

Wildland fire suppression related fatalities in Canada, 1941-2010: a preliminary report

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Abstract. This paper compiles for the first time a comprehensive summary of firefighter deaths associated with wildland fire suppression operations in Canada covering the period from 1941 to 2010. It is based on three sources of information: (i) annual reports of forest fire losses published and/or compiled by the federal forest service in Canada (1941-1990); (ii) annual reports of the Canadian Interagency Forest Fire Centre (1991-2010); and (iii) a summary being compiled for the Canadian Firefighters Memorial based on information supplied by fire management agencies and private aircraft companies. According to all of these records, there have been some 165 reported wildland fire suppression related fatalities in Canada over the past 70 years. This represents an average of at least two fatalities per year. There were no known fatalities reported in 23 of those 70 years. The maximum number of fatalities (16) in any given year occurred in 1955 in British Columbia, which also incurred 45% of the 132 firefighter deaths reported in Canada from 1941 to 1990. Many of the firefighter deaths have involved aircraft accidents.

Additional keywords: Canadian Fallen Firefighters Foundation, Canadian Interagency Forest Fire Centre, fatal accident, fire safety, fire statistics, line of duty death, wildland firefighter.

Introduction

Approximately 45% of Canada's land mass is covered by forests (Rowe 1972). With respect to wildland fires in Canada, noted global fire historian Dr. Stephen J. Pyne (2007) had this to say:

Fire is a defining element in Canadian land and life. With few exceptions, Canada's forests and prairies have evolved with fire. Its peoples have exploited fire and sought to protect themselves from its excesses, and since Confederation, the country has devised various institutions to connect fire and society.

For an appreciation of the significance of wildland fires in Canada, here are a few basic national statistics (after Hirsch and Fuglem 2006):

- About 8600 fires occur each year, burning over an area of some 2.5 million hectares.
- Lightning is responsible for approximately half the number fires, the majority of which occur in June and July, and roughly 85% of the total area burned.
- Fire management expenditures have reached \$500-600 million annually and are growing.

Wildland fire suppression is an inherently dangerous activity (Jackson 1948, 1950). As a result, fatalities unfortunately do occur from time to time. In contrast to the extensive reporting on wildland fire suppression related fatalities in the US (Wilson 1977; NWCG 1997; Mangan 1999, 2007, 2010; Munson and Mangan 2000), there has been no similar effort undertaken in

Canada to date. To our knowledge this paper constitutes the first attempt at a comprehensive compilation of data on wildland fire suppression related fatalities in Canada, representing two distinctly different, but parallel efforts by the authors unknown to each other until October 2010.

Annual reporting by the Government of Canada's forest service

Canada's federal forest service began annual reporting of nation-wide forest fire statistics in 1909 based on data supplied by provincial, territorial, and federal wildland fire agencies (Van Wagner 1988; Murphy *et al.* 2000). Beall (1982) provides an excellent historical overview of the evolution of this process. The information included in this annual reporting gradually expanded in scope. In 1940, the first attempt to begin reporting the 'number of fatalities' nationally was initiated, although it wasn't until the following year when every agency provided data on this particular fire statistic. Such reporting continued up until 1990 and typically provided a 10-year average. Thus, a 50-year database of fire suppression related fatalities by province/territory readily exists, and except for seven years (1970-1976), is a matter of published record. The data sources, according to their various formats (Fig. 1) as described by Beall (1982), are as follows:

- 1941-1947: from within the annual reports of the Dominion Forest Service.
- 1948 -1957: from reports of the Canada Forestry Branch (Anonymous 1949-1958).
- 1958-1969: from reports of the Canada Department of Forestry (Anonymous 1960, 1961; Lockman 1966, 1969, 1970, 1972; Maclean and Lockman 1967*a*, 1967*b*; and Mactavish and Lockman 1962, 1963, 1964).
- 1970-1976: from unpublished "Forest Fire Losses in Canada" summaries, Environment Canada, Canadian Forestry Service, Forest Fire Research Institute, Ottawa, ON.¹
- 1977-1990: from the Canadian Forestry Service (Brady 1979; Higgins and Ramsey 1992; Ramsey and Higgins 1981, 1982, 1986, 1991).

This first time compiled summary of the 'number of fatalities' from the above sources is presented in Table 1. This effort was started in the late 1990s (Alexander 2010*b*).

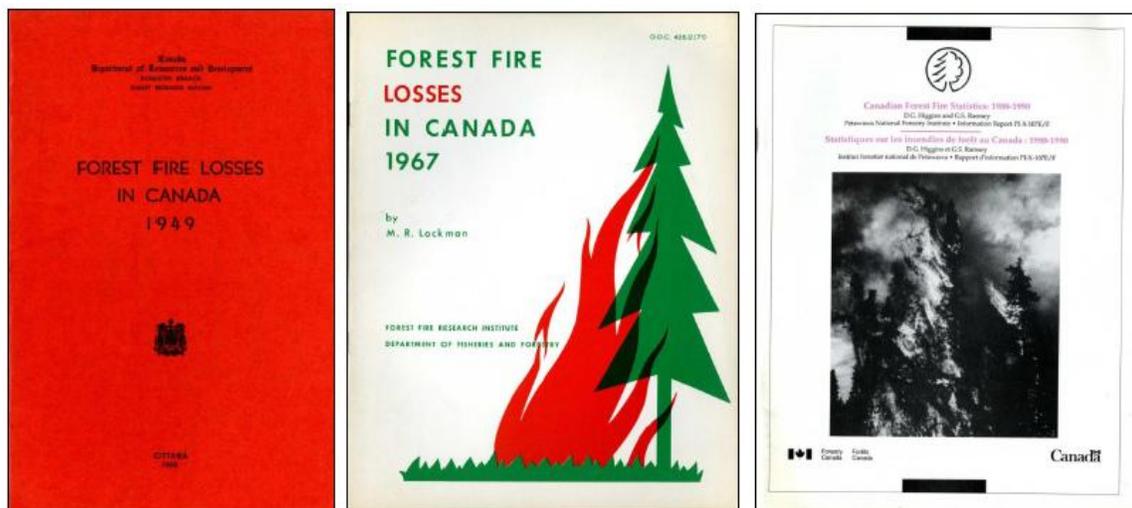


Fig. 1. Three examples of the annual reports on national fire statistics published by the Government of Canada's federal forest service over the period from 1941-1990.

¹ On file with Natural Resources Canada, Canadian Forest Service, Northern Forestry Centre, Edmonton, AB.

