An Evaluation of Manitoba's Forest Fire Preparedness System

By

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"AN EVALUATION OF MANITOBA'S FOREST FIRE PREPAREDNESS SYSTEM"

A practicum submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of Master of Natural Resources Management.

By

PETER JOHN KONOPELNY

1993

ABSTRACT

Manitoba Natural Resources Fire Program protects 33.4 million hectares of forest land within its forest protection zone. These forests cover the majority of the province and are predominantly located in the northern and eastern portions of Manitoba. The forests provide the wood supply to two major pulp and paper industries and a myriad of smaller forest product producers. Manitoba's forests also provide the substrate for trapping and hunting, as well as recreational havens for many Manitobans.

This study was prepared for Manitoba Natural Resources as part of the ongoing review and evaluation of the Provincial Forest Fire Program. The information contained within will provide fire managers and policy makers with documented facts and figures that can be utilized to enhance the Fire Program. The study monitors data found in the 1990, 1991, and 1992 wildfire databases to determine if the Fire Program is meeting the response time and fire size objectives established after the 1989 fire reviews. By comparing documented response times, travel distances, and fire sizes to forest priority zones and alert levels, the study found the Fire Program to have an Initial Attack success rate exceeding 95%, yet it is only partially meeting its stated policy objectives. An amendment to the existing time objectives is recommended so that response time objectives provide a more realistic measure of the type of initial attack response the Manitoba Forest Fire Preparedness System provides.

A comparison of the N.O.A.A. satellite forest fuels database utilized by the Intelligent Fire Information System (IFMIS), and the National Fire Information System (NFIS), was made with documented wildfire report fuel types. The fuels database was found to be inaccurate and it is recommended that

efforts remain focused on replacing this information with GIS data derived from forest inventory maps. Preliminary fire growth comparisons between computer predicted rates and documented fire sizes was done with the results provided in an attached appendix. The study also found errors in the meridian references of some fires in the 1990, 1991, and 1992 wildfire databases, and their correction is recommended before further computer prediction systems based on historical fire locations are developed.

This evaluation provides a starting point which Manitoba's fire managers can utilize to improve the Fire Program and sets out areas for future evaluation.

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Chapter 1

Introduction

1.1 Background Information

Manitoba Natural Resources began a concerted effort to improve its Forest Fire program in 1990. This action was a direct result of the 1989 fire season of 1,226 fires which burned 3,567,947 hectares of forest and agricultural wildland.

Two reviews were conducted; i) an internal review conducted by fire personnel from other Canadian fire management agencies, and ii) a ministerial appointed departmental review panel. As a result of these reviews, recommendations were made to improve the Provincial Fire Program. Throughout the review process considerable attention was focused on the Initial Attack Response System. The Initial Attack Response System is a key operational component that determines the level of preparedness and the deployment of crews and equipment across the province. The system outlines objectives for fire control size, attack time, travel time, crew man-up and man-down processes, and information and data requirements regarding weather and forest conditions throughout the province. Natural Resources Operations Division outlines the intent and key objectives of the Initial Attack Response System in operational guideline F030105, dated 92/04/14 (Appendix A).

Fire action and suppression objectives are determined by the Fire Priority Map shown in Figure 1.0. The map is divided into five zones. Initial attack

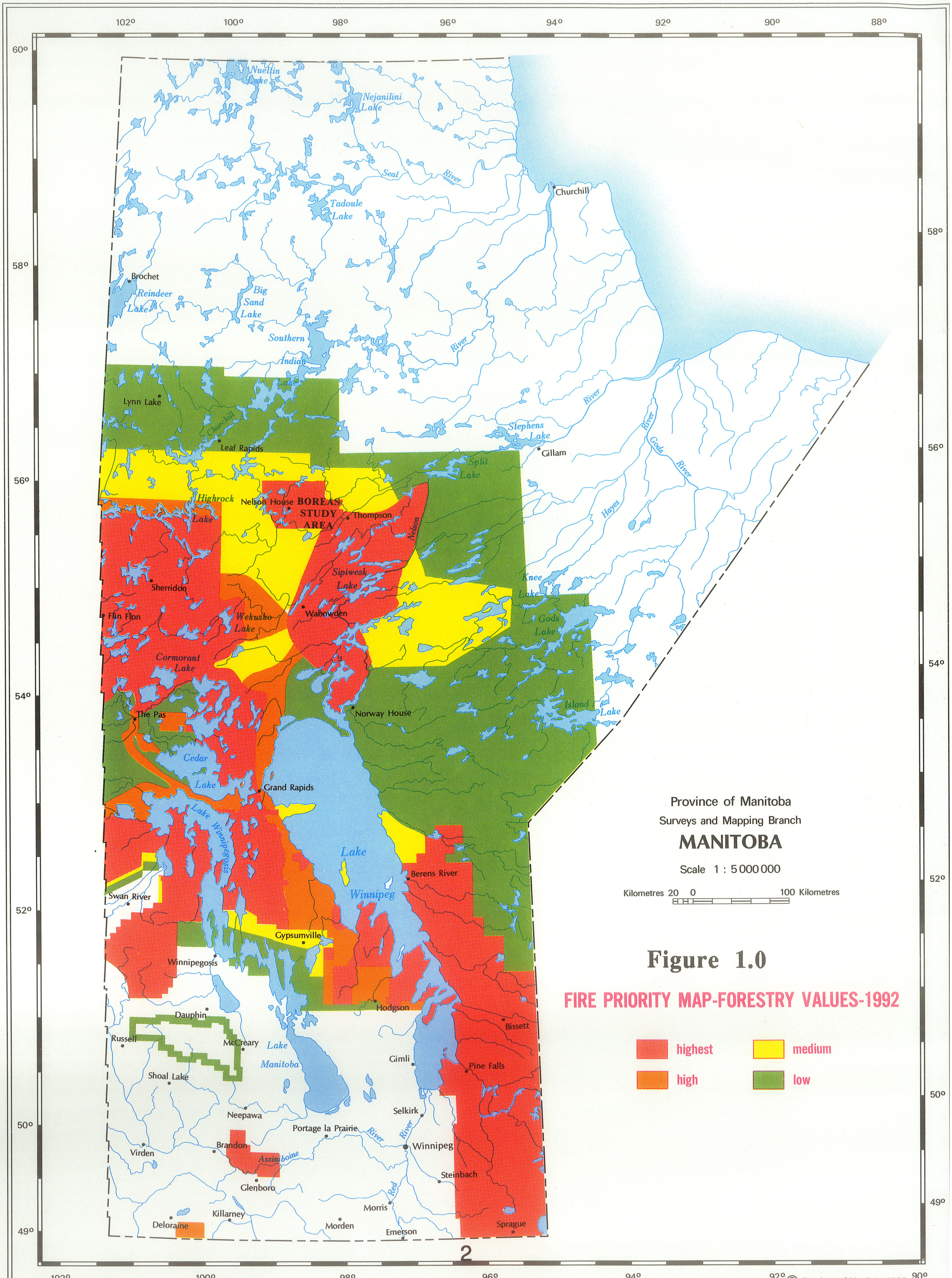


Figure 1.0

FIRE PRIORITY MAP-FORESTRY VALUES-1992

Cartography by: Surveys and Mapping Branch, Manitoba 1980 time objectives shown in Table 1.0 are based upon the forestry values at risk within each zone. These attack time objectives by priority zone are clearly defined by the operational guideline F030105.

Table 1 : Travel times and alert levels by forest priority zone (Manitoba Initial Attack Response System 1992)

ZONE	level 0	level I	level II	level III	level IV
RED	60 min.	60 min.	30 min.	15 min.	15 min.
ORANGE	60 min.	60 min.	30 min.	15 min.	15 min.
YELLOW	60 min.	60 min.	30 min.	30 min.	30 min.
GREEN	60 min.	60 min.	30 min.	30 min.	30 min.
WHITE	60 min.	60 min.	30 min.	30 min.	30 min.

Response times based upon the forestry values-at-risk provide the highest priority to the red zone and the lowest priority to the white zone. Life and property values are not shown in response time tables or maps, since the policy defines that they receive an immediate response.

The alert level is determined by reviewing actual and forecasted weather information to provide the basic inputs to calculate the appropriate fire weather indices, and define the daily alert level. Other inputs such as lightning occurrence, geographic information (fuel types), communication systems, local knowledge, previous fire history and resources currently available are integrated into fire operations and planning as shown in Figure 2.0.

The priority zone system coupled with equipment and manpower levels determine the response time target levels which should be met in order to action fires while they are still manageable and their suppression remains cost

