlibrary loaning materials. A comprehensive report, written by a consortia group for academic libraries, details library resource sharing activities, issues, and trends (Beaubien et al., 2006). Recommendations within this report were made to improve the mutual benefits of resource sharing. The purpose of examining this discipline was to reuse the recommendations they have produced by applying them to forest fire resource sharing operations. Table 8 summarizes the recommendations made by Leon et al. (2003) and Beaubien et al. (2006) and justifies why parallel recommendations are applicable to forest fire resource management

Table 8: Inter-library loaning recommendations

Potential problems within forest fire resource management	Inter-library loaning recommendations	Implementation into forest fire resource management
	(Leon, et al., 2003)	
Fire managers were asked if it would be reasonable to implement a standardized evaluation tool for all agencies to see how effectively they use their resources. Only 4 agreed that it would be reasonable.	To find mistakes and rate sharing partners, turnaround times and number of errors encountered during the sharing process should be recorded.	Errors in forest fire management may include: unfilled requests, and delayed or incorrect deliveries. To evaluate the resource sharing system effectively, fire managers need to be convinced of the benefits of standardized record keeping.
Not all resource requests are being tracked by external agencies.	Record the number of transactions made and the amount of staff used within a given time period to gauge future needs.	In any given year some agencies rely heavily on resource sharing while others do not (Figure 4). To cope with variability and gauge future need, records should be kept of the number of staff working in each agency and the number of resource requests made to each external agency.
To my knowledge there has not been any information collected regarding knowledge and information sharing between internal departments within individual agencies.	Teach staff about jobs other than their own so they can communicate more efficiently with others and understand situations outside their department.	Determine the level of communication between departments. If communication is low, initiate job shadowing or exchanges to increase familiarity.
Nine agencies track their resources on a provincial or territorial level. However, the information collected is not visible to other agencies.	Network individual workstations to share inter-library loaning data. Allow resources to be seen from any system, permitting patrons to find the resources they need in a timely manner.	Six of 11 managers agreed it would be good to create a data collection system where national forest fire resource data was available to all agencies daily. Convince the remaining managers of enhanced collaborative communication and timing.
Decision-support systems are used in 8 out of 11 agencies and resource tracking systems are used in 9 of 11 agencies (Managers were not asked to give details about these systems).	Give staff the opportunity to critique software so that it better reflects their needs.	Decision-support systems, software and protocols should be critiqued by staff. Their opinions could highlight inefficiencies. Agencies without any decision-support system should attempt to employ one.

The majority of agencies did not have protocols for when to request more resources, which supplier to request resources from first (under various circumstances) and the level of risk they are willing to take to share their resources with other requesting agencies.	Establish consortium-wide minimum resource sharing standards to set a level of optimal service.	Establish national minimum resource sharing standards. Protocols could be predetermined so that each agency would at least provide the minimum level of service.
	(Beaubien, et al., 2006)	
Ten agencies made an attempt to communicate an increased need for fire management resources to their minister or cabinet.	Presenting common issues collectively to top administrators carries more weight than raising issues within individual libraries.	Instead of approaching politicians individually, agencies should identify similar issues and bring them up collectively in a political forum.
Only 6 fire managers thought it would be reasonable to create a national standard for procedural guidelines. Currently, there is no uniform method of record keeping.	Information should be collected uniformly throughout member libraries to facilitate ranking and comparison. This information should also be used for follow-up studies to examine the impact of any changes to sharing procedures.	Record keeping guidelines should be initiated to simplify analysis and communication between agencies by instilling uniform terminology.

Figure 4: Use of External Resources



This Figure shows the extent to which forest fire management agencies relied on external resources in the past 10 years (Data acquired from the survey)

According to inter-library loaning research, the key to success in resource sharing is to: provide information openly to all sharing partners, evaluate their performance, and work collectively towards common goals. Currently there are mixed feelings about standardized evaluation tools within forest fire management. While one fire manager said that standardized evaluation was “a good idea” and that “consistency is always good”, another managers stated that evaluation should be a “jurisdiction by jurisdiction prerogative”. Recommendations from inter-library loaning research should serve as a precedent for forest fire management agencies.

5.2 Crisis and Emergency Management

Emergency management contends with a variety of events including: natural disasters, terrorist attacks, pandemics, and pollution. These situations require structural, operational, and procedural planning before, during and after an event. Much like forest fire managers, emergency managers need to be well versed in the communication and critical decision making aspects of resource management. From a communication perspective, Zagorecki, Ko, and Comfort (2010) found that hierarchical organizations that limit communication to specific people are less effective than organizations that allow free and open communication amongst everyone involved. Their recommendations set out to improve the efficiency of communication in rapidly changing emergency management environments. Pearson and Clair’s paper on reframing crisis management yielded unique recommendations about decision making and how to avoid trusting a false sense of security. Moreover, Smart and Vertinsky (1977) outlined a comprehensive list of problems and solutions to deal with

the increasing demands imposed on decision making units during emergency events. All of these recommendations can be found in Table 9.

Table 9: Crisis and emergency management recommendations

Potential problems within forest fire resource management	Crisis and emergency management recommendations	Implementation into forest fire resource management
	(Zagorecki, Ko, & Comfort, 2010)	
Communication is vital to efficient forest fire resource management.	Communication procedures can help parties ensure a homogeneous understanding of the resource sharing process and of people's roles.	An open discussion about procedures can help to identify incorrect, inefficient, or unnecessary steps in the communication process.
Seven managers said that their agency typically communicates with other agencies (not through CIFFC) to request resources.	Self-organized communication can create a well-connected network of individuals.	This kind of communication should be encouraged to increase the efficiency of communication throughout the resource sharing system.
	(Pearson & Clair, 1998)	
All 11 fire managers agreed that their agency is aware of climate change. Six have implemented response plans. It is possible that some agencies have not fully acknowledged the potential risks associated with climate change.	Do not be deceived by false securities and be sure to acknowledge the potential in future risks so that plans can be prepared well in advance.	If fire managers are overconfident in their agency's ability to manage fire, they may run the risk of being unprepared for more serious fire events in the future. Fire managers need to acknowledge risks of climate change so that plans can be made in advance of change.
	(Smart & Vertinsky, 1977)	
Forest fire resource sharing can be a complex and stressful endeavor, especially if the resources required are unavailable.	Increased stress can reduce cognitive abilities. Develop stress profiles on leaders and use stress-reduction techniques to decrease stress.	Stress reduction techniques such as meditation can be used during stressful situations so that cognitive abilities are not impaired.
Of 11 agencies 6 share their resource stock information directly with other Canadian agencies (not through CIFFC).	Set up outside channels of communication to cut through hierarchy.	Agencies should be encouraged to communicate with one another directly in crisis situations to make sharing faster.

The purpose of these recommendations is to make responding to emergency events easier by improving communication and reducing stress. To be effective, these solutions need to be implemented well in advance of a crisis event. Currently, 4 of 11 agencies do not trust that Canada's current sharing system will suffice for fire suppression needs in the coming decade. Before large simultaneous forest fire events become more frequent in Canada, these recommendations should be considered to help improve response procedures.

5.3 Information tracking: Blood donations & Health Records

Several information sharing systems have been developed over the years to allow companies and organizations to sharing information in real-time using the internet. The emergence of electronic medical health records in Canada, for example, has shown great potential to increase the speed and accuracy of patient care throughout all branches of health care. Also, the US Department of Defense has created a web-based decision support system to track, manage, and assess blood reserve availability in blood banks (Delen et al., 2009). Each of these systems was created to increase the visibility of critical information, a concept that is also very important to forest fire management. In 1997, the Canadian Forest Service suggested that a national fire-information network be used to share fire statistics over the internet (Williamson & Johnston, 2009). Ten years later, the Core Team of the Canadian Wildland Fire Strategy made a similar recommendation about sharing fire management information (Natural resources Canada, 2007). The majority of fire managers believe it would be reasonable to employ a data collection system where nationwide forest fire resource data is readily available to all Canadian agencies on a daily basis to enhance

collaborative communication and timing. However, such a system has yet to be developed for forest fire resource sharing.

Although the idea of sharing information is good, implementing large information sharing systems can be troublesome, threatening to waste valuable time and money if done improperly. It may be premature for forest fire managers to begin implementing a national information sharing system today; however, if Canadian agencies begin exploring other information sharing system ventures now, they may be able to bypass major mistakes and create a system with greater ease in the future. The following sources (Table 10) have been explored to demonstrate the benefits of using such a system and to uncover significant information tracking strategies that could be applied to forest fire resource management.

Table 10: Health record and blood bank donation management recommendations

Potential problems within forest fire resource management	Health record and blood bank donation management recommendations	Implementation into forest fire resource management
	(Canada Health Infoway, 2010)	
All but 2 fire managers reported their agencies track resources daily using a decision support system. There is no national level decision support system to track the movement of all fire suppression resources in real-time.	The system uses standards to collect information in uniform format.	A common data collection format would allow for easy comparisons of the agencies.
	The system allows doctors offices, clinics, hospitals, and labs to share up-to-date information on patients, making it easier to provide the best possible care. Access to a patient's previous medical history makes it easier to diagnose problems.	A comprehensive list of fire suppression resources available throughout Canada would provide fire managers with a national scope of the fire situation. Thus, allowing managers to make decisions based on what is happening elsewhere.

	(Delen, et al., 2009)	
(Same as above)	Blood bank resource management systems allow greater visibility of resources in the supply chain.	To increase visibility throughout the resource management system, inventories would have to be collected nationally.
	The outputs of this system are easy to read and color coded to help decisions makers quickly identify optimal solutions.	Developing appropriate computer outputs can save fire managers time by highlighting critical information.

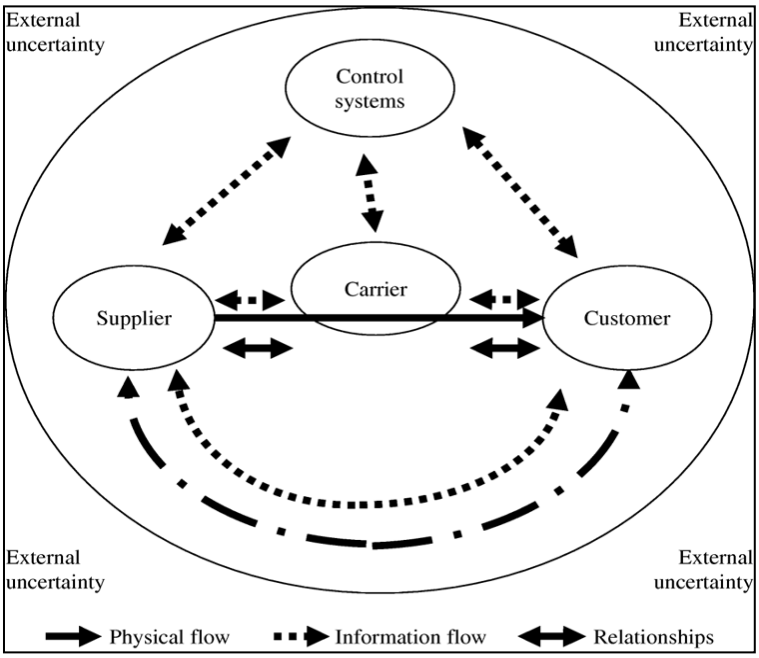
Since forest fire resource sharing is a national endeavor, the scale of the health records system would be an appropriate comparison. Alternatively, the blood bank example has more comparable needs to that of forest fire information sharing since both activities deal with sudden resource requests and the need to distribute resources to different locations as required. If forest fire management agencies decided to implement their own information sharing system, these examples would be a good starting point. Already eight agencies have decision-support systems to help them distribute resources within their jurisdiction and 9 of 11 agencies track their resources internally. Unfortunately, even though some agencies are using these systems, other agencies are of the mind that "there are too many parameters to consider" to use these kinds of systems effectively. However, it would be realistic to implement a national data collection system since much of the information and organization required is already being used by the majority of agencies.