Table 1. Number of wildland fire fatalities by Canadian province/territory as reported in the annual forest fire statistics compiled by the federal forest service, 1941-1990

Year	BC	AB	SK	MB	ON	QC	NB	NS	PE	NL	NT	YK	Total
1941	-	1	-	-	-	5	-	-	--	--	--	--	6
1942	1	-	-	-	-	-	-	-	--	--	--	--	1
1943	-	-	-	-	-	-	-	-	--	--	--	--	0
1944	-	2	-	-	-	-	-	-	--	--	--	--	2
1945	-	-	-	-	-	-	-	-	--	--	--	--	0
1946	-	-	-	1	-	-	-	-	--	--	-	-	1
1947	-	-	-	-	-	-	-	1	--	--	-	-	1
1948	-	-	-	-	11	-	-	-	--	--	-	-	11
1949	-	-	-	-	3	-	-	-	--	--	-	-	3
1950	6	-	-	-	-	-	-	-	--	--	-	-	6
1951	3	-	-	-	1	-	-	-	--	-	-	-	4
1952	2	-	-	-	-	-	-	-	--	-	-	-	2
1953	-	-	-	1	-	-	-	-	--	-	-	1	2
1954	-	-	-	-	-	-	-	-	--	-	-	-	0
1955	11	-	-	3	2	-	-	-	--	-	-	-	16
1956	5	1	-	-	-	-	-	-	--	-	-	-	6
1957	-	-	-	-	-	-	-	-	--	-	-	-	0
1958	6	2	-	-	-	-	1	-	--	-	-	-	9
1959	1	-	-	-	1	-	-	-	--	-	-	-	2
1960	3	-	-	-	-	-	-	-	--	-	-	-	3
1961	-	-	-	2	1	-	-	-	--	-	-	-	3
1962	2	-	-	-	-	-	-	-	--	-	-	-	2
1963	-	-	-	-	-	-	-	-	--	-	-	-	0
1964	-	-	-	-	-	-	-	-	--	-	-	-	0
1965	-	-	-	-	-	-	-	-	--	1	-	-	1
1966	-	-	-	-	-	-	-	-	--	-	-	-	0
1967	5	-	-	-	3	-	-	-	--	-	-	-	8
1968	2	-	-	-	-	-	-	-	--	-	-	-	2
1969	-	-	-	-	-	-	-	-	--	-	-	-	0
1970	-	-	-	-	-	-	-	-	--	-	-	-	0
1971	-	-	-	-	-	1	-	-	--	-	6	-	8
1972	-	-	-	-	-	-	-	-	--	-	-	-	0
1973	-	-	-	-	-	-	-	-	--	-	-	-	0
1974	4	-	-	-	-	-	-	-	--	-	-	-	4
1975	-	-	-	-	-	-	-	-	--	-	-	-	0
1976	-	-	-	-	-	-	-	-	--	-	-	-	0
1977	-	-	-	-	-	-	-	-	--	-	-	-	0
1978	-	-	-	2	-	-	-	-	--	-	-	-	2
1979	1	-	-	-	-	-	-	-	--	-	-	-	1
1980	-	-	2	-	-	-	-	-	--	-	-	-	2
1981	-	-	-	-	-	-	-	-	--	-	-	1	1
1982	-	-	-	-	-	-	-	-	--	-	-	-	0
1983	-	1	-	-	-	-	-	-	--	-	-	1	2
1984	4	-	1	-	-	-	-	-	--	-	-	-	5
1985	3	-	-	-	-	-	-	-	--	-	-	-	3
1986	-	-	-	-	-	5	-	-	--	-	-	-	5
1987	-	-	-	-	-	3	-	-	--	-	-	-	3
1988	-	-	1	-	-	-	-	-	--	-	-	-	1
1989	-	-	1	-	-	-	-	-	--	-	-	-	1
1990	2	-	1	-	-	-	-	-	--	-	-	-	3
<i>n</i> = 50	61	7	6	9	22	14	1	1	0	1	6	3	132

Note: BC = British Columbia; AB = Alberta; SK = Saskatchewan; MB = Manitoba; ON = Ontario; QC = Quebec; NB = New Brunswick; NS = Nova Scotia; PE = Prince Edward Island; NL = Newfoundland-Labrador; NT= Northwest Territories; YT = Yukon Territory.

There are a couple of points to note in regards to Table 1. The Yukon Territory and Northwest Territories did not start contributing data to the national fire statistics database until 1946 (Murphy *et al.* 2000). Similarly, Newfoundland-Labrador didn't begin until 1949. Finally, Prince Edward Island only began reporting in 1974. However, based on local knowledge (D. McAskill, Prince Edward Island Department of Environment, Energy and Forestry, pers. comm., 2009) and other sources (e.g. Janzen 1990), it is believed that no wildland fire suppression related fatalities occurred in any of these jurisdictions between 1941 and the time they began reporting such statistics to the federal forest service. The 1971 Canada-wide total in Table 1 includes one (1) fatality on 'Other Federal Lands' but the specific location remains unknown.

On the basis of the data contained in Table 1, the following facts can be reasonably deduced about the wildland fire suppression related fatalities in Canada during the 50-years from 1941-1990:

- There was a total of 132 reported fatalities.
- The mean value (2.6) would suggest that on average there are about 2-3 fatalities per year.
- There were no known fatalities reported in 15 of the 50 years of record.
- The maximum number of fatalities in any given year (16) occurred in 1955.
- British Columbia sustained the highest number of fatalities (61), followed by Ontario (22) and then Quebec (14). Prince Edward Island was the only jurisdiction to have not registered a single fatality during this time.

Fig. 2 provides a general indication of the geographical distribution of the 132 reported fatalities.