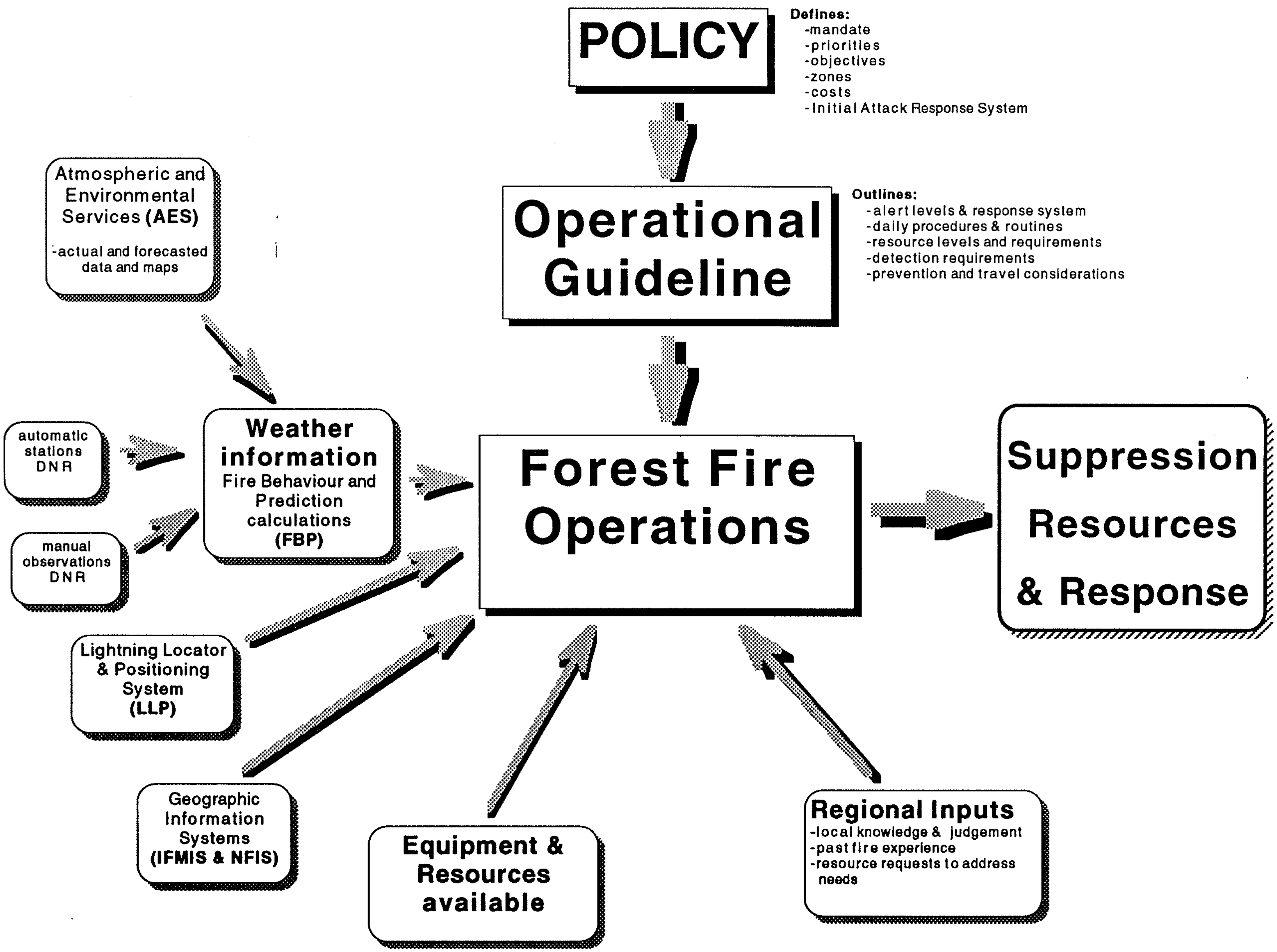


Figure 2 : Manitoba Fire Program Policy and Operational Planning flowchart

effective. A fire size of <1.2 hectares is the control size goal defined by Fire Program Policy PO/15/02 dated June 8, 1990 (Appendix B).

1.2 Problem Statement

Manitoba's Initial Attack Response System is reviewed annually to determine if any changes are required to improve fire suppression capabilities. Current attention and change has focused on the methods by which the alert levels are calculated, and to revisions of regional crew and equipment levels based on past fire experiences. To date no quantitative evaluation of the initial attack response system has focused on comprehensively reviewing documented initial attack travel times from field staffs' wildfire reports. Manitoba is now at a point to begin critically reviewing response times as there is adequate fire report data for the last three years to compare the theoretical objectives to the documented travel times.

The past three fire seasons also provide an indication of the equipment and manpower levels required to meet the provinces forest fire management needs, and this will be compared to the levels set out by the Initial Attack Response System operational guideline.

1.3 Objectives

The main objective of this study was to analyze the initial attack component of Manitoba's Initial Attack Response System. In order to achieve this task the following specific objectives were:

1) to determine if the Fire Program was meeting its intended travel time and forest fire size objectives as defined by policy and operational guideline.

2) to assess the relationship between documented travel times and

resource and equipment levels available when fires were actioned.

3) to review the relationship between documented travel distances and resource placement.

4) to determine if a relationship exists between funding and response time.

5) to compare actual wildfire size data and Intelligent Fire Information Management Information System (IFMIS) size projections for the time period spanning detection to initial attack arrival.

6) to discuss and evaluate the appropriateness of the intended travel times and size objectives

7) to provide practical recommendations to the Fire Program regarding the initial attack travel time component of the Alert Response System.

1.4 Methods

Travel times were quantified by alert level, zone, and location, by utilizing existing computerized data found in the 1990, 1991, and 1992 wildfire reports. The data was analyzed to determine if the system was meeting the specific objectives set out by operational guideline. All pertinent information fields of the wildfire report, daily planning sheets, and provincial operating plan were reviewed. The study also utilized the IFMIS program to compile fuel types and fire growth predictions for fires occurring in 1990, 1991 and 1992.

1.5 Limitations

This study was limited to the 1990, 1991, and 1992 fire seasons. Data from previous years was not reviewed or compared since the Initial Attack Response System used different indicator and trigger mechanisms prior to the 1990. The value of comparing any pre and post 1990 data is questionable since there is little dispute within Manitoba Natural Resources that the current Initial Attack Response System is a substantial improvement over previous systems.

The size and complexity of the current database also necessitated that this study limit its cross comparisons and precision to those parameters and combinations stated in Chapter 3, Methods. This scoping was essential to maintain the size and usefulness of the study under the current time constraints.

This study did not attempt to review the methods by which alert levels were calculated and determined by the Initial Attack Response System, nor did it attempt to redefine existing resource and priority values. The intent was to focus on initial attack response times as recorded in existing data and to rationalize existing trends and patterns.

It should also be noted that existing wildfire report data possessed inherent error and biases due to data collection methods, field interpretation, report structure, and format. These concerns did not reduce the importance of the data to the study since every problem encountered provided valuable knowledge regarding the strengths and weaknesses of the wildfire report.

This study reviewed the IFMIS theoretical fire growth predictions for the 1991 and 1992 fire seasons. It should be noted that the extent of analysis was limited to the compilation and referencing (see Chapter 3) of t=15, 30, 45, and 60 minute interval predictions in an attached appendix. This appendix should provide other growth model specialists a starting point to review and determine the application of the growth models to the recorded Manitoba data. This study did not investigate growth model formulas or specific reasons for deviation beyond indicating whether predicted models were corresponding to documented data, and suggesting general areas for specialists to investigate.

It must also be noted that since the 1990 data was originally in the

Manitoba Data Services mainframe format, the ability to browse and error check the database was more limited than the 1991 and 1992 P.C. based data. Some slight inconsistencies did occur in which case they were identified and noted. In the course of this study other questions were raised in related program areas, however their in depth review and scrutiny was left for future fire and operational management researchers.

While this study contains many elements similar to an operations research approach it should be noted that it did not attempt to apply or define a specific model type or theory. Rather it attempted to validate existing procedures (i.e. attack time coverage, growth projections, and strategic placement) and determine if they are functioning as planned.

1.6 Importance of the Project

Manitoba Natural Resources began wildfire report data collection in 1932 and has maintained a computerized wildfire database for all fires since 1976. In the past this data has been valuable in forestry management, annual report statistics, and basic Fire Program evaluation and review. Yet its operational application by resource managers is under utilized.

The increased costs and complexity associated with suppressing forest fires in the 1990's has made it essential for fire managers to justify current and future programs with accurate facts and figures pertaining to their operations. This study attempts to assess current alert response time trends, and provide future direction regarding operational research and data collection needs.

This study also has a human and legal perspective since the Fire Program must provide an adequate level of service and protection to the forests and the people of Manitoba.

Chapter 2

Literature Review

2.1 Fire History in Manitoba

Department of the Interior reports dating back to 1914 provide some of the earliest data and analysis of forest fires in the prairie provinces (Dwight, 1918). These reports written by T.W. Dwight provide qualitative commentary and quantitative data regarding weather, vegetation, administration, fire cause, and total area burned for all major regions of the country. General trends described by Dwight for the prairie provinces indicate a spring fire period in May and a summer fire period in the months of July and August (Dwight, 1918). The slow fire period during June is consistently accompanied by increased amounts of rainfall during that month. This pattern of a spring and summer fire seasons in Manitoba is well documented and described by Hirsch (1991).

Dwight's (1918) early observations and commentary regarding the fire season and local employment cycles provide a commentary still echoed today:

> Light rainfall through March, April, and May, 1914, with rising temperatures, caused a comparatively large number of fires in May. Heavier rainfall in June combined with the growth of green vegetation reduced the number. This is a typical phenomenon in this region where there are many areas of grassland and many poplar forests with deciduous undergrowth. The dry grass in the spring combined with rising temperatures and usually light rainfall before the deciduous trees and shrubs have leafed out makes a dangerous period until the end of May. Then there is comparative safety until the new growth of grass becomes

dry in August.

> If the staff is augmented in the spring to cope with the situation then, and if it is desired to keep on the extra men in case of another dangerous period later in the summer, it is necessary in the interest of economy to provide other work for them. On account of the early opening of the fire season, the period of comparative safety in the middle of the season complicates the problem of the administrator who must make provision for the economical utilization of the services of the extra guards when they are not required for continuous fire patrol.

Beginning in 1914, fire history records specific for Manitoba provide a rudimentary breakdown of the number of fires, suspected causes and acres burned each season. An early relationship between fire occurrence and annual precipitation levels is restated by Harrison in his 1934 report.

> It is quite well established that there is a cyclic variation in the amount of precipitation, which embraces a period of about eleven years. Observations made at one weather recording station in Manitoba continuously since 1872 show the variations above and below the normal precipitation with remarkable regularity. Comparison of the dates of known high fire hazard with these records shows a close correspondence between the periods of greatest damage and those of least precipitation.

Harrison believed that a series of disastrous fires occurred in the province during the period 1830-1885, he based his hypothesis on forest age class observations made by timber crews in the 1920's and 1930's (Harrison, 1934). Other major fire events of this era include the 1919 burn of the east side of the Porcupine Mountains, and the severe period of 1928 and 1929 which culminated in extreme losses in 1929. Harrison (1934) attributed the fire losses of 1929 to recurring dry climatic cycles.