5.4 Uncertainty and Risk in Transport Supply Chains

Supply chains are networks of interconnected businesses that provide products and services to customers. Supply chain management involves storing materials, making

products, collecting inventory, and delivering goods. The goal is to deliver finished products from point A to point B. Uncertainty of location, quantity, timing, and availability of supplies can turn this simple task into something much more complex (Rodrigues, Stantchev, Potter, Naim, & Whiteing, 2008). Rodrigues et. al. (2008) provide a framework to help organizations mitigate the effects of uncertainty within the supply chain. The authors developed a 'logistics triad' whereby they describe the three main channels of uncertainty: the supplier, the carrier, and the consumer (Figure 5). The triad is used to identify any sources of uncertainty that could affect the supply chain. Supply chain risk management is another means of identifying things that might disrupt the manufacturing or delivery process. Manuj and Mentzer (2003) provide strategies for diminishing these risks. The following recommendations (Table 11) provide a basis from which forest fire managers might diminish uncertainty and risk within the resource sharing process.

Figure 5: Logistics Triad



(Rodrigues et al., 2008)

Table 11: Transport supply chain recommendations

Potential problems within forest fire resource management	Transport supply chain recommendations	Implementation into forest fire resource management
	(Rodrigues, et al., 2008)	
Levels of uncertainty within resource management have yet to be determined.	Identify sources of uncertainty generated within one of the three partners (Figure 6). Rank the sources from most to least important and re-engineer the supply chain by eliminating sources of uncertainty.	The supplier is the agency sharing resource, the customer is the requesting agency, and the logistics provider is the external agency that facilitates sharing. This structure can be used to identify areas of uncertainty within the sharing system.
Six fire managers said it would be reasonable to create a nationwide forest fire resource data sharing system to enhance collaborative communication.	To avoid communication errors, all parties need full access to each other's information.	Initiate open access information sharing networks between Canadian agencies.
	(Manuj & Mentzer, 2008)	
The flow of communication within individual agencies is unknown. Regardless, improvements can always be made to improve communication.	Moderate the composition of teams used within the supply chain. Mixing previous experiences with new strategies can create unique relationships that improve management procedures.	Mix people from different departments, agencies, and/or levels of seniority during meetings and projects to facilitate the flow of new ideas from different perspectives.
Reports detailing available resources in each agency are provided to CIFFC daily.	All parties need be kept up to date so that the decisions they make reflect the current situation. Mistakes are easily made when one party is uninformed.	Real-time updates to resource information would help eliminate barriers in communication and reduce the chance of error.
Seven of 11 agencies communicate directly with other forest fire fighting agencies (not through CIFFC).	Inadequate knowledge about language and norms of different parties can cause strife.	More effort should be made to understand the norms of other agencies to facilitate better communication.

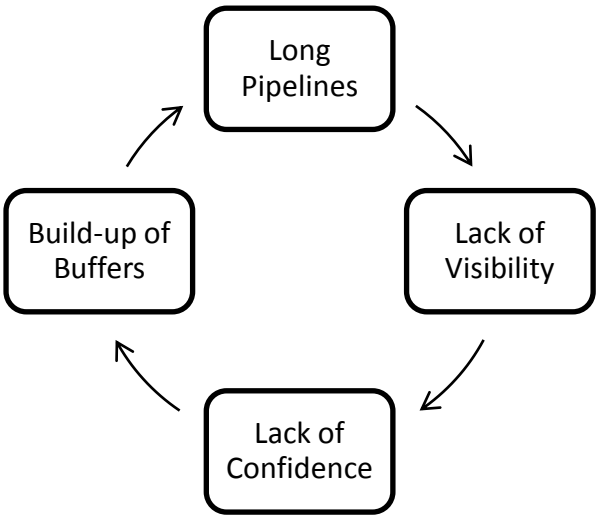
Out of 11 fire managers, 8 agree that annually reviewing the sharing capacity is a good idea. However, not all external agencies record incoming resource requests.	"What is not measured cannot be managed, further what is measured incorrectly or under-measured will be mismanaged" (p. 216). Performance metrics can be made, once information is collected to evaluate how the supply chain is working.	Agencies should record what resource they are requesting, who they are requesting from, and whether or not their request was filled. This would make it easier to evaluate resource sharing performance throughout the country.

Transportation supply chain management acknowledges that there are multiple players to consider when distributing resources. Without the cooperation of all players, tasks become difficult to accomplish. It is important that each forest fire management agency acknowledges how their actions might affect other agencies, CIFFC, Compact partners, and other international partners. In particular, when agencies rely too heavily on external resources they begin to put excess strain on the resource sharing system, making it less effective for everyone. The survey asked managers to provide a range of percent to demonstrate how much of their suppression needs should be covered by their own agency in a normal fire year. While nine agencies believe that 81-100% of the suppression resource should be provided by their own agency, 2 fire managers believe that their agency should only be providing 61-80%. Although this difference is not exceedingly different, it shows how agencies have differing perspectives, making it challenging to instill interagency cooperation.

5.5 Confidence within Supply Chain Management

Members of a supply chain rely on each other's performances to meet their own goals making each member vulnerable to the consequences of their partners' decisions (Das & Teng, 1988). Control mechanisms, such as contracts or standards, are used to insure a certain level of predictability within the supply chain. Confidence can be increased by improving trust and control mechanisms. However, if the combination of the two is insufficient, a lack of confidence can be created and initiate, what Christopher & Lee (2004) refers to as, a risk spiral (Figure 6). The spiral is created when low confidence forces managers to order more stock as a buffer against tardy shipments (Christopher & Lee, 2004).

Figure 6: Risk Spiral



(Christopher & Lee, 2004)

Overall, agencies seem to be fairly confident in their external agency's ability to provide them with the resources they request. For example, eight of 11 fire managers are 81-100% confident in CIFFC's ability to provide them with resources. However, forest fire management agencies still use buffers to get the resources they need. A buffer in forest fire management would be if a fire manager ordered more resources than his/her agency needed because they knew their requests would not be met in full. The logic being that, by requesting more than they need, they might get more than they would have, had they only requested

exactly what they needed. Unfortunately, buffers obscure visibility within the supply chain and create longer pipelines (time between the request and the delivery of a resource) and the longer agencies wait to suppress a fire, the more time they will likely need to spend suppressing it (Rachaniotis & Pappis, 2006). Therefore, the lack of confidence could decrease suppression efficiency.

The consequence of diminished confidence is the expansion and acceleration of the risk spiral; constantly making conditions worse (Christopher & Lee, 2004). The only way to stop the spiral is to increase confidence. Table 12 demonstrates a number of recommendations put forth to increase confidence within the supply chain.

Table 12: Supply chain management recommendations

Potential problems within forest fire resource management	Supply chain management recommendations	Implementation into forest fire resource management
	(Das & Teng, 1988)	
The survey results demonstrated that fire managers have a variable level of confidence in their sharing partner's ability to provide them with resources.	The key to confidence is open and prompt communication with all partners to confirm information symmetry throughout the process.	Agencies need to share information openly to improve confidence within the resource sharing system.
Each agency has its own values and norms. Only 6 out of 11 fire managers have expressed their willingness to conform to a common set of standards.	It is critical that interaction remain continuous throughout the process to help develop of a common set of values and norms to increase overall predictability within the partnership.	Agencies should initiate common procedures to increase predictability, thus increasing confidence in their sharing partners.

(Briody & Trotter, 2008)		
Agencies communicate to share resources and to some degree they also collaborate for research; however, communication between agencies can always be improved.	Communication facilitates learning and knowledge sharing between partners to assess resource availability, roles of various staff, current and future needs, and organizational standards. Development of personal relationships is necessary, having relationship between companies is not enough.	For forest fire management, this means that individuals from each agency need to become familiar with one another and that simply sharing resources between agencies is insufficient in terms of maintaining the flow of communication.
While the majority of agencies had a high level of trust for one another, some areas of trust could be improved. For examples, all agencies should trust that their partners are sharing equal proportions of their resources.	Level of trust is typically based on the degree to which partners were able to demonstrate the following: competence, integrity, reliability, honesty, and commitment. Partners who trust each other are more likely to share ideas freely, be open to discussions, fulfill promises, make consistent decisions, and show more commitment.	Agencies requesting resources need to maintain confidence in the controls established through various agreements and trust that their partners will supply the resources they request. Lending partners should learn to trust in other agencies to help them if something was to develop while their resources were being used elsewhere.
(Christopher & Lee, 2004)		
CIFFC logs available resources from every agency on a daily bases but the frequency of these updates could be increased.	Status reports can log inventory, demands, shipment schedules, suppliers/carriers capacity, anticipated blockages, and forecast upcoming requests. To use information optimally, it needs to be updated regularly and logged accurately.	Frequent updates will give staff a better idea of the national situation with regard to resource sharing. This information would be particularly useful during simultaneous forest fire events where resources are limited.
Only 2 out of 11 fire managers reported that they have protocols for when to request resources from another resource-sharing partner if their primary sharing partner cannot fulfill the request.	Alerts should be used so that if deviation occurs, someone is notified and changes can be made to help get back on track. Alerts must be sensitive enough to pick up unexpected deviations but not too sensitive that alerts come up for everything.	Alerts should be used to enable managers to see if their primary resource supplier is able to fulfill their demand. It might be beneficial to have secondary and tertiary plans in case resource demands across the country are unexpectedly high.

CIFFC's annual reports demonstrate that there is sometimes "competition for resources".	Synchronizing standards and channels of communication helps to ensure visibility throughout the supply chain, increasing confidence.	If fire managers know what is happening nationally, they will have a better idea of how many resource they could get and how many may be requested of them. Increased visibility may increase confidence and transform resource sharing into a collective effort rather than a competition.