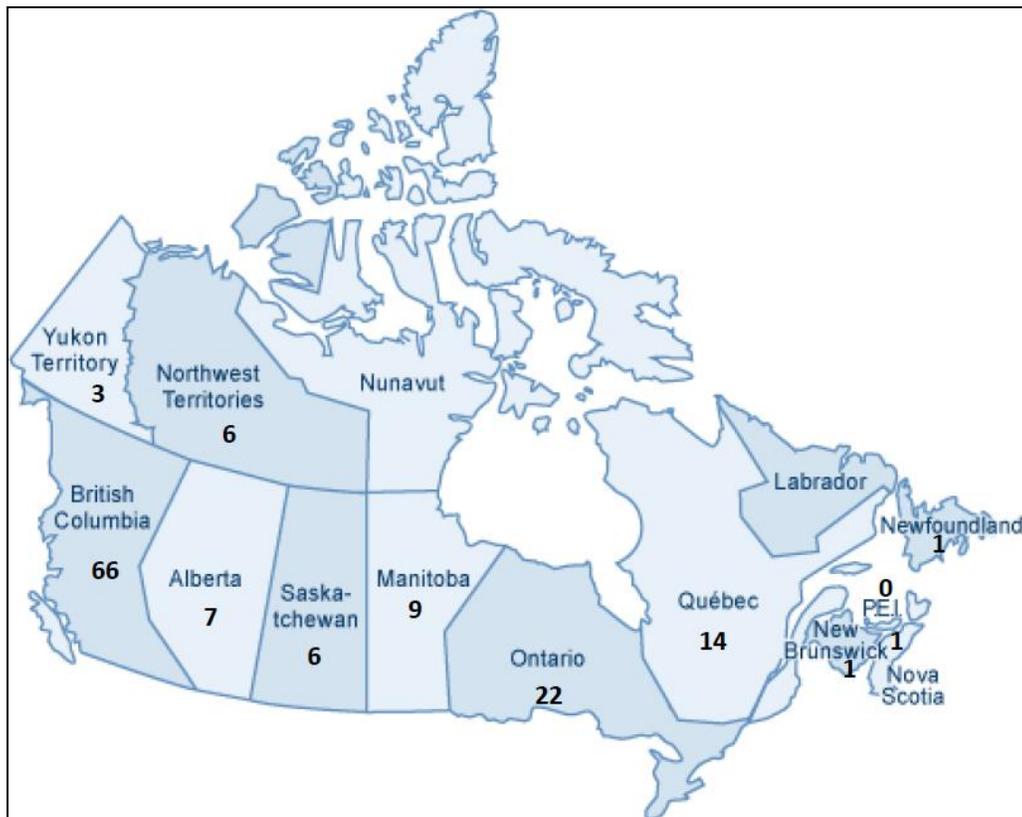


Fig. 2. Map illustrating the number of wildland fire suppression related fatalities in Canada for the 50-year period from 1941-1990 according to the provincial/territorial totals given in Table 1.

With the downsizing of the Canadian Forest Service (CFS) in 1995 and closing of the Petawawa National Forestry Institute, the compilation and reporting of national forest fire statistics by CFS fire research ceased. The National Forestry Database Program operated by the CFS (http://nfdp.ccfm.org/fires/quick_facts_e.php) continued to compile forest fire statistical data but not on fire suppression related fatalities. In 1997, the Canadian Interagency Forest Fire Centre (CIFFC) began producing annual reports which included data on firefighter fatalities in Canada but only the total number (<http://www.ciffc.ca/>). In other words there was no jurisdictional breakdown (Table 2). According to the data reported in Table 2, there were a total of 33 reported wildland fire suppression related fatalities in Canada during the 20-year period from 1991-2010, for a 70-year total of 165. The mean value (2.4) would also suggest on average at least two fatalities per year. There were no known fatalities reported in 23 of the 70 years of record.

Table 2. Total number of wildland fire suppression related fatalities for the period 1986 to 2010 as reported by the Canadian Interagency Forest Fire Centre (from CIFFC 2011)

Year	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Fatalities	6	3	3	0	3	4	2	0	2	4	0	0	0	0	0	2	0	3	2	0	3	3	2	1	5

To our knowledge, the forest services of Alberta and British Columbia are the only two organizations in Canada that have specifically developed ways to memorialize wildland firefighters that have died in the ‘line of duty’ (Figs. 3 and 4). In this way, as Gulliford (1997) phrased it, ‘The living have remembered the dead, and therefore, the dead go on living’.

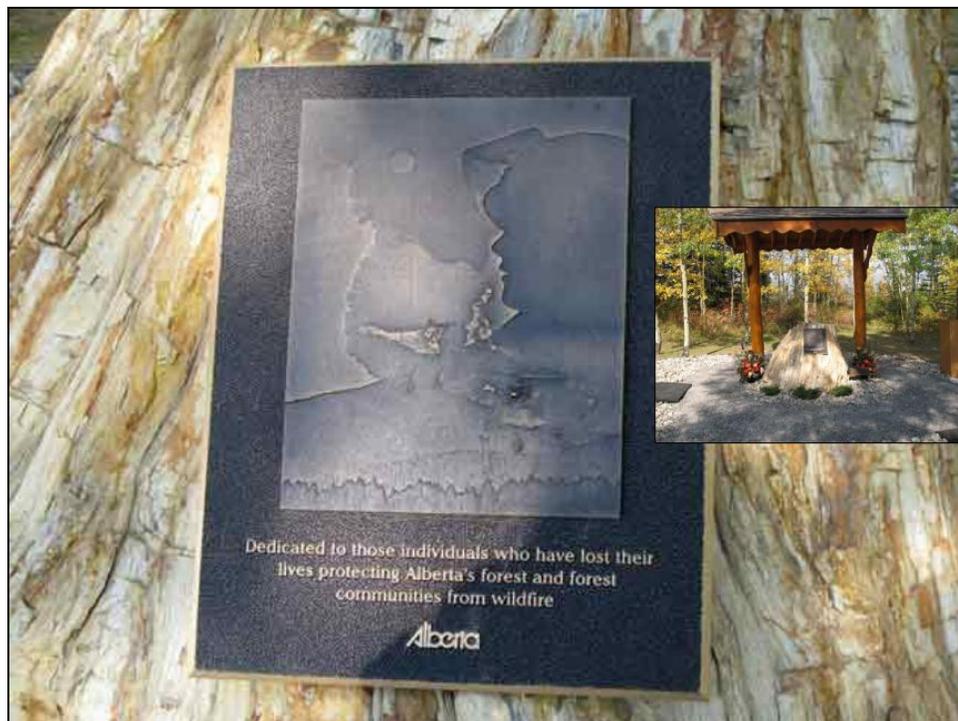


Fig. 3. Alberta Fallen Wildland Firefighter Memorial located at the Hinton Training Centre, Hinton, AB. Photos courtesy of B. Mayer, Alberta Sustainable Resource Development.



Fig. 4. Copy of the print that is prominently displayed in some 40 offices of the British Columbia Wildfire Management Branch. Courtesy of D. Marek, British Columbia Wildfire Management Branch.

The Canadian Fallen Firefighters Foundation initiative

The Canadian Fallen Firefighters Foundation (CFFF) was founded in 2003 (<http://www.cfff.ca/>). The CFFF includes paid and volunteer structural, wildland, military, and industrial firefighter fatalities. The CFFF began holding an annual ceremony starting in 2004. The CFFF have been working towards the establishment of the Canadian Firefighters Memorial in Ottawa, Ontario, scheduled for unveiling in September 2012. The intent is to include the names of all firefighters who have died in the 'line of duty'. The current list, dating back to 1848, includes the name of the firefighter, the incident date, and city/province, and can be viewed on the CFFF website (Fig. 5).