A compilation of basic fire records from 1914 to the present is shown in Table 2, with corresponding 5-year and decade averages provided in Table 3 and 4. Long term trends shown in figures 3 and 4 appear to indicate an increase

Table 2 : Number of fires and area burned in Manitoba 1914 to 1992

	number of fires			area burned (ha)		
year	human	lightning	total	human	lightning	total
1914	n/a	n/a	329	n/a	n/a	36,213
1915	n/a	n/a	637	n/a	n/a	557,269
1916	n/a	n/a	125	n/a	n/a	15,072
1917	n/a	n/a	195	n/a	n/a	71,711
1918	104	2	106	n/a	n/a	10,327
1919	164	15	179	n/a	n/a	166,026
1920	227	15	242	n/a	n/a	118,705
1921	124	8	132	n/a	n/a	16,239
1922	192	55	247	n/a	n/a	20,147
1923	160	26	186	n/a	n/a	41,793
1924	295	15	310	n/a	n/a	19,412
1925	148	12	160	n/a	n/a	16,268
1926	421	42	463	n/a	n/a	22,824
1927	87	23	110	n/a	n/a	10,613
1928	311	34	345	n/a	n/a	170,115
1929	581	79	660	n/a	n/a	1,377,912
1930	258	159	417	n/a	n/a	284,363
1931	233	15	248	21,699	992	22,691
1932	278	37	315	31,607	4,315	35,922
1933	315	57	372	20,259	971	21,230
1934	223	14	237	10,734	542	11,276
1935	130	13	143	7,665	4,694	12,359
1936	449	105	554	28,548	182,149	210,697
1937	366	80	446	81,677	106,056	187,733
1938	547	10	557	69,215	794	70,009
1939	484	17	501	50,811	2,339	53,150
1940	635	31	666	180,523	53,432	233,955
1941	230	29	259	43,976	7,237	51,213
1942	172	2	174	85,077	1	85,078
1943	142	11	153	14,307	1,112	15,419
1944	243	8	251	42,393	7,123	49,516
1945	143	25	168	3,677	951	4,628
1946	366	26	392	50,974	1,542	52,516
1947	100	62	162	10,534	19,215	29,749
1948	395	79	474	229,729	164,241	393,970
1949	310	73	383	46,975	21,304	68,279
1950	123	30	153	15,330	14,551	29,881
1951	135	34	169	5,578	14,140	19,718
1952	324	54	378	67,143	3,182	70,325
1953	181	47	228	53,580	27,357	80,937
1954	101	20	121	48,286	27,435	75,721
1955	213	114	327	50,039	28,485	78,524
1956	209	137	346	39,577	45,920	85,497
1957	259	83	342	50,858	47,417	98,275
1958	346	40	386	317,721	14,757	332,478
1959	107	48	155	9,972	981	10,953
1960	213	235	448	18,237	148,560	166,797
1961	558	149	707	712,757	390,042	1,102,799
1962	200	85	285	14,989	56,232	71,221
1963	318	125	443	15,759	12,763	28,522
1964	379	202	581	n/a	n/a	338,442
1965	174	51	225	n/a	n/a	6,780
1966	156	79	235	n/a	n/a	2,491
1967	421	217	638	48,778	81,574	130,352
1968	196	35	231	18,163	1,255	19,418
1969	171	155	326	2,096	22,687	24,783
1970	220	97	317	5,957	31,150	37,107
1971	412	78	490	7,094	1,417	8,511
1972	305	234	539	2,925	15,736	18,661
1973	462	153	615	8,632	14,753	23,385
1974	254	237	491	14,124	147,037	161,161
1975	217	141	358	6,352	16,992	23,344
1976	755	373	1,128	73,117	54,983	128,100
1977	663	193	856	156,938	74,620	231,558
1978	298	84	382	6,677	18,023	24,700
1979	265	375	640	5,067	77,090	82,157
1980	556	526	1,082	190,454	323,838	514,292
1981	430	232	662	19,718	356,503	376,221
1982	295	130	425	10,884	4,561	15,445
1983	293	242	535	7,393	91,760	99,153
1984	405	287	692	50,463	79,727	130,190
1985	211	135	346	1,967	9,856	11,823
1986	144	73	217	6,512	3,830	10,342
1987	314	205	519	15,224	154,296	169,520
1988	382	600	982	34,214	451,439	485,653
1989	513	713	1,226	634,763	2,933,184	3,567,947
1990	282	288	570	5,938	10,427	16,365
1991	388	288	676	23,835	109,856	133,691
1992	193	105	298	103,658	353,796	457,454

data source: Department of the Interior Reports
Manitoba Natural Resources Annual Reports

Table 3 : Number of fires and area burned in Manitoba at 5 year average intervals

	AVG	avg number of fires			avg area burned (ha)		
		human	lightning	total	human	lightning	total
1988/1992	5yr	352	399	751	160,482	771,741	932,223
1983/1992	10yr	313	294	607	88,397	419,817	508,214
1978/1992	15yr	331	286	617	74,451	331,879	406,330
1973/1992	20yr	366	269	635	68,797	264,329	333,126
1968/1992	25yr	345	239	584	56,487	214,353	270,840
1963/1992	30yr	336	222	558	49,223	181,772	230,995
1958/1992	35yr	328	206	534	72,868	173,249	246,117
1953/1992	40yr	311	190	501	69,818	156,008	225,826
1948/1992	45yr	305	175	480	70,166	143,506	213,672
1943/1992	50yr	295	160	455	65,587	129,754	195,341
1938/1992	55yr	306	147	453	67,436	119,118	186,554
1933/1992	60yr	305	140	445	64,297	114,099	178,396
1928/1992	65yr	307	134	441	60,172	105,403	165,575
1923/1992	70yr	301	126	427	55,874	97,875	153,749

Table 4 : Number of fires and area burned in Manitoba by decade averages

	AVG	avg number of fires			avg area burned (ha)		
		human	lightning	total	human	lightning	total
1920/1929	1920's	255	31	286	n/a	n/a	181,402
1930/1939	1930's	328	51	379	32,222	30,285	62,507
1940/1949	1940's	274	35	309	70,817	27,616	98,433
1950/1959	1950's	200	61	261	65,808	22,423	88,231
1960/1969	1960's	279	133	412	83,078	71,311	154,389
1970/1979	1970's	385	197	582	28,688	45,180	73,868
1980/1989	1980's	354	314	668	97,159	440,899	538,058
1990/1992	1990's	288	227	515	44,477	158,027	202,504