If all forest fire management agencies had complete trust in one another, they would never need to request more than they needed, making the system more efficient. Even though it would be impossible to obtain complete trust, fire management agencies should work towards increasing the level of trust so they are less compelled to use buffers. Standards can be introduced to increase predictability, thus increasing trust. When fire managers were asked if they would consider employing resource sharing standards within the forest fire management system, six of them agreed that it would be a good idea. This means that there are still five managers that will need to be convinced of the benefits of standardization.

5.6 Summary

The forest fire management community has existed for decades and as such they have accumulated a great deal of valuable knowledge and expertise. Unfortunately, climate change has the potential to bring about fire situations that are worse than anything experienced in the past. To remain proactive about forest fire suppression, managers should look beyond forest fire management to find new ways of improving resource sharing resiliency so that agencies

can cope with an the increased levels of fire should simultaneous forest fires become the norm.

Examining other resource sharing activities can provide a means of avoiding previous mistakes, or present an opportunity to mimic past successes. Even if activities have dissimilar motives or goals, a fresh perspective can sometime yield new and more effective ideas. Exploring multiple perspectives can also assist in uncovering trends, which can help confirm the significance of a particular action. For instance, all five resource sharing examples recommended open access to information and increased communication, demonstrating how valuable these activities must be. While it is important that fire managers consider each of these recommendations, it also important that they continue to employ a problem-based research approach to forest fire management issues so that new ideas can be explored.

Chapter 6: Discussion

6.1 Implications

The results of this study show that on occasion simultaneous forest fire events have stressed Canada's forest fire resource sharing system. It is expected that these events will become more frequent due to the effects of climate change. Encountering a greater number of simultaneous events will increase the severity of the resource sharing problem, adding stress to already stretched budgets. Failure to control these fire events more effectively will increase the risk of endangering people, property, and our environment. Over time the strain of these events may also begin to affect our economy by disturbing businesses, reducing tourism, destroying valuable natural resources and increasing public debt.

If forest fire resource management is left unchanged, Canada's resource sharing system will not be able to cope with simultaneous forest fire events. Furthermore, if the frequency of simultaneous events increases, and agencies cope as they did in 1998 and 2003; the reliance on military aid and federal funding will likely escalate. Unfortunately, considering the severity and cost of disaster events are increasing (Public Safety Canada, 2011; The Institute for Catastrophic Loss Reduction, 2012), DFFA and military resources may not be as available as they have been in the past. Therefore, relying on these resources to assist with response and recovery is not a sustainable solution. Change in forest fire management is necessary to acquire long term solutions to this resource sharing problem.

I have identified 2 potential options for change. The first is to simply buy more suppression resources. Having more resources in stock could reduce an agency's dependence

on external resources, making it less vulnerable to the effects of resource shortages. However, only 2 out of 11 fire managers said their agencies would be financially stable enough to augment its resource stocks in anticipation of worsening conditions within the next ten years. Thus, purchasing more resources to fill the need is not a viable option for the majority of agencies.

Fortunately, the combined results from the historical analysis, case study, and survey, afforded a better understanding of simultaneous events, suggesting a number of ways the resource sharing system could be enhanced. Thus the second, more practical, option for change would be to increase the resilience of the resource sharing system. The following discussion will review the major findings of this study, what they imply, and what modifications might be done to enhance forest fire resource management for the future.

Information Availability

There is no uniform method of collecting resource request information from all external agencies, making it difficult to assess how many requests are being made throughout a fire season. Also, behavioral differences have skewed the number of resources being requested[11]. This implies that there is no record of the total number of resources agencies typically need from their sharing partners throughout a fire season. A "need for resources" should include any instance when a fire situation surpasses the capabilities of an individual agency to suppress fires using their own resource stocks, and should be acknowledged even

[11] For instance, when the national need is high, some managers may choose not to request resources because there is too much competition with other agencies, while other managers might exaggerate their resource requests to get what they want.

when agencies choose not to request external resources. This information is necessary to effectively predict and manage future needs.

To tackle these issues, a template (Table 13) should be used by all agencies to collect information about their resource needs. This information will present a more accurate appraisal of the national need for resource sharing. Evaluations can be done to determine if the need for resources is changing and to see if the resources being requested are being delivered. Moreover, once a record is kept of the resources needed by each agency, the total can be evaluated against the size and intensity of the fires they encountered, making it easier to detect when an agency is asking for a great deal more or less than they likely needed. Although this will suffice for the interim, a more detailed analysis of game theory within the forest fire management system is necessary. Kate Larson and Alan Tsang, of the Cheriton School of Computer Science at the University of Waterloo, together with Rob McApline of the Ontario Ministry of Natural Resources have already begun to tackle this dimension of fire resource management in their publication entitled, *Sharing of Fire Fighting Resources* (2012).

Table 13: Example of what information should be collected

#	Date	Summary of Circumstances	Resources Needed	Resources Requested (if any)	External Agency Used	Date Requested	Request filled? (Y/N)	If yes, when/to what extent?	If no, how did you proceed?
1									

Money flow during a crisis event is also unclear. In 2003, the Province of British Columbia spent $375 million to suppress forest fires which was $320 million over their

original budget (Filmon, 2004). The Fire Storm Report (2003) explained that there is a direct fire account which is not budgeted to any limits which can be increased in response to the fire driven needs. Also, the case study revealed that the disaster events of 2003 may have surpassed allotted DFAA budgets. The financial stress incurred by the federal and provincial governments as a result of these simultaneous events has demonstrated that there may be a need for agencies to acquire more funds or to use the funds they have differently. Unfortunately the flow of money within and between provincial and federal governments is difficult to follow. Even after numerous inquiries to British Columbia's Wildfire Management Branch and Ministry of Finance, as well as to the Department of Finance Canada, Public Safety Canada and the Treasury Board of Canada, I was unable to obtain the information that I needed regarding government expenses, particularly with regards to where funds were being acquired and whether these expenses were hindering other government funded activities like health care or education.

The difficulties of acquiring financial information made the case study analysis difficult. However the lack of accessible information indicates a need for future study. A detailed analysis of money flow during extreme fire events would demonstrate how emergency funding is acquired. Only then will there be a way to find out if money is being used effectively or if there are better ways of managing fire management budgets. The analysis should identify whether or not these expenses are hindering other provincially or federally funded activities, and/or if they are increasing federal debt. Once the consequences of exceeding fire management budgets are realized, government officials may be more inclined to make adjustments to fire management budgets. It would also be beneficial to re-

visit this analysis every 2 to 5 years to ensure money is being used appropriately and to see if there are any new developments with regards to climate change that might necessitate a change in financial planning.

Financial Support

As previously mentioned, increased financial support is necessary to prepare for the effects of climate change on future fire regimes. Fire managers have attempted to communicate the need for increased financial support to their ministers or cabinet. However, with no perceived immediate economic or political benefit to making changes, ministers have not always seen pre-emptive adjustments as necessary or favorable (Environment Canada, 2011). However, I have demonstrated that in 2 out of 12 years Canada's forest fire resource sharing system has been challenged. This should encourage political leaders to make changes as early as possible considering the chance of avoiding a crisis for more than 4 years (an electoral cycle) is less than 50%[12]. Furthermore the case study demonstrates that if nothing is done to change how simultaneous forest fires are managed they may begin to contribute to the deterioration of other emergency management systems (Figure 3).

Now that this information is available, it is still necessary to present it to the right audience. It was determined in the supplemental analysis that agencies should be presenting their issues collectively in order to demonstrate the severity of their financial need. The audience of such a presentation should be both familiar with forest fire management and willing to collaborate with several different parties. The Canadian Council of Ministers of the

[12] The chance (P) of a stressful national situation is 2/12 on an annual basis. That is a (1-p)= 0.83 chance of managing stress in any year. The chance of escaping a crisis in any n year stretch is therefore $(1-p)^n$. Therefore, within a 4 year stretch the chances of escaping a crisis are about 0.83^5 which is 0.48 (or less than half).

Environment (CCME) has had many years of experience facilitating coordinated action between various government bodies regarding environmental issues at a national scope. The CCME could be approached so that they may use their influence to facilitate action.

Public pressure can also be used to further communicate the need for increased fire management budgets. Survey results show that addressing the public was the only option fire managers did not use to communicate their need for increased funding. These results were surprising considering that many agencies have made substantial efforts to raise risk awareness in their respective communities through programs like Firesmart. Given that this channel of communication has already been established, fire managers should use it to share knowledge about the roles and responsibilities of forest fire management and its growing need for financial support. Even though increased public awareness is not likely to result in an increase in fire management budgets, this awareness might make it easier for political leader to suggest increasing fire management budgets with fewer objections from the public.

Opportunities to Thrive

Recommendations have been made by the National Workshop for Fire Activity in Canada (1997), and Natural Resources Canada (2007) to initiate a real-time information sharing system between all Canadian fire management agencies. No such system has been developed to track fire suppression resources. Additional recommendations uncovered throughout the supplemental analysis suggest that information sharing needs to be open and continuous in order to effectively eliminate errors and to increase efficiency (Leon et al., 2003; Rodrigues et al., 2008; Delen et al., 2009; Canada Health Infoway, 2010; Christopher & Lee, 2004; Manuj & Mentzer, 2008). The majority of fire managers surveyed agreed that

initiating a database to share resource information would be reasonable. Overall it is clear that there is an opportunity to improve upon the speed and accuracy of information exchange within forest fire management.

Currently, instead of using a database to share and update information via the computer, CIFFC collects a report from each agency on a daily basis that lists the resources that they have available and then disseminates the national situation to each of the agencies (K. Connors, personal communication, May 29th, 2011). If the number of simultaneous events increases, the number of resource requests will likely increase as well. In order to efficiently manage a larger number of resource requests, more frequent updates will be necessary to assess which resources are still available. National awareness of available resource will also be critical. Information could be delivered faster and more efficiently if it is available in a shared database. This would enable fire managers to obtain information at any time without having to rely on CIFFC's updates. Furthermore, to ensure that the most accurate information is available, CIFFC should monitor the nature, amount, and frequency of information sharing.

The supplemental analysis demonstrated another necessity for increased efficiency: standardization. Das and Teng (1988) explained that standards can help develop a common set of values and norms to increase overall predictability of people's actions within a partnership. CIFFC has already benefited from the initiation of national standards including retardant specifications, work wear standards for forest firefighters, physical fitness requirements for fire fighters, annual exchange standards/specifications and charge rates (Natural resources Canada, 2007). While the benefits of standardization have been realized,

there is still some resistance to implementing resource management standards. This resistance is likely due to the distinctiveness of individual agency protocols and plans, and the agency's desire to remain in control. Some fire managers commented in the survey that "rules are not the answer, partnerships are key" and that "each agency needs the ability to manage their own resources".