Paul Buxton-Carr currently serves as the wildland firefighter representative on the CFFF Board of Directors. Beginning in 2005, an effort was made to seek details on wildland firefighter fatalities, including pilots and flight crew, using a network of contacts in fire management agencies across Canada as well as private aircraft companies. The initial focus was on gathering basic information related to name, age, residence, location and date of incident, and cause of death. To date (April 2011), information on 149 fatalities has been compiled.

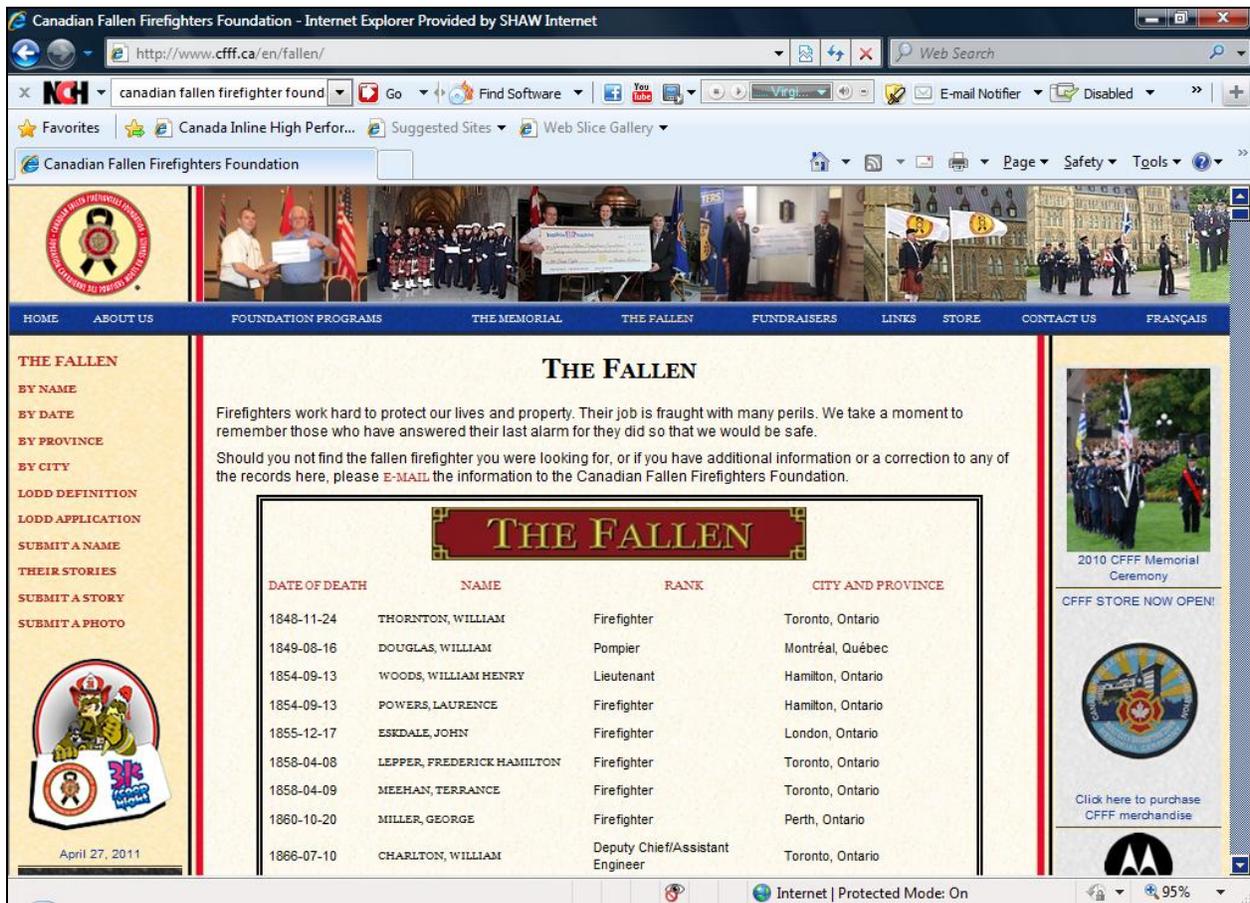


Fig. 5. Screen capture from the Canadian Fallen Firefighters Foundation website that lists firefighters that have died in the ‘line of duty’ (<http://www.cfff.ca>).

Causes of wildland firefighter fatalities in Canada

The federal forest service reports specify that the tabular data simply indicate ‘The number of fatalities due directly to fire or while in the act of controlling a fire’ (Brady 1979). The annual reports issued for the period 1948-1969 quite often, but not always, included some general comments (Table 3).

Unfortunately, the statistics reported in the federal forest service annual reports did not include fatalities related to prescribed fires. One notable example is the seven deaths associated with the Geraldton PB-3/79 incident in north-central Ontario on August 22, 1979 (Alexander and Thomas 2006, p. 17), otherwise known as the Esnagami Lake tragedy (Kirkpatrick 2004, pp. 177-178).

The CFFF website currently includes short summaries for some but not all of the wildland firefighter fatality incidents (Fig. 6). In the compilation effort associated with the Canadian Firefighters Memorial, the specific cause of death has not yet been determined for all of the reported fatalities. As a result, it is premature to attempt to provide a breakdown of the fatalities by cause, such as burnover or entrapment, aircraft accident, vehicle accident, heart attack, falling tree/snag or drowning, among others.

Table 3. Comments related to the reporting of the number of fatalities in the annual reports of the Government of Canada's federal forest service for the period 1948-1969