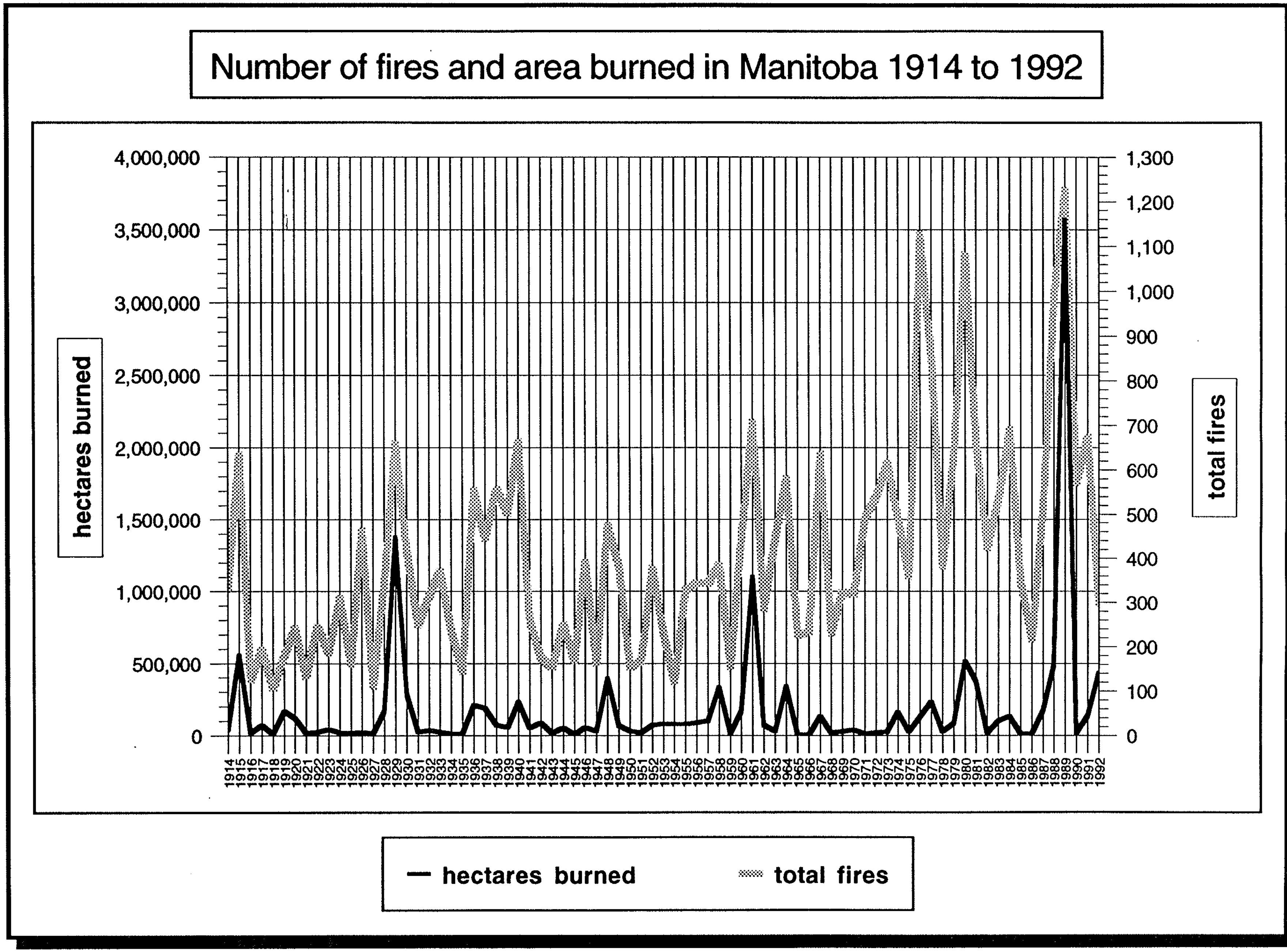


Figure 3 : Number of fires and area burned in Manitoba 1914 to 1992

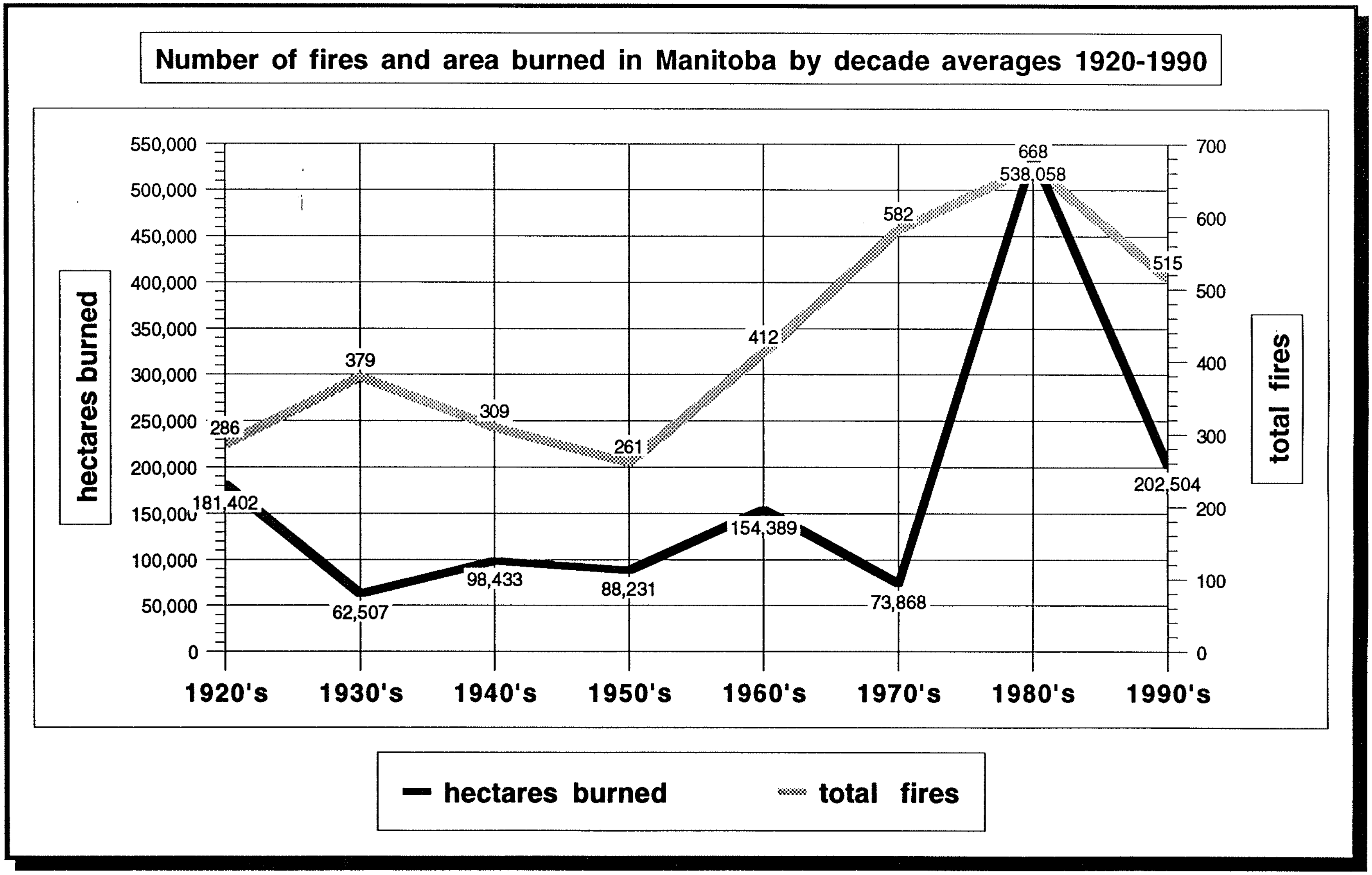


Figure 4 : Number of fires and area burned in Manitoba by decade averages 1920-1990

in fire occurrence and area burned over recent years. This apparent trend is likely the result of improved information in recent years, since not all fires were detected, reported, or discovered in the early part of the century due to limited access and detection methods. Even today, Manitoba's far north experiences fires that remain undetected due to their remoteness.

It is the author's opinion that 25 year averages provide the most comparable statistics for numbers of fires and area with regards to the number of fires and area burned as they reflect the effects of modern day detection, reporting, and mapping procedures. Based upon this premise, an average of 584 fires occur in Manitoba each year, producing an average annual burned area of 270,840 hectares.

Throughout recorded history the area burned has exceeded 1.0 million hectares in only three season; 1929, 1961 and 1989. These major fire years have occurred roughly 30 years apart and it is not known whether the events are cyclic, random, weather or forest stand related. Hirsch and Flanningan (1990) have calculated a return period of a 1989 fire event to be between 400 - 770 years by the normalizing the distribution of fire data from 1918 to 1989. Hirsch (1991) has also documented the relationships between lightning, weather, and fire occurrence for the 1989 fire season, and provides a detailed fire weather analysis for the major fire events that year.

2.1.1 Financial statistics

Over the past 10 years fire costs in Manitoba have averaged $22.4 million (1992 dollars IPI) per fire season and $36,792/fire (1992 dollars IPI). For a complete account of Manitoba's fire costs see Table 5.0. With the exception of the 1989 fire season Manitoba consistently spends less on fire suppression than Ontario and Alberta, and slightly more than Saskatchewan (Tables 6, 7, and 8).

Table 5 : Manitoba fire statistics and financial figures 1982 - 1992

year	# fires	area burned	avg size ha.	base (actual)	base $92	extra (actual)	extra $92	total (actual)	total $92	total $92/fire	$92/ha protected
				in millions of dollars							
1982	425	15,445	36	4.2	5.8	3.7	5.2	7.8	11.0	$25,867	$0.3
1983	535	99,153	185	5.7	7.6	9.3	12.4	15.0	20.0	$37,434	$0.6
1984	692	130,190	188	5.1	6.6	6.9	8.9	12.0	15.5	$22,449	$0.5
1985	346	11,823	34	5.0	6.3	3.4	4.2	8.4	10.6	$30,507	$0.3
1986	217	10,342	48	6.3	7.8	1.6	1.9	7.9	9.7	$44,862	$0.3
1987	519	169,520	327	6.5	7.7	8.6	10.1	15.1	17.8	$34,316	$0.5
1988	982	485,653	495	6.4	7.2	17.8	20.0	24.2	27.2	$27,671	$0.8
1989	1,226	3,567,947	2910	6.6	7.0	56.7	60.7	63.2	67.7	$55,256	$2.0
1990	570	16,365	29	8.6	8.9	11.9	12.3	20.5	21.3	$37,335	$0.6
1991	676	133,691	198	8.5	8.6	10.3	10.4	18.8	19.0	$28,058	$0.6
1992	298	457,455	1535	8.6	8.6	6.3	6.3	14.9	14.9	$50,034	$0.4
10 yr avg	**606**	**508,214**	**838**	**6.7**	**7.6**	**13.3**	**14.7**	**20.0**	**22.4**	**$36,792**	**$0.7**

protection area = 33.4 million hectares

note: figures indicated ($92) represent constant 1992 dollars derived from the Statistics Canada implicit price index Gross Domestic Product database D20556, (1986=100)

data source: Manitoba Natural Resources

Table 6 : Alberta fire statistics and financial figures 1982 - 1992

				Forest Protection expenditures								Program Support Expenditures (actuals)						
year	# fires	area burned	avg size ha	base (actual)	base $92	extra (actual)	extra $92	prep (actual)	prep $92	total(actual)	total $92	overtime	20% of budget	total support	grand total(actual)	grand total $92	$92/fire	$92/ha protected
1982	1,257	688,374	548							88.6	124.1				88.6	124.1	$98,707.01	$3.2
1983	756	2,849	4	19.4	25.9	8.2	10.9	8.6	11.4	36.2	48.2	1.4	5.8	7.2	43.4	57.9	$76,568.32	$1.5
1984	1,368	78,963	58	19.6	25.4	12.7	16.4	9.3	12.0	41.6	53.8	1.0	5.8	6.8	48.4	62.5	$45,707.30	$1.6
1985	937	12,854	14	18.5	23.3	9.5	12.0	10.9	13.8	38.9	49.0	1.1	6.0	7.1	46.0	57.9	$61,824.74	$1.5
1986	584	2,677	5	18.4	22.7	5.4	6.6	7.7	9.5	31.6	38.8	1.1	6.1	7.2	38.7	47.7	$81,635.06	$1.2
1987	1,235	36,112	29	17.6	20.7	13.6	16.0	12.1	14.2	43.3	50.9	1.5	6.0	7.5	50.8	59.7	$48,367.90	$1.6
1988	872	14,538	17	16.5	18.5	14.5	16.3	18.5	20.7	49.5	55.6	1.9	5.8	7.7	57.2	64.3	$73,693.01	$1.7
1989	795	6,411	8	18.6	19.9	9.2	9.9	14.1	15.1	41.9	44.9	1.0	5.8	6.8	48.7	52.2	$65,688.84	$1.4
1990	1,296	30,534	24	16.9	17.6	21.3	22.1	30.2	31.4	68.4	71.1	2.6	6.1	8.7	77.1	80.1	$61,804.33	$2.1
1991	923	6,172	7	18.2	18.4	12.1	12.2	16.9	17.1	47.2	47.7	2.2	9.5	11.8	59.0	59.5	$64,515.22	$1.5
1992	1,055	3,329	3	18.4	18.4	9.6	9.6	22.6	22.6	50.6	50.6	1.8	11.0	12.8	63.4	63.4	$60,124.96	$1.6
10 yr avg	**982**	**19,444**	**20**	**18.2**	**21.1**	**11.6**	**13.2**	**15.1**	**16.8**	**44.9**	**51.1**	**1.6**	**6.8**	**8.3**	**53.3**	**60.5**	**$63,993.0**	**$1.6**