Resource management becomes more chaotic during simultaneous forest fire events. If the frequency of these events increases, it will be valuable to know exactly how each of the resource sharing partners is likely going to react. Standards can help guide resource sharing procedures so that agencies perform in a particular way under various circumstances; therefore standardization can help predict how each agency will act. Once standards have been initiated, fire management staff should be surveyed to assess whether or not the standards have increased the efficiency of the resource sharing system. Furthermore, every 5-10 years, standards should be re-evaluated to determine if they are still appropriate or if modifications need to be made. The survey and subsequent evaluations should be issued by CIFFC since they will likely play a large roll in creating the standards.

Since the provinces and territories are in charge of forest fire management, it is necessary that each agency agrees upon the installation of an information sharing database and on standardization before these mechanisms can be implemented nationally. Reluctant fire managers need to be convinced of the opportunities that could come from implementing information sharing networks and standardization throughout Canada. Using precedence from similar endeavors can demonstrate how each of these mechanisms could benefit forest fire resource management. The blood bank example from the supplemental analysis could be

used to convince managers of initiating an information sharing system. The blood bank system has succeeded in efficiently tracking, managing, and assessing blood reserve availability by increasing the visibility of critical information (Delen et al., 2009). Meanwhile supply chain management demonstrates how each member involved in the requesting and distribution process is vulnerable to the consequences of their partners' decisions. Examples of supply chain management can show managers how standardization would increase predictability and decrease vulnerability. Both of these options provide an opportunity to prepare for an increase in simultaneous forest fire events.

Evaluation

Natural Resources Canada's evaluation of CIFFC (Natural Resources Canada, 2007), was the only evaluation I was able to find that assessed the effectiveness of forest fire resource sharing in Canada. This evaluation mainly considered the center's relevance/rationale, results, and cost-effectiveness (Natural Resources Canada, 2007). Most of the recommendations in the CIFFC evaluation do not apply to this study since they are focused on improving CIFFC as a business rather than evaluating how efficiently resources are being shared between agencies. Some of the limitations however, were similar to those identified in this study. For instance, the need for increased distribution of national situation information and the initiation of standards were both discussed. Since its evaluation, CIFFC was able to increase the dissemination of information and it successfully initiated standards regarding personnel and equipment.

If climate change begins to influence forest fire regimes the resource management system needs to be re-evaluated. This time all external agencies (including CIFFC, the

Compact partners and any other international resource sharing partners) need to be included in the discussion. This evaluation would enable fire managers to better determine Canada's ability to cope with an increased number of simultaneous forest fire events and to assess national resource sharing strengths and weaknesses. Since Natural Resources Canada has already performed an evaluation of CIFFC, and because they are a national entity, it would be most appropriate for them to carry out this evaluation.

6.2 Recommendations

Typically the large scale investment necessary to make big changes is triggered by extreme events that give legitimacy to government action (Adger, Arnell, & Tompkins, 2005). This makes it difficult for Canadian fire management agencies to act proactively to the threat of climate change and simultaneous forest fires. However, not all improvements require great funding. Smaller steps can be taken now to help the transition to larger plans later on. A phased approach is appropriate for implementing plans gradually. Since we are unsure of exactly when climate change will begin to affect forest fire regimes, it would be beneficial to remain flexible and only make smaller adjustments to the resource sharing system until more information can be confirmed. Therefore, the following recommendations should be implemented in phases:

Phase 1: Collect more information to determine the national need for resources and create a report that details the flow of financial funds during extreme fire events - This information will help to make more accurate predictions regarding the number of resources and the amount of financial support agencies are likely to need in the future. This information needs to be collected by individual agencies.

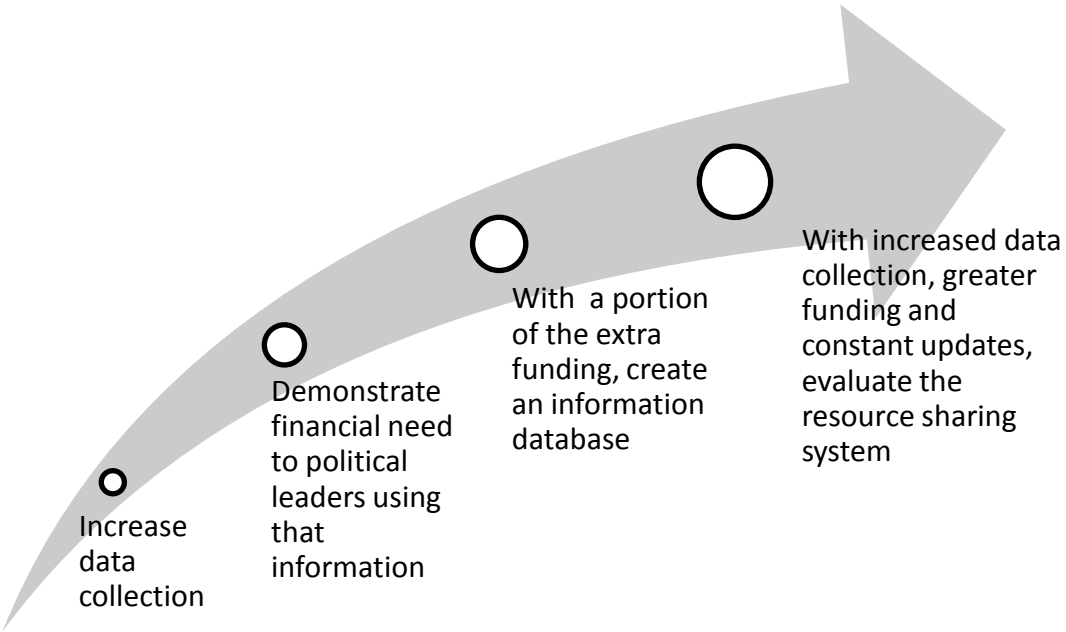
Phase 2: Using the results of this study and the new information being collected, demonstrate to political leaders the severity of the resource sharing situation and request an increase in budgets – Agencies should approach the CCME collectively and use the Council as a resource to facilitate coordinated action regarding forest fire management needs such as budget increases.

Phase 3: Increase resource sharing efficiency by creating a national network that shares resource information and by standardizing resource sharing policies and procedures – Neutralize opposing agencies with precedence of successful examples. CIFFC already collects information and has initiated equipment standards therefore they have the experience necessary to manage these changes.

Phase 4: Formally evaluate the resource sharing system – Assess interagency resource sharing and include all external agencies to observe whether resource sharing has improved and to make appropriate adjustments to management as necessary. Since Natural Resources Canada has had experience with evaluating CIFFC in the past, they should implement this evaluation process.

Information collection is the first phase because it is the easiest to accomplish with the least financial investment. Once more information is collected and evaluated there will be a better understanding of the number of resources typically needed in a fire seasons. This information, along with the results of this study, can be used to demonstrate the need for increased fire management budgets to political leaders. If budgets are increased there will be an opportunity to create an information database to be shared amongst all agencies. As agencies become more familiar with one another through the exchange of information it will be easier to suggest standards that will further improve resource sharing efficiency. After all of these modifications are made, the entire resource sharing system as whole should be evaluated.

Figure 7: Increasing resilience – a phased approach



The goal of each phase is to improve the efficiency of resource sharing between all 13 Canadian forest fire management agencies and their sharing partners (including American and other international partners) (Figure 7). This will then help ensure that the number and severity of national forest fires do not exceed the suppression capability of national resource stocks, thus ensuring the protection of the public, their communities, and Canada's natural resources.

6.3 Conclusion

This research set out to assess how well existing forest fire resource sharing agreements have mitigated the impacts of simultaneous forest fire events. Results demonstrated that, while resource sharing is an excellent tool for reducing the costs associated with fire suppression, its utility is limited and there have been instances where Canada's resource sharing system has been overwhelmed.

The more important question then became: Will current forest fire resource sharing practices be able to cope with an increase in resource requests, if simultaneous forest fire events increase as a result of climate change? The answer is no. Current coping mechanisms will not be sufficient as natural disasters become more costly and more frequent.

Optimistically, if the five recommended phases presented above were implemented this year, fifteen years from now, resource sharing would be simpler with: standards of operation, information shared openly and conveniently, and frequent evaluations to facilitate continuous improvement as the environment changes. However, it is important to realize that

even if adjustments are made, the purpose of forest fire resource management remains the same; to reduce the risk to people, property, and our natural resources. The intent of these recommendations is not to dramatically change a system that works, but to modify it so that it may continue to fulfill its function as the circumstances around it change.

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Appendix A: Inductive Coding Tallies

Years	Code (Key Word)	Tally
1993	Reliance	1
1994	Short Supply; Many requests	2
1995	[Requests] could not be filled; Recall (x2); Restricted [availability]; Competition; Border agreement	6
1996	Scarce	1
1997	Strain; Recall	2
1998	[Requests] could not be filled; Backed up; Scarce; Competition; Interagency dependence; At a premium; Military	7
1999	Reliance; Compact	2
2000		0
2001	Recall; Restricted [availability]; Compact	3
2002	[Requests] could not be filled (x2); Recall; Scarce; Competition; At a premium; Was burning	7
2003	[Requests] could not be filled; Outstanding Request; Strain; [resource pools] Dried up; Critical resource allocation protocol (x2); Competition (x2); At a premium; Military; In flames	11
2004	Critical resource allocation protocol; Compact	2
2005	[resource pools] Dried up; Scarce; Critical resource allocation protocol; Compact	4
2006	Outstanding Request (x6), Strain; Incident prioritization worksheet; Competition; Compact	10
2007		0
2008	Border agreement; Compact	2
2009		0