Year(s)	Comments
1948	Eleven persons lost their lives as a result of forest fires in 1948. This number, although considerably higher than any other in recent years, is fortunately much smaller than those resulting from some of the disastrous fires earlier in the century.
1949	Three lives were lost – all in Ontario – as a result of forest fires during the year.
1950	There were six fatalities, all in British Columbia, as a result of forest fires in 1950. This is almost double the average for the past ten years.
1951	Four people lost their lives as a result of forest fires in 1951, which represents a decrease of two as compared with the lives lost during the previous year, but an increase as compared with the 10-year average ... Deaths attributed to forest fires are not necessarily caused by the fires concerned. A firefighter killed en route to a fire, for instance, would be classed as having lost his life as a result of fire.
1952	Two lives were lost as a result of forest fires in 1952, both in British Columbia ... This is the same number as in 1951, and is somewhat lower than the average for the previous decade.
1953	One person in Manitoba and one in the Yukon Territory died through forest fires in 1953. The yearly average for the previous decade was three lives lost.
1954	No lives were lost through forest fires in 1954. The yearly average number of fatalities for the previous decade remained at three.
1955	Sixteen people lost their lives as a result of forest fires in 1955 ... Canada-wide statistics of this item go back only to 1940, but none of these previous years showed such a large total. Only two of the 16 killed were fire fighters, neither of who was included in the 11 fatalities suffered in British Columbia.
1956	Reports indicate that six persons lost their lives as a result of forest fires in 1956. Five were in British Columbia and one in Alberta.
1957	No deaths were attributed to forest fires in 1957.
1958	The regrettable increase in the number of fatalities attributed to forest fires is also noted.
1959-63	No comments.
1964	For the second consecutive year, no deaths were attributed to forest fires in 1964.
1965-66	No comments
1967	Even more tragic, however, than all other forms of losses recorded in 1967, are the many fatalities suffered as a result of forest fire protection activities. A total of 8 deaths were reported across Canada. Three water-bomber pilots and two flying fire-observers were killed in the air crashes in British Columbia while three men also lost their lives in Ontario. Only two fatalities were reported on an average over the past ten years.
1968-69	No comments.

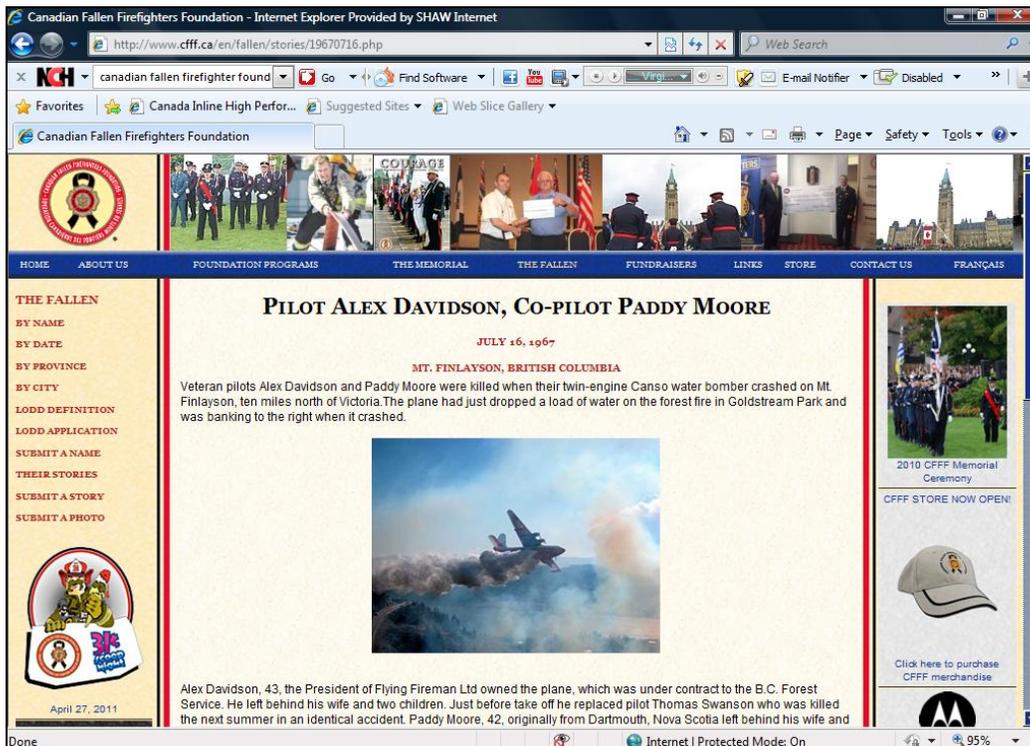
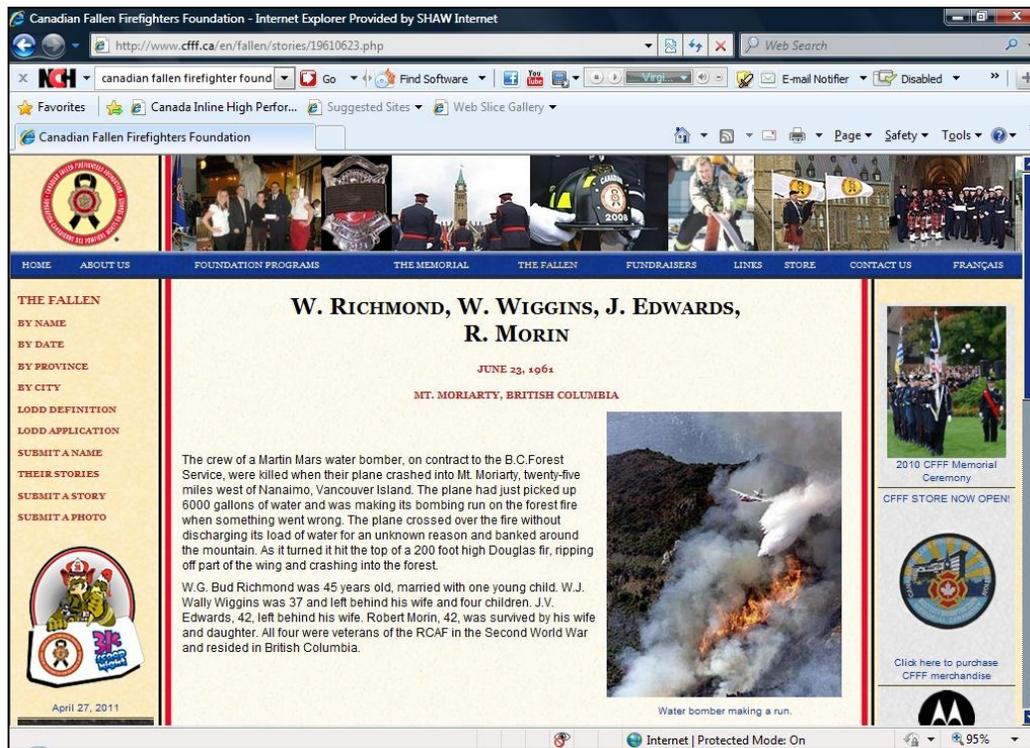


Fig. 6. Screen captures from the Canadian Fallen Firefighters Foundation website illustrating two examples of the 'Their Stories' element to memorializing wildland firefighters that have died in the 'line of duty' (<http://www.cfff.ca/>).