in millions of dollars

protection area = 38.5 million hectares

note: figures indicated ($92) represent constant 1992 dollars derived from the Statistics Canada implicit price index Gross Domestic Product database D20556, (1986=100)

data source: Alberta Forestry, Lands and Wildlife

Table 7 : Saskatchewan fire statistics and financial figures 1982 - 1992

year	# fires	area burned	avg size ha.	base (actual)	base $92	extra (actual)	extra $92	total (actual)	total $92	total $92/fire	$92/ha protected
				in millions of dollars							
1982											$0.0
1983	436	55,549	127	1.0	1.3	7.2	9.5	8.2	10.9	$24,991	$0.3
1984	895	309,231	346	1.1	1.4	13.6	17.6	14.7	19.0	$21,238	$0.5
1985	520	17,478	34	8.0	10.0	0.9	1.2	8.9	11.2	$21,565	$0.3
1986	493	13,045	26	11.6	14.3	0.7	0.8	12.3	15.1	$30,713	$0.4
1987	980	225,040	230	13.7	16.1	20.0	23.5	33.7	39.6	$40,431	$1.1
1988	1,064	81,109	76	14.1	15.9	17.7	19.8	31.8	35.7	$33,569	$1.0
1989	1,020	471,049	462	17.7	19.0	25.2	27.0	42.9	46.0	$45,060	$1.3
1990	897	187,349	209	17.8	18.5	14.7	15.2	32.5	33.8	$37,638	$1.0
1991	762	239,373	314	30.9	31.2	-1.0	-1.0	29.9	30.2	$39,625	$0.9
1992	701	96,192	137	25.1	25.1	-0.7	-0.7	24.4	24.4	$34,807	$0.7
10 yr avg	**777**	**169,542**	**218**	**14.1**	**15.3**	**9.8**	**11.3**	**23.9**	**26.6**	**$32,964**	**$0.8**

protection area = 35.3 million hectares

note: figures indicated ($92) represent constant 1992 dollars derived from the Statistics Canada implicit price index Gross Domestic Product database D20556, (1986=100)
negative extra suppression dollars in 1991 and 1992 reflect money that was allocated and not spent

data source: Saskatchewan Environment and Resource Management

Table 8 : Ontario fire statistics and financial figures 1982 - 1992

				in millions of dollars							
year	# fires	area burned	avg size ha.	base (actual)	base $92	extra (actual)	extra $92	total (actual)	total $92	total $92/fire	$92/ha protected
1982	1,396	3,892	3	28.6	40.1	2.9	4.1	31.5	44.1	$31,601	$0.9
1983	2,244	443,662	198	29.2	38.9	19.5	26.0	48.7	65.0	$28,944	$1.4
1984	1,240	120,420	97	28	36.2	7.5	9.7	35.5	45.9	$37,019	$1.0
1985	887	1,007	1	31	39.1	2.5	3.1	33.5	42.2	$47,587	$0.9
1986	1,088	145,561	134	32	39.4	16.3	20.1	48.3	59.5	$54,648	$1.3
1987	1,923	75,582	39	31.3	36.8	22.7	26.7	54	63.5	$33,016	$1.4
1988	3,260	390,706	120	30.7	34.5	54.6	61.3	85.3	95.8	$29,389	$2.0
1989	2,430	403,886	166	29.9	32.0	31.1	33.3	61	65.4	$26,894	$1.4
1990	1,614	183,693	114	32.7	34.0	30.9	32.1	63.6	66.1	$40,935	$1.4
1991	2,560	318,883	125	43.1	43.5	58.8	59.4	101.9	102.9	$40,197	$2.2
1992	960	175,994	183	40.1	40.1	22	22.0	62.1	62.1	$64,688	$1.3
10 yr avg	**1,821**	**225,939**	**124**	**32.8**	**37.5**	**26.6**	**29.4**	**59.4**	**66.8**	**$40,332**	**$1.4**

protection area = 46.8 million hectares

note: figures indicated ($92) represent constant 1992 dollars derived from the Statistics Canada implicit price index Gross Domestic Product database D20556, (1986=100)

data source: Ontario Ministry of Natural Resources

It should be noted that dollars/fire comparisons provide only the crudest of relative comparisons due to the averaging of costs over all reported fires. The shortcomings of this method become apparent when costs are broken down by actioned, limited action, and no action fires. A more proper comparison is dollars spent/actioned fire as long as an action fire is similarly defined by all provinces. Because the definitions and reporting procedures between actioned and limited action vary between provinces the total number of fires was used.

A better comparison of expenditure levels between provinces is possible by calculating the dollars spent/area protected. In this regard Alberta spends the most for fire protection averaging $1.60/ha/year, followed by Ontario at $1.40/ha/year, and Saskatchewan at $.80/ha/year. Manitoba spends the least on fire protection, averaging $.70/ha/year. These comparisons with neighbouring provinces should not be viewed as direct indicators of program efficiency or failure since unique factors such as the size of the area protected, forest use, equipment, staffing, and observation zone action policy must also be taken into account.

2.2 Forest Fire Research in Canada

Early fire research in Canada focused on the development of fire behaviour models based on the pioneer beginnings by Wright and Beall of the Dominion Forest Service in 1925. This early work was followed-up from the 1950's to present by the efforts of Van Wagner and the many other individuals with the Canadian Forestry Service (now Forestry Canada). This groups' research work has been classified into six categories by Van Wagner (1984):

1. Fire Behaviour - concerned with
    a) fuel moisture physics,
    b) fire spread physics,
    c) prediction of fire behaviour by forest type,
    d) fire/weather interactions,
    e) fire danger rating systems,
    f) spatial weather models.

2. Fire Ecology - concerned with
    a) post-fire forest regeneration mechanisms,
    b) cyclic forest development from fire to fire,
    c) prediction of post-fire forest development,
    d) age-class distribution in fire-cycled forest.

3. Fire Suppression - concerned with
    a) performance rating of fire control equipment, airtankers, fire retardants and water additives,
    b) aerial ignition devices,
    c) backfiring methods,
    d) new suppression methods.

4. Prescribed Fire - concerned with
    a) tree damage and mortality,
    b) use of fire for hazard reduction, seedbed preparation, and vegetation control,
    c) design of prescriptions for proper burning conditions,
    d) operational techniques.

5. Fire Economics - concerned with
    a) economy of alternative fire control tactics,
    b) estimation of values-at-risk,
    c) effect of fire on timber supply,
    d) relation between fire control expense and burned area,
    e) ultimate impact of fire on the forest economy.

6. Fire Management Systems - concerned with
    a) remote sensing applications,
    b) computerized systems for integrating weather, fuel type, and terrain into fire spread and growth models,
    c) prediction of lightning and man-caused fires,
    d) air patrol routing,

e) resource deployment,
f) attack strategy,
g) management of weather and fire data bases,
h) information systems of various kinds.

By the early 1980's fire behaviour research accounted for approximately 36% of the research effort, with fire suppression and management systems accounting for 22% and 18% respectively (Van Wagner, 1984). This research focus has resulted in the development of the Canadian Forest Fire Danger Rating System (CFFDRS), which is central to all forest fire preparedness systems in Canada.

The (CFFDRS) system provides a standard numerical rating of fire potential which is based on a uniform fuel type and the fire weather elements of dry bulb temperature, relative humidity, wind speed, and precipitation. These factors are used to calculate the six basic fire weather indices; Fine Fuel Moisture Code (FFMC), Duff Moisture Code (DMC), Drought Code (DC), Initial Spread Index (ISI), Buildup Index (BUI), and the Fire Weather Index (FWI).

These basic fire weather indices have been incorporated into the Canadian Forest Fire Behaviour Prediction (FBP) System, a variety of planning tools, and alert response systems as indicator and trigger mechanisms. Their continued use in the daily operation of all forest fire organizations in Canada underscores the extent of their application.

2.3 Manitoba Forest Fire Report Data

The routine compilation of forest fire data through standardized fire reports is another strength of the institution in Canada with Department of the Interior Reports by Dwight dating as far back as 1914 (Dwight, 1918). Early data collection was focused on basic information fields such as the number of fires, area burned, volume of timber lost, cause, general location, and date of fire occurrence. As time progressed fire reports contain increased amounts of information and detail and became an integral component of forestry management plans (Harrison, 1934). The computerization of Manitoba's fire report data in the 1976 provided the basis for a wildfire recording system which was fully integrated with provincial forestry inventory data (Tuinhof and Nicholls, 1978).

The computerization of forest fire information involved the usage of two forms; wildfire report FP-40, and Damage and Loss Sheet FP-41 (Tuinhof and Nicholls, 1978). The wildfire report itemized fire times and acreages at ignition, detection, report, suppression, control, and extinguishment. Other information fields included standard cause classification, fire weather indices, suppression costs and person days expended on fire suppression. A non-computerized remarks section was also included for comments regarding fire spread, and factors affecting suppression. Damage and loss sheets also provided relevant data for the Forestry Branch regarding forest management unit, township, range, stand number/type, area, and ownership status.

The Forestry Branch was responsible for data input and output and produced the following reports on an annual basis from 1976 until 1990 (Tuinhof and Nicholls, 1978):

1) annual statement of fires by causes,
2) status of land and ownership and area burned,
3) status of land an area burned by merchantability of stands,
4) cost of suppression and number of man-days employed,
5) method of detection,

6) monthly distribution of fires,

7) forest fire cause analysis statistics,

8) area and volume losses for individual fires with summaries by districts and regions.

In 1991, the Fire Program established its own database system to compile and report wildfire data on a ongoing basis in order to provide fire managers with a accessible source of fire statistics. The Forestry branch still compiles those portions of the wildfire report which relate to stand management and inventory, while Fire Program maintains its database with all data fields found on the fire report.

2.4 Intelligent Fire Management Information System (IFMIS)

The Intelligent Fire Management Information System (IFMIS) is a software package was developed by Forestry Canada to provide a decision support system for forest fire managers who prepare and dispatch initial attack resources. It is a tool that integrates fire weather, forest inventory, and suppression resources to provide an overall picture of the current fire situation (Anderson & Lee, 1993). The software utilizes the Canadian Forest Fire Danger Rating System (CFFDRS) to determine fire weather conditions, predict potential fire behaviour, and assess the coverage of suppression resources.