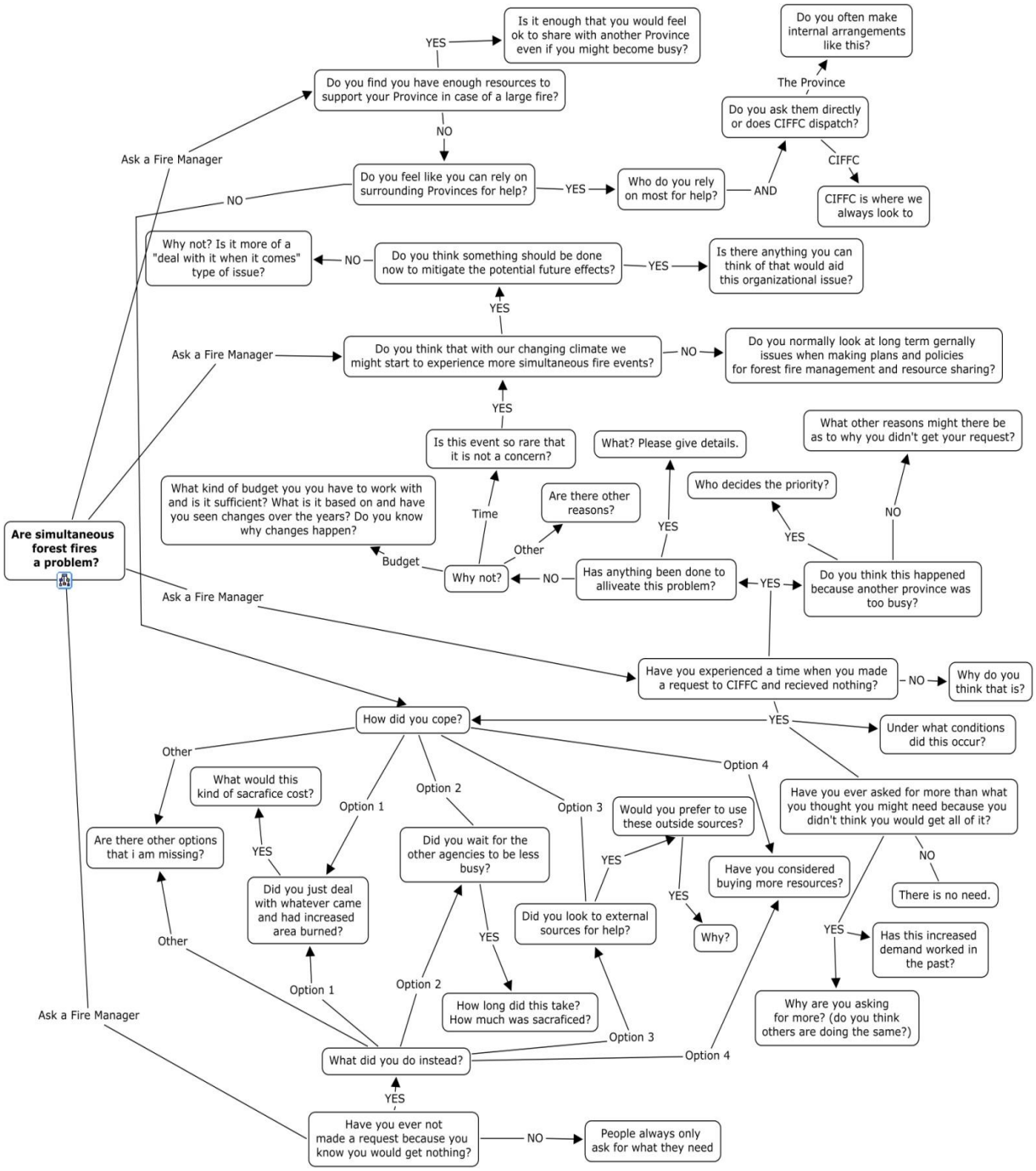
Appendix B: CRED Disaster Selection Criteria

For a disaster to be entered into the CRED International Disaster Database at least one of the following criteria must be fulfilled:

- Ten (10) or more people reported killed
- Hundred (100) or more people reported affected
- Declaration of a state of emergency
- Call for international assistance

(EM-DAT: The OFDA/CRED International Disaster Database – www.emdat.be – Université catholique de Louvain – Brussels – Belgium.)

Appendix C: Question Web



Appendix D: Survey - Recruitment Email

(Administered by the Director of CIFFC)

Will Climate Change Provoke a Forest Fire Management Crisis?

Hello,

This email is a request for assistance with a project to be conducted by Megan Gereghty as part of her Master's degree in the School of Planning at the University of Waterloo, Ontario, under the supervision of Dr. Roger Suffling. The title of the research project is "Evaluating Fire Fighting Cooperation in Canada at Times of Crisis".

They have set out to find whether or not predictions of increased forest fire frequency and intensity are threatening Canada's ability to effectively distribute available resources (including helicopters, bomber planes, fire crews, hoses, etc.), particularly when different provinces and territories are overwhelmed simultaneously. The purpose of this survey is to determine if simultaneous events are an existing issue and whether or not current sharing practices can withstand an increase in these events in the future as a result of climate change. The combination of archived information and this survey should determine if simultaneous events are/will be an issue.

The intent of the study is to connect with the forest fire manager of each province/territory by inviting them to participate in this survey. Attached to this email is the survey which was created to gather information about managing and requesting resources. The first page includes further information about the project. The publication of Megan's thesis will share the knowledge from this study with other forest fire researchers and forest fire agencies throughout Canada.

***Please note that while opening the document you may be prompted to allow "macros". By agreeing to this feature you will be able to open and fill out the form.**
Participation in the 20-minute survey is voluntary. Your name and/or geographical area will not appear in the thesis or reports resulting from this study. **Completed surveys are to be saved once filled in and sent back to Megan at mgereght@uwaterloo.ca.**

This study has been reviewed and received ethics clearance through the University of Waterloo, Office of Research Ethics.
If you have any questions regarding the study or would like more information to assist you in reaching a decision about participation, please contact Megan at 519-998-8094 (***mgereght@uwaterloo.ca***) or her supervisor, Dr. Roger Suffling at 519-888-4567 ext.33184 (***rcsuffli@uwaterloo.ca***).

Megan is very much looking forward to receiving your responses and thanks you in advance for your assistance with this project.

Yours sincerely,

_____
CIFFC Director

Appendix E: Survey - Comprehensive Cover Letter

Evaluating fire fighting cooperation in Canada at times of crisis:
Survey for Forest Fire Managers

You are invited to participate in a research study conducted by Megan Gereghty, under the supervision of Dr. Roger Suffling in the School of Planning at the University of Waterloo, Canada. The survey is for a Master's thesis. The objective of the survey is to find out details of provincial and territorial forest fire resource sharing practices. The following is the rationale for the study:

Increased forest fire frequency and intensity are predicted to threaten Canada's ability to effectively distribute available forest fire management resources (including helicopters, bomber planes, fires crews, hoses etc.), particularly when different provinces and territories are stressed simultaneously. The purpose of this study is to determine if simultaneous events are an existing issue and whether or not current sharing practices can withstand an increase in these events in the future as a result of climate change. The combination of historical information and this survey should determine if simultaneous events are a reality. An examination of inter-organizational sharing methods used by other professions will help foster new ideas for resource sharing practices. Hopefully, preparedness in advance of high risk forest fire situations will result in a greater level of safety for Canadian communities.

If you decide to participate, you will be asked to complete the following 20-minute survey that is completed anonymously. Survey questions focus on forest fire events that your jurisdiction has encountered as well as its forest fire resource management practices, particularly with regard to requesting external resources. The results from this survey should be beneficial to fire managers throughout Canada by helping to identify areas that may require modification.

Participation in this study is voluntary. You may decline to answer any individual question(s) that you do not wish to answer and you can withdraw from participation at any time by not submitting your responses. There are no known or anticipated risks from participating in this study.

Any information that you provide will be confidential. Responses will be collected via email and any personal or geographical identifiers will be separated from the surveys as soon as files are downloaded from the email. There will be no personal identifiers in the survey itself. The data collected from this study will only to be viewed by the Master's student, Megan Gereghty and her supervisor, Dr. Roger Suffling. All data will be summarized before distribution and no individual will be identified from the summarized results.

If you wish to participate please fill out the following Word form. Completed forms can be sent to Megan Gereghty (mgereght@uwaterloo.ca).

Should you have any questions about the study, please contact either Megan Gereghty at 519-998-8094 (mgereght@uwaterloo.ca) or Dr. Roger Suffling at 519-888-4567 ext. 33184 (rcsuffli@uwaterloo.ca). A copy of the summarized survey data will be sent to all provincial and territorial forest fire managers regardless of participation by approximately July, 2012.

I would like to assure you that this study has been reviewed and received ethics clearance through the Office of Research Ethics at the University of Waterloo. However, the final decision about participation is yours. If you have any comments or concerns resulting from your participation in this study, please feel free to contact Dr. Susan Sykes, Director, Office of Research Ethics, at 1-519-888-4567 ext. 36005 (ssykes@uwaterloo.ca).

Please consider taking some time out of your busy schedule to fill out this survey; your response is very important to us and will help build better fire resource-sharing outcomes!

Appendix F: Survey – Thank You Letter

Thank you for participating in our Forest fire fighting cooperation survey! Your feedback is extremely valuable to us.

We have hypothesized that simultaneous forest fire events will increase the amount of stress put on Canada's resource sharing system and that if climate change predictions hold true, this stress will only increase if nothing is done to change current management procedures. The purpose of this survey was to obtain detailed information about forest fire resource management and sharing from all provinces and territories in order to prove this hypothesis and to determine areas that could be modified to prepare for the future.

The results of the survey will remain confidential. Any personal or geographical identifiers have been separated from the survey and will not be included in the summary. Summarized results will be sent to all provincial and territorial forest fire managers via email by approximately July, 2012.

If you have any general comments or questions related to this study, please contact Megan Gereghty of the School of Planning at 519-998-8094 (mgereght@uwaterloo.ca) or Dr. Roger Suffling at the School of Planning at 519-888-4567 ext. 33184 (rcsuffli@uwaterloo.ca).

We would like to assure you that this study has been reviewed by, and received ethics clearance through, the Office of Research Ethics. If you have any concerns regarding your participation in this study, please contact Dr. Susan Sykes, Director, Office of Research Ethics at ssykes@uwaterloo.ca or 519-888-4567 Ext. 36005.

Appendix G: Survey (with results)

Evaluating forest fire fighting cooperation in Canada at times of crisis: Survey for Forest Fire Managers

Section 1: Climate change and forest fires

1. ***In your opinion, what is the current level of awareness about climate change and increasing forest fire occurrence within your agency*:***

☐ Aware of the issue ☐Unsure ☐Unaware of the issue

	1	2	3	4	5	6	7	8	9	10	11	Total
Aware	x		x	x	x	x	x	x	x	x	x	10/10
Unsure		x										1/11
Unaware												0/11

If you chose "unsure" or "unaware of these issues" please proceed to question 2. Otherwise please answer the questions below by checking the answer that best describes your agency's stance on climate change and forest fire occurrence, adding descriptions where necessary.

Is your organization concerned?

☐YES ☐NO → If **no**, why not? (No comments)

↓

If **yes**, please continue...

	1	2	3	4	5	6	7	8	9	10	11	Total
YES	x		x	x	x	x	x	x	x	x	x	10/10
NO												0/10

Are they in the process of responding or forming plans?

☐YES ☐NO → If **no**, why not? 1 – Implications for our jurisdiction still uncertain 3 – Climate change or other factors have caused a reduction in the number of fires

↓

If **yes**, please continue...

	1	2	3	4	5	6	7	8	9	10	11	Total
YES				x	x	x	x	x	x	x	x	8/10
NO	x		x									2/10

Are these plans being implemented?

☐YES ↓

☐NO → If **no**, why not? 8 - The Provincial government and its partners are currently developing a provincial Natural disturbance Management Strategy. It will be based on risk management and will address, amongst other thing, climate change. Implementation will depend on the final strategy and operational considerations. So far, there has been no operational response 11 – Plans incomplete

If **yes**, what kinds of plans?