The details of the specific cause of death for some of the fatalities that have occurred in Canada are, however, generally well known as a result of the case studies included in firefighter safety training (Thorburn *et al.* 2000; Alexander and Thorburn 2001; Thorburn and Alexander 2001). The wildland fire literature also contains reference to specific firefighter fatalities. The publication by Fogarty and Alexander (1999), for example, was dedicated to a volunteer firefighter who perished as a result of burns sustained from being burnover in a grass fire in central Saskatchewan. Janzen (1990) also wrote that during the 1971 fire season in the Northwest Territories, ‘two men were killed on the fireline by falling snags and another four were involved in an aircraft accident when two Canso water bombers collided’. Kirkpatrick (2004) describes some of the wildland firefighter fatalities that have occurred in Ontario in the past. Other than two firefighter fatalities in northern Alberta in 1944 (B. Mayer, Alberta Sustainable Resource Development, pers. comm., 2011) and another such incident in southern British Columbia in 1962 (Keller 2002), it is believed that there have been no other known incidents involving multiple deaths as a result of entrapments or burnovers.

Implications and concluding thoughts

Canada has reportedly experienced some 165 wildland fire suppression related fatalities over a 70-year period from 1941-2010. This equates to just over two fatalities per year on average. The following 10-year totals suggest a downward trend over time:

10-year period	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2010
No. of fatalities	31	44	16	17	24	12	21

However, all of this masks the wide variability in the number of fatalities from year to year as illustrated in Fig. 7.

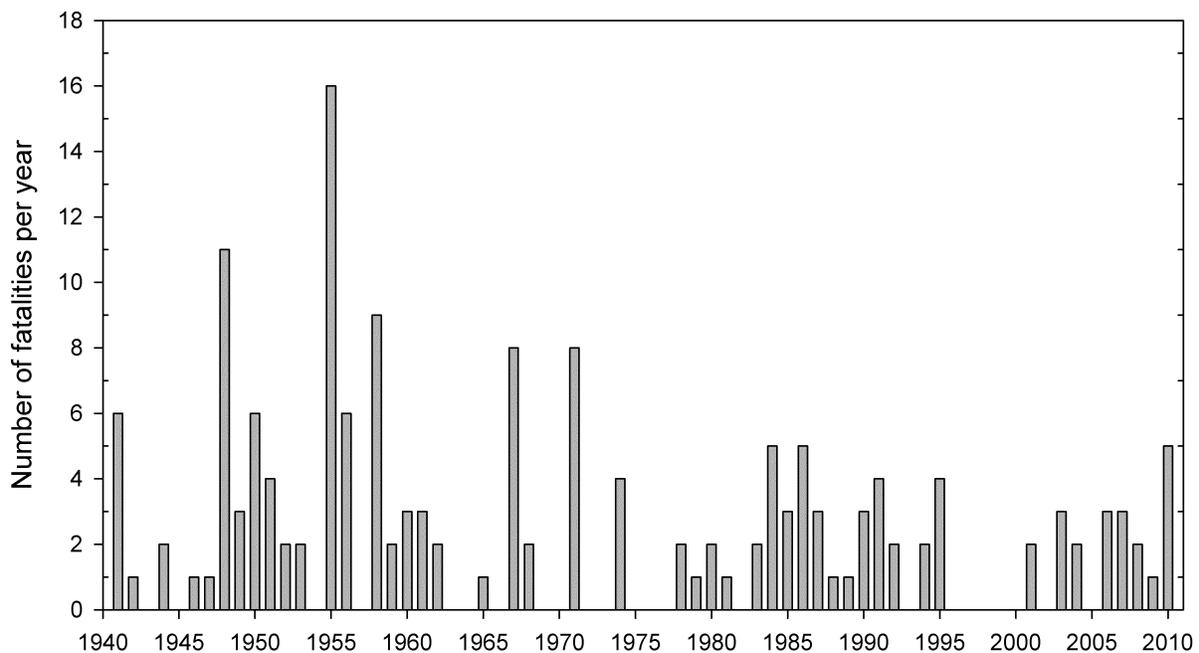


Fig. 7. Number of wildland fire suppression related fatalities by year in Canada from 1941-2010 according to the annual reports of Canada’s federal forest service and CIFFC.

The firefighter fatality statistics contained in the CIFFC annual reports are periodically cited (e.g. Hendrickson and Greer 2001) without any thought as to what the geographical distribution of the Canada-wide totals might be or what, if any, the long-term trends are. Now, for the very first time, we have some insights into those issues. Canada has not suffered near the magnitude of wildland fire suppression related fatalities that the US has endured. For example, there were 196 wildland fire suppression related fatalities in the US during the 10-year period from 2000-2009 alone (Sutton 2010) or in other words, about 20 fatalities per year, in contrast to a total of 16 fatalities in Canada during the same decade. However, it must be borne in mind that the US averages about a hundred thousand wildfires per year (Flannigan *et al.* 2000; Omi 2005). Considering the relative differences in fire incidence between Canada and US, the mean annual occurrence of wildland firefighter fatalities between the two countries is quite comparable.

The various institutions that comprise Canada's wildland fire management community include the forest services of its ten provinces and two of its three territories plus several federal government agencies with land management responsibilities. Such a situation often complicates the collection of national records. The efforts chronicled in the paper should thus be regarded as a 'work in progress'. There is still much to do. For example:

- There is an obvious need to reconcile the differences in the number of fatalities being reported by the various reporting methods (i.e. the so called 'official published record' based on the federal forest service reported and the CIFFC reported data versus the CFFF compilation effort).
- There is a need to extract a breakdown on the number of fatalities by province/territory for the period from 1991 to 2010 from CIFFC in order to supplement the federal forest service record for the proceeding 50 years.
- Written summaries need to be developed for all of the wildland firefighter fatalities for inclusion within the 'Their Stories' element of the CFFF website.

Finally, a statistical breakdown of wildland firefighter fatalities should be undertaken once the above tasks have been completed. The early indications are that ~85% of the wildland fire suppression related fatalities in Canada are aircraft-related crashes (both rotary- and fixed-wing). Again, this is not surprising considering the magnitude of aerial fire suppression action in combating wildfires in Canada (Simard 1979; Murray 1986).

Mangan (2007) analyzed the cause of death associated with 310 wildland firefighter fatalities that occurred in the US from 1990-2006. He found that more than 20% of fatalities continued to occur as a direct result of bunrover and entrapments. He acknowledged that Wilson's (1977) original common denominators were just as important in the 21st century as they were in the 20th. However, as the major causes of firefighter fatalities tend to shift, he suggested that additional factors need to be considered and in this regard, offered the following list of '21st century common denominators for wildland fire fatalities':

1. Firefighters are most likely to die in an aircraft accident. Before every flight, fire managers must ask, 'Is this flight essential?' and 'is everyone onboard essential to the mission?'
2. Firefighters are nearly as likely to die in a vehicle accident as in an aircraft accident. Driving too fast for the conditions, failure to wear seat belts, rushing to a fire, and driving home while exhausted from firefighting kills firefighters.
3. Firefighters can reduce their risk of dying from heart attack on the job by staying fit, maintaining their body weight, and having regular medical checkups.