Manitoba began using IFMIS at an operational level in the Eastern region in 1990, and at a provincial level by 1991. The system is currently being integrated into the new National Fire Information System N.F.I.S. developed by the IDSYS INC. of Messines, Quebec for the 1993 fire season. These computer assisted information systems represent the first and second generations of informational software developed for Canadian forest fire managers.

2.5 Fire Management Policy in Canada and the United States

Beall (1949) described the formative years of fire policy in Canada as falling far short of any acceptable standard. "Keep fire losses as small as possible" was the credo of the day, as the means and facilities limited the success and scale of fire control efforts. Even at this early stage foresters and fire managers were asking themselves the following:

> How much protection is now being given to Canada's forests? How much more protection can be justified on economic grounds, and how can this best be achieved? (Beall, 1949)

The pursuit of these basic questions eventually led to the establishment of minimum standards for forest fire protection in all defined forest zones in Canada. The initial research and development towards this goal began at the Petawawa Forest Experiment Station in the 1940's (Van Wagner, 1965), and these efforts eventually resulted in the forerunner of the Canadian Forest Fire Danger Rating System (CFFDRS).

In an attempt to define an adequate fire policy for Canada the need existed to quantify and define the value of forests based on their timber and other values. Timber values were determined by the market value at the time, while the total non-timber values were assumed to equal the highest timber value as calculated from current market prices (Beall, 1949). The difficulty of valuating non-timber values posed as difficult a task in 1949 as it does today as revealed in the tone of Beall (1949) footnote in the matter:

> Among the authorities consulted, the few who ventured an opinion on the point seemed to be in agreement that, in the average productive forest, the combined values of stream flow protection, recreation, and wildlife are at least equal to, and may greatly exceed, the wood value. In Headley's opinion, 'fire damage to tree growth, forage, and physical improvements probably averages much less than other forms of damage which are commonly called intangible'.

In the absence of any other reliable quantitative method 'burned area' quickly became accepted as the best indicator of forest fire damage since it was the most universal and reliable item reported on a fire by fire basis.

Since the 1920's, several policy eras have evolved in forest fire suppression. Early policies, developed by Show and Kotok (1930) in the late 1920's, established fixed goals based upon the maximum area which could be burned over a full rotation period. These acceptable burn areas were defined by foresters as being the maximum average annual rate of fire damage compatible with sound forestry management. Burned area objectives were calculated for all tree species and forestry zones in Canada and the United States. On average the Canadian methodology provided a slightly lower acceptable burned area than the American method. These values ranged from .01%-2.5% of the forest cover type depending on tree species and forestry zone (Beall, 1949; Show and Kotok, 1930). Protection levels focused on keeping burned areas below this maximum goal to ensure successful rotation and harvest.

A secondary standard which began to evolve at this time was that of elapsed time objectives. These hour control standards as they became to be known were developed to determine the maximum time that could elapse from a fires ignition to its attack and subsequent control. These elapsed time standards eventually led to the first work period objective in the United States which came to be known as the 10:00 a.m. policy.

The U.S. Forest Service adopted the 10:00 a.m. policy in 1935 (see Appendix C for full text) with the goal of ensuring that fire control agencies possessed the manpower and equipment to control every fire within the first work period (Loveridge, 1944). This goal to obtain control by 10:00 a.m. the following morning was based on the premise that:

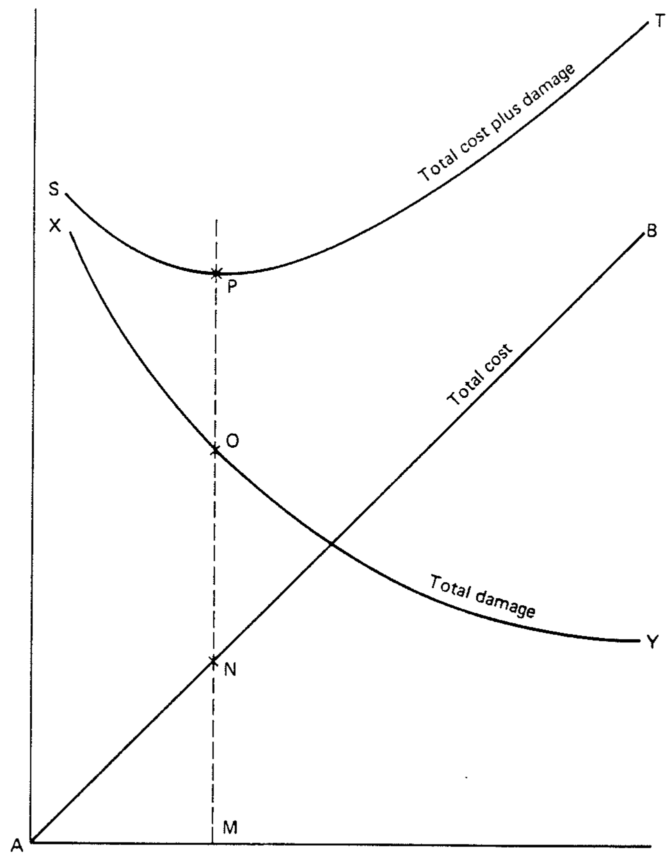
1) small fires are always cheaper to control then large fires,

2) large fires always cause greater damages than small ones.

The prevailing logic was that if both premises were maintained the result would result in minimal costs and damages. The 10:00 a.m. policy was abandoned in 1978 as it assumed all fires were damaging, and it was not always cost effective since it often promoted expensive manual night fighting over more efficient daytime mechanized suppression. It was at this point that the focus of fire suppression thus became a highly specialized equipment-oriented daylight operation (Chandler et al., 1983).

At the present time the least cost plus loss policy is the center of American and to a some extent Canadian fire policy. The policy attempts to achieve efficiency and cost effectiveness by placing fire expenditures and response at the optimum point where the costs to suppress plus the loss or damages are minimized. The most desirable point on the total cost plus loss curve (Figure 5) is shown as point P which corresponds with a damage level of point O and a fire expenditure of point N. Any point to the right of the intersection of the total cost and total damage line is inefficient since one is spending more to protect the resource than what the resource is worth. While this approach is theoretically sound from an economics viewpoint, the successful application of this theory requires comprehensive knowledge and quantification of all values at risk.

Another approach to fire policy was the subjective one of adequate control. The concept was originally put forth by Flint in 1928 and it is defined as "the degree of protection which will render the forest property as safe on the average from destruction by fire as are other forms of destructible property in which moderately willing investors are willing to place funds".



Line AB represents a range of complete fire control costs necessary for different degrees of fire control intensity on an assumed unit.

Line XY represents damage which would decrease as a result of increasing cost and intensity of fire control.

Line ST represents the sum of the values from the base line to AB and from the base line to XY. Thus MN+MO = ST at P.

N marks the point of fire control cost which will result in P, the lowest attainable total of all costs and damage.

Figure 5 : Least cost plus loss curve (from Brown and Davis 1973)

Its important to note the social political nature of adequate control as it implies a protection level which is defined by varying value sets (Brown and Davis, 1973). Therefore the level of adequate protection will differ depending on who will utilize or own the forest. The pulp mill may define adequate protection of its timber berth quite differently from the person who canoes in its streams. For the most part however, the owners and taxpayers determine and define an adequate level of control through the proxies of government and fire budgets. The adequate control approach is unique in the fact that it utilizes risk as an integrated element. A combination of adequate control and least cost plus loss, is likely the most widespread and least understood approach used by fire control agencies.

Over the past 60 years fire policy, means, and facilities have changed greatly, resulting in a greater role for fire management agencies. For example the focus of early fire suppression was on saving timber values associated with the forestry resource, in settled areas this soon gave way to other human and real property values while forestry values continued to justify fire suppression in remote areas. At the present time the determination of intangible or non-market values has provided a focus for economists and resource managers and may eventually lead the way for future policy changes. In addition to this other aspects such as natural fire cycles, and artificial fuel loaded environments, are only now being evaluated and linked to the "keep fire losses as small as possible" policy.

2.6 Travel time and strategic planning

Travel time to arrive at a fire once it has been reported has long been recognized as the most critical element of fire suppression. This belief is based upon the general principle that if you arrive at the fire while it is still small you are able to control and extinguish the fire more quickly and with less effort than if you were to have arrived at a later point in time (Brown and Davis, 1973). This time/size relationship is the basis upon which the earliest forest fire response actions were developed

Based upon this premise initial attack preparedness systems have evolved to ensure the majority of fires are actioned early on, before they attain a size that prevents initial suppression efforts. This action should theoretically result in lower suppression costs as large project fires are avoided, and large wood volumes are saved.

The goal of minimizing losses through quicker response led to the early hour control standards and fire crew coverage models developed in the United States during the early 1930's (Show and Kotok, 1930). Hour control can be defined as the attack time needed to hold burned acreage to an acceptable minimum. This attack time can be broken down into four distinct components:

1) discovery - time from start to discovery
2) report - time from discovery until an individual responsible to action the fire is notified
3) dispatch/get-away - time it takes for suppression resources to get ready and depart for the fire
4) travel time - time required to travel to the fire.

Early researchers found the need to define varying attack times depending on the cover type (fuel), the character of the fire season, and the wind and humidity and conditions on a given day (Show and Kotok, 1930). Fire managers concentrated on designing initial attack systems capable of responding to average worst case conditions. This resulted in varying attack times based on fire cause and fuel type (Show and Kotok, 1930). Experience had shown that attack times based on human caused starts in a given fuel type would provide a safety margin adequate for lightning fires, because human caused fires generally had a faster rate of spread than lightning caused fires, as they usually burned in human altered forest environments (Show and Kotok, 1930).

Human caused fires received the fastest response since the values at risk were more identifiable, information regarding start time and location was good, and road accessibility was generally better than remote lightning areas.