	1	2	3	4	5	6	7	8	9	10	11	Total
YES				x	x	x	x		x	x		6/8
NO								x			x	2/8

2. ***Has your agency* ever encountered an event where the resources they requested from an external agency* were not available because they were already being used by another agency dealing with fire suppression?***

☐ YES ☐ NO

	1	2	3	4	5	6	7	8	9	10	11	Total
YES				x	x		x		x	x		5/11
NO	x	x	x			x		x			x	6/11

If <u>no</u> please skip to question 5, otherwise continue to question 3

3. ***In which years has the simultaneous need* for resources hindered your agency's ability to obtain forest fire fighting resources from external agencies? Please select all applicable years.***

2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Individual Selections (x)	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total
4				**x**				**x**	**x**		**3/10**
5				**x**	**x**					**x**	**3/10**
7		**x**					**x**		**x**		**3/10**
9		**x**									**1/10**
10		**x**		**x**			**x**				**3/10**
Year's total	**0**	**3**	**0**	**3**	**1**	**0**	**2**	**1**	**2**	**1**	**13/13**

4. ***Considering the years that you selected above, please check the coping mechanism your agency used to deal with the inability to obtain resources and select its level of effectiveness. Please elaborate on your choice in the space provided:***

(✓)	Coping mechanism	Outcome (circle and elaborate)
☐	Wait until resources became available from your agency's primary suppliers*	☐ Effective ☐ Neither Effective ☐ Ineffective or ineffective **Why?**
☐	After being denied resources from the primary supplier*, make requests to other external agencies*	☐ Effective ☐ Neither Effective ☐ Ineffective or ineffective **Why?** Please also specify the external agency used:
☐	Wait for the weather to change and the situation to work itself out	☐ Effective ☐ Neither Effective ☐ Ineffective or ineffective **Why?**

☐	Suppress the fire as best you can using only the resources your agency has and do not look for external aid	☐ Effective ☐ Ineffective **Why?**	☐ Neither Effective or ineffective
☐	Other, please describe:	☐ Effective ☐ Ineffective **Why?**	☐ Neither Effective or ineffective

Coping mechanism	Effective	Neither	Ineffective	Why?
Wait until resources became available from your agency's primary suppliers*	5	4	9, 10	5: Depending on the duration of need, we always wait for the other agencies to mount a reply. Only sometimes do resources come quickly. If you plan ahead, you have time to find supplies. 10: may never become available
After being denied resources from the primary supplier*, make requests to other external agencies*	5, 7, 9, 10	4		5: Our primary source is CIFFC, which is really a broker for many other agencies. So one request is really going to many sources of supply, and will continue to re-request over days. Alternatively, we go to GLFFC, and get resources from MI, MN, or WI. It has been a while since CIFFC went to the USA 7: Able to access US resources through compact (Minnesota, Wisconsin) 9: eventually gets resources (USFS) 10: Private of international
Wait for the weather to change and the situation to work itself out		4, 7, 10	5	5: Waiting is not a strategy. If there are not recourses, you will manage with what you have, set priorities and keep going. 7: Time of year- fall 10: sometimes the better alternative but have to take risks

Suppress the fire as best you can using only the resources your agency has and do not look for external aid	5, 10	4, 7, 9		5: the first part of the sentence and the last are not mutually exclusive. Fire managers to both simultaneously. 7: Add internal resources as they become available within the province. 9: have no choice 10: May have to use alternative resources such as more personnel or other kinds of aircrafts
Other, please describe:	7	4		4: Increased reliance and development of ad hoc local resources, For all the questions above our agency has to include all of those options not just waiting for one over the other. All of these options get pursued simultaneously to help deliver on the gap in resources.7:Prioritize fire suppression activities utilizing priority zone map

5. ***Considering years in the past decade, please select an answer in every row that best fits your opinion:***

Within your agency's jurisdiction...

	Increased	**Remained the same**	**Decreased**
Has forest fire intensity:	☐	☐	☐
Has the number of forest fires:	☐	☐	☐
Has the simultaneous need* for forest fire suppression resources:	☐	☐	☐
Has the frequency of unfulfilled resource requests from your agency to external agencies*:	☐	☐	☐
Has the ability to suppress fires using only your agency's own resources:	☐	☐	☐

	Increased		Remained the same		Decreased	
	#'s List	/11	#'s List	/11	#'s List	/11
Has forest fire intensity:	4, 6, 7	3/11	1, 5, 8, 9, 10, 11	6/11	2, 3	2/11
Has the number of forest fires:	4	1/11	5, 7, 9	3/11	1, 2, 3, 6, 8, 10, 11	7/11
Has the simultaneous need* for forest fire suppression resources:	4, 6, 7, 10	4/11	1, 2, 5, 8, 9, 11	6/11	3	1/11
Has the frequency of unfulfilled resource requests from your agency to external agencies*:	4	1/11	1, 2, 5, 6, 7, 8, 10, 11	8/11	3, 9	2/11
Has the ability to suppress fires using only your agency's own resources:	11	1/11	1, 2, 5, 6, 7, 8	6/11	3, 4, 9, 10	4/11

6. ***In your opinion, if simultaneous resource requests become more frequent throughout the Canadian resource sharing system...***
   Will Canada's resource sharing system need to increase its forest fire suppression resource stock on a national scale to meet demand?

☐ YES ☐ NO ☐ NOT SURE

	1	2	3	4	5	6	7	8	9	10	11	Total
YES	x	x	x	x		x			x		x	7/11
NO					x			x				2/11
NOT SURE							x			x		2/11

Would your agency need to increase its forest fire suppression resource stock to cope internally?

☐ YES ☐ NO ☐ NOT SURE

	1	2	3	4	5	6	7	8	9	10	11	Total
YES			x	x		x			x	x	x	6/11
NO		x			x		x	x				4/11
NOT SURE	x											1/11

Section 2: Resource sharing practices

7. ***Please choose your agency's top three worst fire years since 2002 from each of the following drop down lists:***

(worst) 1st -2002

2nd -2002

3rd -2002

	Top 3 Years		
	1st	***2nd***	***3rd***
1	2004	2009	2002
2	2002	2004	2005
3	2006	2007	2005
4	2003	2009	2010
5	2011	2005	2003
6	2002	2006	2008
7	2003	2010	2008
8	2005	2007	2002
9	2011	2002	2004
10	n/a	n/a	n/a
11	2008	2009	2003

8. ***Please choose all years from the last decade when your agency:***

Not only requested help but heavily relied on resources provided by external agencies

2002 ☐ 2003 ☐ 2004 ☐ 2005 ☐ 2006 ☐ 2007 ☐ 2008 ☐ 2009 ☐ 2010 ☐ 2011 ☐

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	**Total**
1			x					x			2
2											0
3						x					1
4		x	x	x			x	x	x		6
5		x		x	x	x				x	5
6	x				x						2
7		x			x	x	x		x	x	6
8	x	x		x	x	x		x	x		7
9	x	x								x	3
10		x								x	3
11		x					x	x			3
Total	3	7	2	3	4	4	4	4	3	4	38

Dealt with their fire suppression needs without requesting any external aid

2002 ☐ 2003 ☐ 2004 ☐ 2005 ☐ 2006 ☐ 2007 ☐ 2008 ☐ 2009 ☐ 2010 ☐ 2011 ☐

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	**Total**
1											0
2	x	x	x	x	x	x	x	x	x	x	10
3	x	x	x	x	x		x	x	x	x	9
4											0
5			x				x	x	x		4
6			x			x		x			3
7	x		x	x				x			4
8			x				x			x	3
9			x	x	x	x	x	x	x		7
10							x				1
11	x		x	x	x	x			x	x	7
Total	4	2	8	5	4	4	6	6	5	4	48

9. ***In the last decade, have you ever gone a whole fire season <u>without</u> requesting resources from the following external agencies?***

CIFFC resource sharing

☐ YES ☐ NO ☐ NOT SURE

	1	2	3	4	5	6	7	8	9	10	11	Total
YES		x	x	x	x	x	x	x	x	x	x	10/11
NO												0/11
NOT SURE	x											1/11

Compact* resource sharing

☐ YES ☐ NO ☐ NOT SURE

	1	2	3	4	5	6	7	8	9	10	11	Total
YES		x	x		x	x	x	x	x	x	x	9/11
NO	x			x								2/11
NOT SURE												0/11

International resource sharing

☐ YES ☐ NO ☐ NOT SURE

	1	2	3	4	5	6	7	8	9	10	11	Total
YES		x	x	x	x	x	x	x	x	x	x	10/11
NO	x											1/11
NOT SURE												0/11

10. ***Please indicate what percent of the total amount of suppression resources (equipment, crews, supplies, etc.) used on average over the last decade would be provided by each of the following? (The total should equal 100%)***

	%
Your own agency's stock	
CIFFC Partners	
Compact Agreement Partners	
Other International Aid (Please list nations):	
Other (Please list):	
Total:	**=100%**

	Your own agency's stock	CIFFC Partners	Compact Agreement Partners	Other International Aid	Other (Please list)
1	70	20	10	0	0
2	100	0	0	0	0
3	65	5	5	0	25
4	90	7	2	1	0
5	79	20	1	0	0
6	97	3	1	0	0
7	93	6	1	0	0
8	70	25	5	0	0
9	90	8	1	1	0
10	88	9	1	1	0
11	95	4	1	0	0
Average	85.18%	9.73%	2.55%	0.27%	2.27%

11. ***When looking to obtain external fire suppression resources, in what order (1 is first) would your agency typically ask the following external agencies for help?***

CIFFC Partners

Compact Agreement Partners

Other American States

Other International Aid

Armed forces personnel

Other (Please list):

	Counts										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
CIFFC Partners	1	1	3	1	1	1	1	2	1	1	1
Compact Partners	2	2	2	2	3	2	2	1	2	2	2
Other American States	x	4	4	3	4	3	3	x	x	4	3
Other International Aid	x	5	5	4	x	5	6	x	3	5	4
Armed forces personnel	x	3	6	5	x	4	5	3	4	6	5
Other (Please list):	x	6	1	x	2	x	4	x	x	3	x

12. ***What percent of the resources <u>needed by your agency</u> do you think should be provided by your own agency in an average fire year? (Please choose one)***

☐ 0-20% ☐ 21-40% ☐ 41-60% ☐ 61-80% ☐ 81-100%

	0-20	**21-40**	**41-60**	**61-80**	**81-100**
1				x	
2					x
3					x
4					x
5				x	
6					x
7					x
8					x
9					x
10					x
11					x
Total	0	0	0	2	9

And in a "worst in the decade" fire year?