4. Unexpected events such as falling snags, rolling rocks, downed power lines, and lightning strikes cause more than 8 percent of fatalities during wildland firefighting operations. Firefighters and fire managers can reduce fatalities by learning to expect these unexpected events.

One of the guiding principles of the Canadian Wildland Fire Strategy Declaration is that ‘public safety—including the safety of firefighters—is paramount’ (Canadian Council of Forest Ministers 2005). The growing number of wildland-urban interface fire incidents and forest health issues in Canada coupled with concerns about climate change should be a cause for concern in the future in regards to the safety of not only the general public but wildland firefighters as well (Mangan 2000; Thorburn *et al.* 2000; Alexander and Stam 2003; Alexander 2010c).

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References

- Alexander ME (2010a) Surface fire spread potential in trembling aspen during the summer in the boreal forest region of Canada. *Forestry Chronicle* **86**, 200-212.
- Alexander ME (2010b) Wildland fire suppression related fatalities in Canada, 1941-2010. <http://www.wildlandfire.com/docs/2011/canada/WildlandFireSuppressionRelatedFatalities-in-Canada-1941-2010-by-ME-Alexander.pdf> [Verified 5 July 2011]
- Alexander ME (2010c) ‘Lest we forget’: Canada’s major wildland fire disasters of the past, 1825-1938. In ‘Proceedings of 3rd Fire Behavior and Fuels Conference’, 25-29 October 2010, Spokane, WA. (Eds DD Wade, M Robinson) (CD-ROM) (International Association of Wildland Fire: Birmingham, AL)
- Alexander ME, Stam JC (2003) Safety alert for wildland firefighters: fuel conditions in spruce-beetle-killed forests. *Fire Management Today* **63**(2), 25.
- Alexander ME, Thomas DA (2006) Prescribed fire case studies, decision aids, and planning guides. *Fire Management Today* **66**(1), 5-20.
- Alexander, ME, Thorburn RW (2001) Fireline safety training course available on CD-ROM. *Fire Management Today* **61**(2), 45.

- Anonymous (1949) Forest fire losses in Canada, 1948. Canada Department of Mines and Resources, Mines, Forests and Scientific Services Branch, Dominion Forest Service. (Ottawa, ON)
- Anonymous (1950) Forest fire losses in Canada, 1949. Canada Department of Resources and Development, Forestry Branch, Forest Research Division. (Ottawa, ON)
- Anonymous (1951) Forest fire losses in Canada, 1950. Canada Department of Resources and Development, Forestry Branch, Forest Research Division. (Ottawa, ON)
- Anonymous (1952) Forest fire losses in Canada, 1951. Canada Department of Resources and Development, Forestry Branch, Forest Research Division. (Ottawa, ON)
- Anonymous (1953) Forest fire losses in Canada, 1952. Canada Department of Resources and Development, Forestry Branch, Forest Research Division. (Ottawa, ON)
- Anonymous (1954) Forest fire losses in Canada, 1953. Canada Department of Resources and Development, Forestry Branch, Forest Research Division. (Ottawa, ON)
- Anonymous (1955) Forest fire losses in Canada, 1954. Canada Department of Resources and Development, Forestry Branch, Forest Research Division. (Ottawa, ON)
- Anonymous (1956) Forest fire losses in Canada, 1955. Canada Department of Resources and Development, Forestry Branch, Forest Research Division. (Ottawa, ON)
- Anonymous (1957) Forest fire losses in Canada, 1956. Canada Department of Resources and Development, Forestry Branch, Forest Research Division. (Ottawa, ON)
- Anonymous (1958) Forest fire losses in Canada, 1957. Canada Department of Resources and Development, Forestry Branch, Forest Research Division. (Ottawa, ON)
- Anonymous (1960) Forest fire losses in Canada 1958 and 1959. Canada Department of Forestry, Forest Research Branch. (Ottawa, ON) [reprinted in 1964.]
- Anonymous (1961) Forest fire losses in Canada 1960. Canada Department of Forestry, Forest Research Branch. (Ottawa, ON)
- Beall HW (1982) Foreword – Canadian forest fire statistics: an historical sketch. In ‘Canadian Forest Fire Statistics, 1980’. (Comps GS Ramsey, DG Higgins) Environment Canada, Canadian Forestry Service, Petawawa National Forestry Institute, Information Report PI-X-17, pp. i-ii. (Chalk River, ON)
- Brady RP (1979) Canadian forest fire statistics, 1977. Environment Canada, Canadian Forestry Service. (Ottawa, ON)
- Canadian Council of Forest Ministers (2005) Canadian wildland fire strategy: a vision for an innovative and integrated approach to managing the risks. Natural Resources Canada, Canadian Forest Service, Northern Forestry Centre. (Edmonton, AB)
- CIFFC (2011) Canada report, 2010. Canadian Interagency Forest Fire Centre. (Winnipeg, MB)
Available at http://www.cifffc.ca/images/stories/pdf/2010_Canada_Report.pdf [Verified 25 March 2011]
- Higgins DG, Ramsey GS (1992) Canadian forest fire statistics: 1988-1990. Forestry Canada, Petawawa National Forestry Institute, Information Report PI-X-107E/F. (Chalk River, ON)
- Flannigan MD, Stocks BJ, Wotton BM (2000) Climate change and forest fires. *The Science of the Total Environment* **262**, 221-229.
- Fogarty LG, Alexander ME (1999) A field guide for predicting grassland fire potential: derivation and use. Forest Research, National Rural Fire Authority, and Natural Resources Canada, Canadian Forest Service, Fire Technology Transfer Note 20. (Rotorua and Wellington, New Zealand and Ottawa, ON)