Longer response times was afforded lightning fires since access was poorer, fires required 2-3 days before they reached a detectable size, and lightning events often resulted in multiple fire starts in remote areas. The sites of many early lightning fires were often only accessible by foot and pack animals, and resulted in extensive logistical planning and expense to suppress. The net result of all these factors was that a much lower priority was afforded attack times for lightning fires as compared to human caused fires.

Show and Kotok (1930) found that the time from dispatch to arrival generally remained constant regardless of the severity of the fire year and that if suppression began within one hour of ignition, the probability of successfully suppressing the fire was high. It was found that crews were more likely to successfully suppress a fire that was less than 10 acres in size than one which exceeded 10 acres in size. In cases when initial attack failed and fires were lost, reasons were generally attributed to the flammability and dryness of the fuels, a bad fire day, or in some instances a bad fire year (Show and Kotok, 1930).

The earliest quantifiable studies regarding initial attack coverage methodology was done by Norcross and Grefe (1931) in the 1920's and involved calculations to determine how large an area a fire fighter could cover while traveling over land at 2 mph, as compared to traveling along a fire path at 4 mph, as compared to traveling in an automobile along a narrow forestry road at 20 mph. The strategic placement and application of ground resources and equipment is graphically shown in Figure 6 (from Norcross and Grefe, 1931).

Similar travel time studies were conducted in Canada at the Petawawa Forest Experiment Station during the 1940's. Originally published anonymously in 1948, and followed up by Van Wagner (1965) a comprehensive travel time map and associated fuel type map was developed and integrated into a fire control plan for the Petawawa Forest. The travel time map divided the forest into time zones at 15 minute intervals, with a maximum travel time of 100 minutes.

> The limits of penetration by foot and by boat were then plotted at strategic points for the various time limits, allowing speeds of 2 miles/hour for foot travel and 10 miles/hour for water travel (after a 10 minute delay for launching). Allowance was made for natural obstacles such as swamps and steep hills (Van Wagner, 1965).

Many of these early time distance relationships form the basis for the linear programming parameters found in the sophisticated fire planning computer applications of today. With regards to elapsed time from detection to suppression, Norcross and Grefe (1931) indicated that detection or discovery time should be kept to a minimum, report time was dependent upon communications systems, getaway time was dependent on the efficiency of the personnel, and that travel time was dependent on the speed of the vehicle, its start location and associated road network. They concluded that every minute reduced in discovery, report, and getaway was far more valuable when moved to the travel time component. The application of these early studies had a direct result in the development of the fire road and trail systems across the United

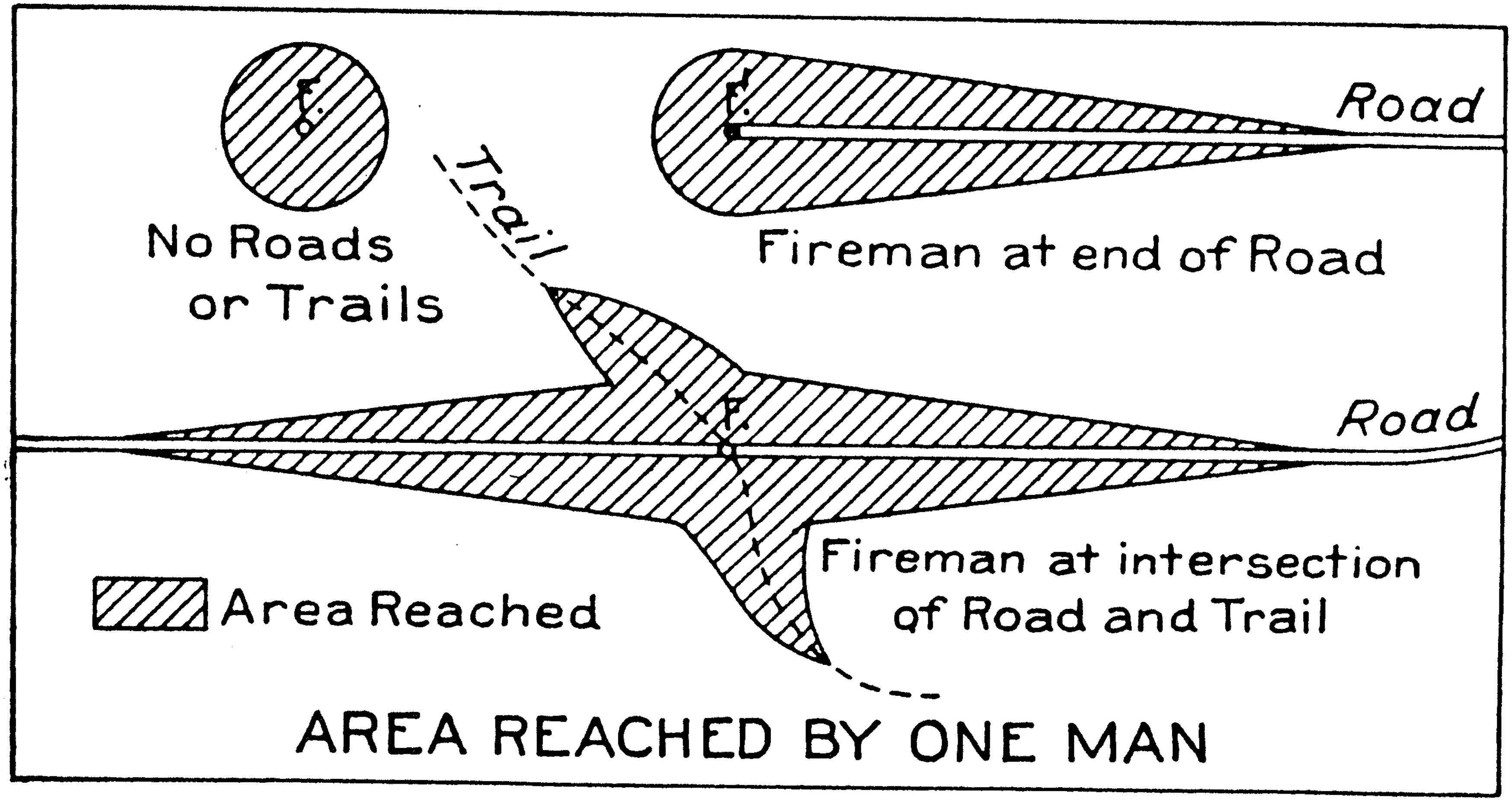


Figure 6 : Theoretical coverage patterns for a single firefighter taking road and trail networks into account
(reproduced from Norcross and Grefe, 1931)

States, and likely affected fire trail development in Canada as well (Brown and Davis, 1973). These studies also served as the basis for the earliest attack time formulas based on distance and travel time. As time progressed, road development based on multiple use rather than exclusive fire use occurred. This led to better roads, higher standards and even faster response times in areas where fire interests overlapped other uses. (Brown and Davis, 1973).

As initial attack planning developed through the 1950's and 1960's three general approaches were used to reduce the time needed to arrive at a fire

- Strategically place initial attack crews to reduce their travel time to the fire.
- Increase travel time through the use of a faster vehicle.
- Increase speed and access through improved transportation networks on the ground.

These three approaches continued through the 1960's until increased aircraft usage and availability changed the transportation requirements and the need for improved ground transportation was diminished.

In areas with no road networks initial attack strategies depended upon aircraft and boat transportation as a means of reaching the fire site. The cargo, fuel, speed, and weather limitations of early aircraft limited the amount of equipment and men which could simultaneously be placed on a fire. Over time, faster more dependable float planes evolved to further enhanced the ability to place initial attack forces at remote fires from the air.

Despite these advances, attacking a remote wilderness fire using fixed wing aircraft still depended on water and shore access. The development of the specialized waterbomber was the beginning of a varied resource mix approach to fighting forest fires from the air. With its beginnings as early horizontal dump tanks, water filled bags above the floats, the fillable float, the Canso flying boat, and finally to the production of the specialized Canadair CL-215, the waterbomber changed the strategy with which fires were fought.

2.7 Helicopters and initial attack

Helicopter usage for initial attack is a standard in forest fire suppression in Canada's boreal forests today. Helicopters have a large advantage over fixed wing aircraft as they can usually land adjacent to a fire's location, or rappel suppression crews to the fire. This ability to have immediate access to the fire site lowers the time required since crews generally do not have to hike long distances into a fire. It is however important to note the limitations of the helicopter as compared to fixed wing waterbomber aircraft due to slower speeds and reduced payloads and ranges. These factors limit helicopter coverage to specific strategical roles. While distance and payload limitations were greater in the early days of rotary aircraft some key operational strategies regarding helicopter usage on initial attack did evolve in the North America during the early 1970's (Brown and Davis, 1973).

1) The reduced air speed can result in serious delays in actioning fires 50 to 100 miles away, but this delay is minor for fires 10 miles away.

2) The unit cost of moving men and equipment via helicopter is higher than fixed wing

3) The handicap of slowness is overcome by a decentralized operation which strategically places helicopters at locations where travel distance is reduced.

This final point outlines the basic principle behind all initial attack preparedness systems that utilize attack time objectives based on the resources placed at a given set of initial attack bases. The management of strategically placed resources can be applied to all transportation modes as long as existing transport corridors and limitations are considered. This strategic approach to initial attack planning is essential if a fire manager is to utilize his/her resources in a cost effective manner.

Many of the early concepts involving initial attack coverage patterns have remained applicable for the past 60 years. The circular coverage patterns detailed by Norcross and Grefe (1931) involving a single fire fighter on foot with no road access mirrors helicopter attack circles of today. Other elongated coverage patterns along established road networks and trails share similarities with coverage patterns found today when actioning fires by ground transportation. The concept of locating of fire bases at road or transport intersections remains equally important and applicable today as it did in the 1930's.

The application of helicopters to modern day forest fire fighting in Manitoba has undoubtedly had the greatest effect on initial attack capabilities in the remote portions of the province. The helicopters ability to deploy men and equipment through quick vertical take-off and landing has reduced initial attack travel times when actioning fires within a 30 to 40 mile radius (Brown and Davis, 1973). Beyond a 40 mile radius the increased airspeed of fixed wing waterbombers outweighs their slower getaway time. The net result is a faster waterbomber attack time for fires beyond a 60 mile radius. The mix of crews and machinery for a given fire will vary according to the size, location, fuel, and weather conditions associated with that particular day, as well as the machinery and logistics at the fire managers disposal.