☐ 0-20% ☐ 21-40% ☐ 41-60% ☐ 61-80% ☐ 81-100%

	0-20%	21-40%	41-60%	61-80%	81-100%
1		x			
2				x	
3			x		
4					x
5				x	
6				x	
7					x
8				x	
9				x	
10				x	
11				x	
Total	0	1	1	7	2

13. ***Of all the resource requests made to your agency <u>by outside agencies</u> in a typical fire year, what percent would you say your agency is able to fulfill totally based on the total number of requests that year?***

☐ 0-20% ☐ 21-40% ☐ 41-60% ☐ 61-80% ☐ 81-100%

	0-20	21-40	41-60	61-80	81-100
1					x
2				x	
3					x
4					x
5				x	
6		x			
7				x	
8	x				
9				x	
10				x	
11				x	
Total	1	1	0	6	3

And in a "worst in the decade" fire year?

☐ 0-20% ☐ 21-40% ☐ 41-60% ☐ 61-80% ☐ 81-100%

	0-20	21-40	41-60	61-80	81-100
1				x	
2		x			
3	x				
4				x	
5			x		
6	x				
7				x	
8		x			
9	x				
10	x				
11	x				
Total	5	2	1	3	0

14. ***In 2011, at what agency preparedness level was your agency no longer willing to share their resources with other agencies? The following levels are those in the CIFFC daily fire reports (See appendix B for Levels chart).***

☐ a. Level 1 ☐ b. Level 2 ☐ c. Level 3 ☐ d. Level 4 ☐ e. Level 5 ☐ f. Don't know

	Level 1	Level 2	Level 3	Level 4	Level 5	Don't know
1						x
2			x			
3		x				
4						
5						x
6					x	
7			x			
8		x				
9			x			
10		x				
11				x		
Total	0	3	3	1	1	2

Section 3: About your agency

15. ***Please check a box for each of the following and add a short description under "why/why not" if you chose "yes" or no".***

Does your agency have written protocols and/or guidelines to help make decisions about...

When your agency should be requesting external suppression resources?

☐ YES ☐ NO ☐ NOT SURE

	YES	NO	NOT SURE
1	x		
2		x	
3		x	
4	x		
5	x		
6		x	
7	x		
8		x	
9	x		
10		x	
11	x		
Total	6	5	0

Reasons why - 4: to ensure consistency and good decision making process that anticipates need in advance; 5: we have a daily planning process and forecasting tools; 7: initial attack preparedness system 9: in draft form; 11: to provide guidance to Provincial Fire Duty Officer

Reasons why not - 2: Agency has not requested external resources in past 10 years; 3: good question; 6: wildfire situation and resources demands are assessed on an ongoing basis as situations are unique and dynamic; 8: to many parameters to consider; 10: not in our SOPs. Based on experience and projections

Which supplier* you will request resources from first under various circumstances?

☐ YES ☐ NO ☐ NOT SURE

	YES	NO	NOT SURE
1		x	
2		x	
3		x	
4			x
5		x	
6		x	
7	x		
8		x	
9		x	
10		x	
11	x		
Total	2	8	1

Reasons why - 7: CIFFC - National supplier under MARS; 11: CIFFC because generally looking for airtankers
Reasons why not - 2: generally agreed it would be CIFFC; 3: we know which is first it's just not written down; 5: duty officer will work with all supply sources, depending on situation; 6:wildfire situation and resources demands are assessed on an ongoing basis as situations are unique and dynamic; 8: we don't have any; 9: done by experience; 10: no
Reasons why not sure - 4: Not sure what you are asking here as the boxes don't like us with the question. Regardless the supplier is all dependent on the specific circumstances "closest best resource first". Sometimes that is compact sometimes CIFFC. For example IA targets on the border are actioned all the time in reciprocal effort under the compact would make sense to go through CIFFC

When to request resources from another supplier* if the primary supplier cannot fulfill the request?

☐ YES ☐ NO ☐ NOT SURE

	YES	NO	NOT SURE
1		x	
2		x	
3		x	
4			x
5		x	
6		x	
7	x		
8		x	
9		x	
10		x	
11	x		
Total	2	8	1

Reasons why - 7: Border Cooperation or Compact Agreements;
Reasons why not - 3: that's straight forward, immediately; 6: wildfire situation and resources demands are assessed on an ongoing basis as situations are unique and dynamic; 8: n/a; 9: done by experience; 10: not in our SOPs. Based on experience and projection
Reasons why not sure - 4: we will often make simultaneous requests not black and white. Principle as above “closest best resources”

The level of risk your agency is willing to take to share their resources with other agencies in need?

☐ YES ☐ NO ☐ NOT SURE

	YES	NO	NOT SURE
1		x	
2		x	
3		x	
4			x
5		x	
6		x	
7	x		
8		x	
9		x	
10		x	
11	x		
Total	2	8	1

Reasons why - 7: Initial Attack Preparedness System and Critical Resource Allocation; 11: Level 3
Reasons why not - 2:this decision is the responsibility of the fire management committee; 3: another good question; 5: can't write that down, it is contextual; 6:wildfire situation and resources demands are assessed on an ongoing basis as situations are unique and dynamic; 8: we don't take any risk; 9: done by experience; 10: not defined
Reasons why not sure - 4: we always try to risk manage requests to the highest degree recognizing we must cover basics at home regardless.

16. ***Please select one answer for each of the following.***
From your experience, does your agency typically...

share resources with the same agencies that they receive resources from?

☐ YES ☐ NO ☐ NOT SURE

	1	2	3	4	5	6	7	8	9	10	11	Total
YES	x			x	x		x		x	x		6/11
NO		x	x			x		x			x	5/11
NOT SURE												0/11

If yes which agencies? 1: CIFFC and NWC; 4: All but not limited to only certain agencies. Geographic proximity has a lot to do with it the need for "closest best resource"; 7: provinces/territories (CIFFC) CAN/US Reciprocal Agreement Border Coop and Compacts; 9: CIFFC; 10: BC, AB, SK, MAN, ON, QC, PC

share resource stock and distribution information directly with other Canadian agencies (not through CIFFC)?

☐ YES ☐ NO ☐ NOT SURE

	1	2	3	4	5	6	7	8	9	10	11	Total
YES	x	x		x		x	x		x			6/11
NO			x		x			x		x	x	5/11
NOT SURE												0/11

If yes which agencies? 1: Provinces and territories that request; 2: Northeast Compact; 4: all CIFFC doesn't have monopoly on this we are in constant communication around information with all our partners as need be. For the purpose of National resource capacity CIFFC is main conduit.; 6: border jurisdictions (AB, MB, NWT, Parks); 7: border and Compact agreements; 9: YT, NWT, Sask, BC;

Communicate directly with other Canadian forest fire fighting agencies, not through CIFFC, to get resources?

☐ YES ☐ NO ☐ NOT SURE

	1	2	3	4	5	6	7	8	9	10	11	Total
YES	x			x		x	x	x	x	x		7/11
NO		x	x		x						x	4/11
NOT SURE												0/11

If yes which agencies? 1: BC and Alberta; 4: through compacts. CIFFC still mail conduit; 6: border jurisdictions (AB, MB, NWT, Parks); 7: Quick strike and border agreements; 8: for quick strikes in ON, NB, NFL; 9: YT, NWT, SK, BC; 10: NW Compact

Does your agency...

have a decision-support system to distribute resources internally?

☐ YES ☐ NO ☐ NOT SURE

	1	2	3	4	5	6	7	8	9	10	11	Total
YES	x	x	x	x	x		x	x	x			8/11
NO						x				x	x	3/11
NOT SURE												0/11

If "yes", what kind? 1: alerts; 2: fire management decision support system; 3: class day system based on FWI values; 4: integral part of our management system; 6: internal process; 7: provincial Duty officer and Senior Management; 8: fighting capacity threshold; 9:computer decision support system;

track all of its forest fire fighting resources internally on a daily basis?

☐ YES ☐ NO ☐ NOT SURE

	1	2	3	4	5	6	7	8	9	10	11	Total
YES	x	x	x	x	x		x	x	x	x		9/11
NO						x					x	2/11
NOT SURE												0/11

If "yes", what software is used to do this? 1: iFMS; 2: fire management support system; 3: telephone. Email; 4: same as above; 6: manual process; 7: OPSFMS (Computer Fire Management System); 8: forest fire information system; 9: FIRES program; 10: EMBER resource allocation report

17. ***In your opinion, is your agency financially stable enough to augment its resource stock* in anticipation of worsening conditions within the next 10 years?***

☐ YES ☐ NO ☐ NOT SURE

	1	2	3	4	5	6	7	8	9	10	11	Total
YES						x	x					2/11
NO			x	x	x				x		x	5/11
NOT SURE	x	x						x		x		4/11

18. ***Has your agency communicated increased need for fire management resources to your minister or to cabinet (in the past 5 years)?***

☐ YES ☐ NO ☐ NOT SURE

	1	2	3	4	5	6	7	8	9	10	11	Total
YES	x	x	x	x	x	x	x		x	x	x	10/11
NO								x				1/11
NOT SURE												0/11

If yes, how have they done so? (Select all that apply)

☐ a. During the budget formulation process

☐ b. Informally on an ongoing basis

☐ c. Through written reports

☐ d. By public awareness through individuals

☐ e. By public awareness through companies

☐ f. By public awareness through media

☐ g. By public awareness through other branches of government (ex. Municipalities)

☐ h. Other means, please list:

	1	2	3	4	5	6	7	8	9	10	11	Total
a. During the budget formulation process	x	x		x	x	x	x		x	x	x	**9**
b. Informally on an ongoing basis	x		x	x		x	x		x	x		**7**
c. Through written reports	x	x	x	x		x	x		x	x		**8**
d. By public awareness through individuals												**0**
e. By public awareness through companies												**0**
f. By public awareness through media												**0**
g. By public awareness through other branches of government (ex. Municipalities)				x			x			x		**3**
h. Other means, please list:		x	x	x							x	**4**
Total	**3**	**3**	**3**	**5**	**1**	**3**	**4**	**0**	**3**	**4**	**2**	**31**

Other: 2: other cooperating government departments (air services division of department of transportation and works); 3: breakfast with the deputy; 4: presentation to cabinet and discussion paper; 5: we are always asking for more resources, but managing what we have. That is part of the normal budget process, just to keep up with inflation, deal with capital changes, etc. Every year we request additional funds to deal with suppression costs;

19. ***Please select one answer for each of the following statements based on your personal opinion:***

Your agency trusts that...

Other agencies will share the same proportion of their own resources as you do.

	1	2	3	4	5	6	7	8	9	10	11	Total
AGREE	x			x	x		x		x	x	x	7/11
NEITHER		x	x			x						3/11
DISAGREE								x				1/11

When your agency is in need, all available resources in other agencies will be at your disposal.

	1	2	3	4	5	6	7	8	9	10	11	Total
AGREE	x				x	x	x	x	x	x	x	10/11
NEITHER		x		x								1/11
DISAGREE			x									0/11

All agencies are working towards the betterment of national forest fire resource coordination.