- Gulliford, A (1997) Fire on the mountain: tragic death and memorialization of the Storm King fourteen. *Montana the Magazine of Western History* **47**(2), 44-57.
- Hendrickson N, Greer D (2001) 'Coming Through Fire'. (Raincoast Books: Vancouver, BC)
- Hirsch KG, Fuglem P (Tech Cords) (2006) Canadian wildland fire strategy: background syntheses, analyses, and perspectives. Natural Resources Canada, Canadian Forest Service, Northern Forestry Centre. (Edmonton, AB)
- Jackson S (1948) Fire line safety. *Fire Control Notes* **9**(2&3), 1-3.
- Jackson S (1950) Death on the fire line. *Fire Control Notes* **11**(3), 26-27.
- Janzen SS (1990) The burning north: a history of fire of fire and forest protection in the Northwest Territories. M.A. thesis, University of Alberta, Edmonton.
- Keller K (2002) 'Wildfire Wars: Frontline Stories of BC's Worst Forest Fires.' (Harbour Publishing: Madeira Park, BC)
- Kirkpatrick RB (2004) 'Their Last Alarm: Honouring Ontario's Firefighters'. 2nd edn. (General Store Publishing House: Renfrew, ON)
- Lockman MR (1966) Forest fire losses in Canada, 1964. Canada Department of Forestry. (Ottawa, ON)
- Lockman MR (1969) Forest fire losses in Canada, 1967. Canada Department of Fisheries and Forestry, Forest Fire Research Institute. Ottawa, ON)
- Lockman MR (1970) Forest fire losses in Canada, 1968. Canada Department of Fisheries and Forestry, Forest Fire Research Institute. (Ottawa, ON)
- Lockman MR (1972) Forest fire losses in Canada, 1969. Environment Canada, Canadian Forestry Service. (Ottawa, ON)
- Maclean DL, Lockman MR (1967a) Forest fire losses in Canada, 1965. Canada Department of Forestry and Rural Development. (Ottawa, ON)
- Maclean DL, Lockman MR (1967b) Forest fire losses in Canada, 1966. Canada Department of Forestry and Rural Development. (Ottawa, ON)
- Mactavish JS, Lockman MR (1962) Forest fire losses – Canada, 1961. Canada Department of Forestry, Forest Research Branch. (Ottawa, ON)
- Mactavish JS, Lockman MR (1963) Forest fire losses in Canada, 1962. Canada Department of Forestry, Forest Research Branch. (Ottawa, ON)
- Mactavish JS, Lockman MR (1964) Forest fire losses in Canada, 1963. Canada Department of Forestry, Forest Research Branch. (Ottawa, ON)
- Mangan R (1999) Wildland fire fatalities in the United States: 1990–1998. USDA Forest Service, Missoula Technology and Development Center, Technical Report 9751-2817-MTDC. (Missoula, MT)
- Mangan RJ (2000) Improving firefighter safety in the wildland-urban intermix. USDA Forest Service, Missoula Technology and Development Center, Technical Report 0051-2811-MTDC. (Missoula, MT)
- Mangan R (2007) Wildland firefighter fatalities in the United States: 1990-2006. National Wildfire Coordinating Group, Safety and Health Working Team, National Fire Equipment System Publication PMS 841. (Boise, ID)
- Mangan R (2010) 2007-2009 wildland fire fatalities: analysis and observations. Missoula, Mont, Blackbull Wildfire Services. (Missoula, MT) Available at <http://www.blackbull-wildfire.com> [Verified 25 March 2011]

- Munson S, Mangan RJ (2000) Wildland firefighter entrapments: 1976–1999. USDA Forest Service, Missoula Technology and Development Center, Technical Report 9751-2817-MTDC. (Missoula, MT)
- Murphy PJ, Mudd JP, Stocks BJ, Kasischke ES, Berry D, Alexander ME, French NHF (2000) Historical fire records in the North American boreal forest. In ‘Fire, Climate Change, and Carbon Cycling in the Boreal Forest’. (Eds ES Kasischke, BJ Stocks) pp. 274-288. Ecological Studies Volume 138 (Springer: New York, NY)
- Murray WG (1986) Air tanker and helitanker use in Canada 1978-1984. Government of Canada, Canadian Forestry Service, Petawawa National Forestry Institute, Information Report PI-X-68. (Chalk River, ON)
- NWCG (1997) Historical wildland firefighter fatalities, 1910–1996. 2nd edn. National Wildfire Coordinating Group, National Fire Equipment System, Publication NFES 1849. (Boise, ID) http://www.nwcg.gov/pms/docs/fat_pdf.pdf [Verified 25 March 2011]
- Omi PN (2005) ‘Forest Fires: A Reference Handbook’. (ABC-CLIO: Santa Barbara, CA)
- Pyne, SJ (2007) ‘Awful Splendour: A Fire History of Canada.’ (UBC Press: Vancouver, BC)
- Ramsey GS, Higgins DG (1981) Canadian forest fire statistics. Part I – 1978, Part II – 1979. Environment Canada, Canadian Forest Service, Petawawa National Forestry Institute, Information Report PI-X-9. (Chalk River, ON)
- Ramsey GS, Higgins DG (1982) Canadian forest fire statistics, 1980. Environment Canada, Canadian Forest Service, Petawawa National Forestry Institute, Information Report PI-X-17. (Chalk River, ON)
- Ramsey GS, Higgins DG (1986) Canadian forest fire statistics - 1981, 1982, 1983. Government of Canada, Canadian Forestry Service, Petawawa National Forestry Institute, Information Report PI-X-49E/F. (Ottawa, ON)
- Ramsey GS, Higgins DG (1991) Canadian forest fire statistics: 1984-1987. Forestry Canada, Petawawa National Forestry Institute, Information Report PI-X-74E/F. (Chalk River, ON)
- Rowe JS (1972) Forest regions of Canada. Environment Canada, Canadian Forestry Service, Publication 1300. (Ottawa, ON).
- Simard AJ (1979) The use of air tankers in Canada: 1957-1977. Environment Canada, Canadian Forestry Service, Forest Fire Research Institute, Information Report FF-X-71. (Ottawa, ON)
- Sutton L (2010) Wildland firefighter fatalities by cause, 1999-2009. Available at <http://www.wildlandfire.com/docs/2010/lessons-learned/FS-FireAccidentStats.pdf> [Verified 25 March 2011]
- Thorburn RW, Alexander ME (2001) LACES versus LCES: Adopting an “A” for “anchor points” to improve wildland firefighter safety. In ‘Proceedings of 2001 International Wildland Fire Safety Summit’, 6-8 November 2001, Missoula, MT. (Eds BW Butler, D. Mangan) (CD-ROM) (International Association of Wildland Fire: Montana City, MT)
- Thorburn RW, MacMillan A, Alexander ME (2000) The application of interactive multimedia CD-ROM technology to wildland fire safety training. *Forestry Chronicle* **76**, 953-959.
- Van Wagner CE (1988) The historical pattern in annual burned area in Canada. *Forestry Chronicle* **74**, 182-185.
- Wilson CC (1977) Fatal and near-fatal forest fires: the common denominators. *International Fire Chief* **43**(9), 9-10, 12-15.