	1	2	3	4	5	6	7	8	9	10	11	Total
AGREE	x	x	x	x	x		x		x	x	x	9/11
NEITHER						x						1/11
DISAGREE								x				1/11

If there is a dire need, other agencies will lend their resources even if their own agency is predicting upcoming stress.

	1	2	3	4	5	6	7	8	9	10	11	Total
AGREE				x	x		x					3/11
NEITHER			x						x		x	3/11
DISAGREE	x	x				x		x		x		5/11

In the coming decade, Canada's current sharing system will suffice for fire suppression needs.

	1	2	3	4	5	6	7	8	9	10	11	Total
AGREE					x			x				2/11
NEITHER		x		x		x	x		x			5/11
DISAGREE	x		x							x	x	4/11

20. ***If your agency submitted a request to each of the following external agencies, how confident (in percent value) would you be that the resources requested would be made available? Please select one range for each.***

CIFFC

☐ 0-20% ☐ 21-40% ☐ 41-60% ☐ 61-80% ☐ 81-100% ☐ Not Sure

	0-20	21-40	41-60	61-80	81-100
1					x
2				x	
3			x		
4		x			
5					x
6					x
7					x
8					x
9					x
10					x
11					x
Total	0	1	1	1	8

Compact partners

☐ 0-20% ☐ 21-40% ☐ 41-60% ☐ 61-80% ☐ 81-100% ☐ Not Sure

	0-20	21-40	41-60	61-80	81-100
1					x
2				x	
3					x
4		x			
5					x
6				x	
7					x
8			x		
9					x
10			x		
11					x
Total	0	1	2	2	6

International partners

☐ 0-20% ☐ 21-40% ☐ 41-60% ☐ 61-80% ☐ 81-100% ☐ Not Sure

	0-20	21-40	41-60	61-80	81-100
1					
2					
3	x				
4	x				
5				x	
6	x				
7				x	
8	x				
9			x		
10		x			
11	x				
Total	5	1	1	2	0

Section 4: Potential change

21. ***To alleviate the pressures of simultaneous resource requests on CIFFC and other resource sharing agencies do you consider any of the following to be reasonable?***

Obtain more resources within individual agencies to become <u>more self-sufficient</u> on a Provincial/Territorial scale

	YES	NO	MAYBE	NOT ENOUGH	REASONING
1	x				The more resources Canada wide the better
2	x				
3	x				We all have to increase capacity to meet expect future demand
4	x				Nationally resource capacity has not kept pace with increase in fire workload

5	x				Relieving the requirement to borrow is always a first choice. This includes revising your policy or strategy to not require additional fire suppression resources.
6	x				Shift resources sharing to address extreme situations rather than routine occurrences
7		x			
8			x		
9			x		low overall likelihood
10	x				however, this cost has to be justified
11		x			Reasonably will resourced now
Total	7	2	2	0	

If an agency has the budget to purchase more resources, ensure that they do so in order to increase the overall national stock available for sharing

	YES	NO	MAYBE	NOT ENOUGH	REASONING
1	x				see above
2			x		
3	x				If there is alot of sharing, extra resources cost you little to nothing. The receiving agency pays the bills.
4	x				Same as above
5		x			No agency will have budget to purchase more resources.
6			x		
7		x			
8		x			
9			x		would be a side benefit but not the main reason
10			x		national sharing is important but not the priority
11			x		difficult to think agencies would have that kind of flexibility
Total	3	3	5	0	

Agencies can't always share their resource because they need to insure the safety of their own jurisdiction so, have CIFFC buy its own set of resources that they can manage without this constraint

	YES	NO	MAYBE	NOT ENOUGH	REASONING
1		x			disagree - this is a slippery slope and potentially on of conflict
2		x			
3			x		There are quiet years, what are they going to do if they are not required. Anyway CIFFC's money is our money.
4		x			Absolutely not IFFC is not a delivery agent and should never take on this role.
5		x			CIFFC is not a fire management agency and can't own/manage resources
6		x			Duplications of efforts and poor economies of scale
7		x			
8		x			
9		x			not CIFFC's mandate
10			x		although CIFFC is in existence to exchange resources on the agency behalf
11		x			don't agree with this option
Total	0	9	2	0	

Create a data collection system where nationwide forest fire resource data is readily available to all Canadian agencies on a daily basis to enhance collaborative communication and timing

	YES	NO	MAYBE	NOT ENOUGH	REASONING
1	x				communications is always proven valuable
2			x		
3		x			CIFFC does that now. However there could be more data in the daily report.

4	x				Yes as part of our national response plan a critical element to have current inventory that is up to date annually. Track all resources potentially available not just limited to equipment and Type 1 resources.
5	x				In place now.
6	x				Increase awareness of future availability/demands on resources.
7	x				
8		x			
9			x		too onerous
10	x				
11			x		maybe of use
Total	6	2	3	0	

Whenever possible, use pre-attack planning to strategically place resources where fire predictions suggests there is the highest risk

	YES	NO	MAYBE	NOT ENOUGH	REASONING
1	x				this is done by most agencies internally and with some creative planning could be done nationally
2			x		
3	x				Only makes sense
4	x				Always standard practice regardless.
5	x				Is done now.
6			x		
7	x				
8		x			
9		x			not able to set national priorities
10	x				
11	x				makes sense and used now
Total	7	2	2	0	

Annually review the forest fire resource sharing capacity of CIFFC, the compacts, international partners and individual agencies to measure Canada's resource sharing capacity as a whole

	YES	NO	MAYBE	NOT ENOUGH	REASONING
1	x				again good communications and analysis is beneficial
2	x				
3	x				Have to know how many toys are in the toy box
4	x				See comments re. National response plan
5		x			sharing is contextual
6	x				create annual "inventory" to assess trends and pre-identify sources of resources
7	x				
8	x				
9			x		good idea but too frequent at annual
10	x				we do that already
11		x			Not sure this is needed annually
Total	8	2	1	0	

Implement a standardized evaluation tool for individual agencies to see how effectively they use their resources

	YES	NO	MAYBE	NOT ENOUGH	REASONING
1	x				good idea - consistency is always good
2	x				
3			x		Good luck with that
4		x			Jurisdiction by jurisdiction prerogative.
5	x				
6		x			
7				x	
8		x			
9			x		lots of diversity between agencies
10			x		agencies generally have to analyse their resources in this financial climate
11	x				could be useful
Total	4	3	3	1	

Improve communication links between forest fire management and political leaders to instill the urgency for improvements to the current system

	YES	NO	MAYBE	NOT ENOUGH	REASONING
1	x				again communication always helpful
2			x		
3			x		Good luck with that too.
4	x				Ensure they know risks. Part of the need for National response plan.
5		x			There is a link and I would not suggest one priority is the result of managers not communicating within their governments.
6			x		
7				x	
8		x			
9			x		good luck we try it now
10	x				
11	x				but some of this is done now. Many people fighting for limited financial resources.
Total	4	2	4	1	

In principle, as forest fire management costs fluctuate from year to year, determine a way to carry forward unspent funds into the following fiscal year

	YES	NO	MAYBE	NOT ENOUGH	REASONING
1	x				we have this in the Yukon - called revolving fund
2	x				
3			x		haha Good luck
4		x			Impossible given fiscal structures.
5		x			Governments carry forward funds from year to year. It's called the budget and debt.
6	x				

7		x			Each agency has budget policy to follow with regard to annual budget and allocation
8		x			
9			x		ok in theory but doesn't jive with most budget process realities
10	x				Absolutely, 5 year budgets.
11	x				interesting option
Total	5	4	2	0	

Gradually come to a national standard for procedural guidelines regarding resource management to encourage fluid sharing of resources throughout Canada

	YES	NO	MAYBE	NOT ENOUGH	REASONING
1	x				again good for consistency
2	x				
3	x				It is quite fluid now.
4	x				More the better for seamless integration
5		x			Rules are not the answer. Partnerships are key. Decision making is fluid in context of a complex system.
6			x		
7		x			Each agency need ability to manage their own resources
8		x			
9		x			CIFFC is working on some initiatives now
10	x				that may be a consideration
11	x				
Total	6	4	1	0	

Modify CIFFC's sharing agreement to ensure that each agency has an appropriate level of protection* relative to the amount of forested area it is responsible for, its average area burned and the amount of resources it uses in a year

	YES	NO	MAYBE	NOT ENOUGH	REASONING
1			x		good conceptually - devil in the details i would suspect
2		x			
3	x				Only makes sense
4				x	Not sure exactly what is being asked. The need is to review mars funding formula to ensure it fair and reasonable given the changing face of fire.
5		x			CIFFC is a manifestation of a partnership based on a willingness to share. A partnership cannot ensure that the partners do anything.
6		x			wildfire protection is a provincial responsibility
7		x			Already being done by the provinces and territories
8		x			
9		x			each agency has its own mandate
10		x			Not all agencies have the same fire problem. IE the NWT and PC have natural fire policies.
11			x		It would be an interesting exercise, maybe contain more than the statement. May be hard to define appropriate level of protection over some many diverse financial systems and geographical landscapes.
Total	1	7	1	1	

Glossary

Agreements (resource sharing agreements) – agreements are used to facilitate resource sharing between 2 or more forest fire management agencies

An agency – is a regional organization (typically a province, territory, or state) that shares forest fire resources with other such agencies

An agency under stress – occurs when forest fire events strain an individual agency's forest fire resources such that they seek external assistance from outside their jurisdiction

The Canadian Interagency Forest Fire Centre – a non-profit organization providing Canada with wildland fire control services by facilitating the sharing of fire suppression resources to and from different agencies as necessary

Compact agreement – agreements between provinces and participating US States whereby forest fire resources are shared laterally between the Canada and United States border (Compacts include: the Northwestern, Northeastern and Great Lakes Compact agreements)

Forest fire resources – Any and all equipment, vehicles and/or personal needed within the fire suppression process (for example: waterbombers, hoses, fire fighting teams)

Resource Request – Resource requests describe the amount and types of resources desired by an individual agency and are used when their own resources are insufficient to fight forest fires within their jurisdiction; requests are made by agencies to CIFFC, Compact partners, or other external resource sharing agencies

Resource sharing – lending ones resources to another agency to aid their forest fire suppression process (Sharing is not required; agreements are only made to facilitate these interactions)

Resource sharing system – the resource sharing system is comprised of all sharing partners and includes all of the resources available for sharing at a given point in time

A stressed resource sharing system - occurs when forest fire events strain the forest fire resources of many agencies such that agencies are not able to obtain the resource they request through their resource sharing system

Simultaneous forest fire events or regional fire outbreaks - an occasion when 2 or more fire events cause 2 or more agencies to exhaust their fire suppression resources resulting in the need to request resources from their resource sharing partners