Manitoba currently utilizes five person crews transported via medium lift helicopters. Five man crews would normally use one or two Mark III pumps to deliver water to the fire site. Approximately 2500 feet of hose is aboard during an initial attack response, and average pumping distances will vary from 1000 - 1200 feet (McLarty, 1993). When utilizing a light lift helicopter a set-up crew consisting of a Helitac officer plus 2 members is brought in on an initial ferry with the remaining three crew member brought in via a second trip (McLarty, 1993).

For fires near the initial attack base (i.e.within 5-10 minutes) the helicopter is usually first on the scene followed by the birddog aircraft and waterbombers as required. For fires beyond the 40-50 mile range, the birddog will usually arrive first followed by the waterbombers and finally the initial attack crew (McLarty, 1993).

Logistics for ground crews will vary depending on whether the fire is multiple agency response (ie. municipalities, L.G.D., local towns) or a first response by Natural Resources. In the typical Natural Resources truck response, a 3/4 ton truck is used to transport 4 or 5 fire fighters to the fire site. The inclusion of a tank trailer and pump set up depends on location and water availability.

2.8 Initial Attack Principles

Regardless of crew and equipment levels, the following universal principles are applied by most fire management organizations (Chandler et al., 1983).

1) The fire fighter travels via the shortest, quickest route compatible with their mode of transportation.

2) Upon arrival the fire fighter in charge will assess the situation and decide upon a method of attack.

3) If direct attack is chosen work commences immediately at the most vital point of the fire.

4) If additional help is required work commences on activities which will be of greatest assistance to reinforcement crews once they arrive

5) Once the fire has been contained mop-up begins and continues until all active fire activity is eliminated and no longer poses a threat to surrounding fuels.

These five points indicate the basic factors which must be considered when analyzing the successfulness of a preparedness system. These factors are speed, distance, attack strategy, action required, strength of attack, and the longevity of the attack. Speed and distance are a function of equipment, geography and positioning, while attack strategy, action, strength and longevity are more related to crew production factors.

Quintilio et al (1990) have done considerable research on hand tool crew production rates in the boreal forests of Alberta, however no similar studies have been done with regards to pump and hose production rates in Manitoba. At present, an initial attack effectiveness and productivity study in western Canada is being conducted by Forestry Canada's Northwest Forest Research in Edmonton, Alberta to determine what type of initial attack resources are required to achieve containment under various fire behaviour conditions (Hirsch, 1993). This study should provide some understanding of production rates and efficiencies of initial attack crews throughout Canada's boreal forests.

2.9 Initial Attack Strategies

There are three basic methods to attack and suppress a fire;

1) direct attack along the burning edge,

2) parallel attack through fireline construction adjacent to the fires edge,

3) indirect attack through the establishment of control lines located away from the fires edge (Chandler et al., 1983).

2.9.1 Direct attack

Direct attack involves action at the flame front utilizing water, chemicals, or dirt to suppress the flames. It normally includes the establishment of a line fuel break around the fire to facilitate mop-up operations. This method is employed on small fires which can be controlled and mopped up by the crew unit that was initially sent to it. It can also involve direct attack by CL-215 water bombers in combination with or without other suppression resources. Most successful initial attacks in Manitoba are of this type. This method is the most positive control method because it leaves a cold line behind it, and is the method of choice when fire behaviour permits (Chandler et al., 1983). Direct attack can also involve hot spotting, or direct suppression on the hottest points of the fire with subsequent action on areas of open flame and control line establishment between adjacent hot spots. The method is most effective when water is used, as water is a more effective flame suppressant than dirt. The successful application of this method results in shortened fire action times coupled with smaller burned areas.

2.9.2 Parallel attack

Parallel attack is used for intense fires, or on those fires which have an irregular fire edge. This method involves constructing a control line parallel to the fire line through either manual or mechanized methods. Since active flame suppression is not done at the fire line, a wider line is usually needed. In addition to this line maintenance is required in the form of burned off fuel breaks. Regular patrols may be required to ensure the fire does not spread beyond the parallel line into adjacent fuels. This method allows for fast line construction through the use of heavy equipment such as caterpillars and skidders, however it can result in dangerous situations caused by wind shifts. This type of method is commonly used on medium sized fires through to larger-sized fires in Manitoba depending on the nature of the fire and the topography.

2.9.3 Indirect attack

Indirect attack methods are used when fire intensity is such that it is unsafe to action the fire via any other method, or when values at risk do not justify a large suppression expenditure. One method involves moving suppression resources back from the fire to connected natural and manmade barriers (i.e. roads, fuel breaks, rivers, etc.) inside which all potential fuel for the fire is burned out (Chandler et al., 1983). This method requires expert knowledge and experience with fire behaviour, and is dependent upon temperature, wind, and fuel type conditions. While it is often the cheapest alternative to suppress large fires, its appeal is offset by the large losses which result in area burned out. This method of attack has been applied when attempting to contain large volatile grass fires in southern Manitoba, or in some instances on large limited action fires in Manitoba's north. Another indirect attack method is the strategy of backfiring which involves the burning of fuels directly in front of the approaching fire head (Quintilio et al., 1985). This procedure is achieved through the use of areal ignition devices usually attached to a helicopter. The technique makes use of the strong indraft winds at the fires head which serve to draw in the flames from the backfired line and slow the forward speed of the fire (Quintilio et al., 1985). The reduced forward speed results in the standing of the smoke column to a vertical position, thus providing increased visibility at the active fire head (Van Nest, 1993). This slowing down of the fire head provides more time and visibility for other suppression resources to fight the fire head. Backfiring is a strategy often utilized when fire managers need to slow down large high intensity crown fires in anticipation of more suppression resources or more favorable weather conditions in the immediate future.

The choice of attack strategies most often depends upon the size at which the fire is detected. For the most part initial attack strategies in Manitoba focus on a direct attack method when fires are still within a manageable size (i.e.<1 hectare), but larger fires may be initial attacked with the use of CL-215 water bombers. Once a fire is beyond the capability of a successful initial attack, other strategies such as parallel, indirect, or a combination of the two may be utilized. If the fire is beyond all reasonable methods of control or if values at risk are minimal a no action strategy may be adopted.

2.10 Alberta Presuppression Preparedness System

Alberta was the first western province to develop a formal preparedness system in 1983 (Gray and Janz, 1985). This action was a direct result of the record fire seasons from 1979 to 1983 which set new provincial records for hectares burned, fire incidence, and suppression costs. The severity of fire activity was attributed to the precipitation deficit which occurred over this period coupled with fuel and geographic conditions. The need to reprioritize the objectives and methods of the Alberta Forest Service with regards to forest fire suppression was tantamount if the forest industry was to prosper in the future (Gray and Janz, 1985).

The response to this need was the development of the presuppression preparedness system as outlined by Gray and Janz (1985). The goals of the Alberta system are;

- reduce the number of large campaign fires
- reduce overall direct suppression costs without making presuppression costs beyond the point of diminishing returns
- design a forest based response system responsive to climatic change
- be able to evaluate and audit the system on an ongoing basis

To achieve these goals Alberta embarked on a process to determine key fire behaviour patterns based on weather conditions and forest fuel type. They then determined acceptable initial attack response times based on values at risk and man power and equipment levels needed to successfully suppress fires given the climatic and forest conditions. This was accomplished by ensuring that adequate resources were placed at strategic locations based on the predicted fire hazard prior to fire occurrence. Through this process the system would minimize the risk of costly escaped fires by ensuring that no delays occur in actioning the fire. To accomplish this task in a systematic fashion, Gray and Janz (1985) stated:

> Six levels of preparedness are used based on the indexes that indicate fire ignition potential and fire behaviour severity (Table 9). The same range of FFMC and BUI values were used to develop initial attack times (get away and travel time outlined in Table 10). As fire weather severity rises the initial attack time decreases. Suppression resources are assigned to each level indicating the minimum amount of each resource to be placed on standby (man-up) under each level.

The deployment procedure and operational logic is outlined by Gray and Janz (1985):

> A series of attack centers has been defined. Any base or area used to stage resources becomes an attack center. They may be established facilities, administration points, or a helispot in the forest where resources can be staged on a daily basis. Attack centers are generally located on the basis of best coverage of the area and are manned on the basis of historical and predicted risk potential and priorities of values at risk. The choice of attack centers to be manned on any given day depends on preparedness level, forest priorities and attack times prescribed. The concept is that as the fire danger level rises, the attack centers sphere of influence shrinks so that the combined getaway time plus travel time equals the total attack time objective. For example, a 15-minute attack objective is made up of 3 minutes getaway and 12 minutes travel time. As the sphere shrinks more centers are activated until a maximum level of preparedness is attained. At this level it is possible to have a total forest covered with resources that will never be more than 15 minutes attack from from any fire start.

Table 9 : Preparedness levels and attack standards with attack times from point of dispatch for the Alberta Preparedness System (Gray and Janz, 1985)

level of preparedness	first action on fire	FFMC	BUI/D.C.	Risk
level VI	15 minutes	89 +	85/300 +	risk not a factor
level V	15 minutes	89 +	85 +	risk not a factor
level IV	15 minutes	89 +	61 -85	risk not a factor
level IV	15 minutes	86 - 88	61 -85	high risk
level III	30 minutes	86 - 88	61 -85	risk not a factor
level III	30 minutes	less than 80	greater than 85	risk not a factor
level III	30 minutes	89 +	less than 61	risk not a factor
level II	30 minutes	85 - 88	41 - 60	high risk
level I	60 minutes	less than 85	less than 41	risk not a factor

Table 10 : Getaway and travel times by initial attack objective for Alberta (Gray and Janz, 1985)

Initial attack objective	Getaway Time	Travel Time
15 minutes	3 minutes	12 minutes
30 minutes	5 minutes	25 minutes
60 minutes	10 minutes	50 minutes

The Alberta approach to alert response has undoubtedly worked for Alberta as demonstrated by its low wildfire losses since the establishment of its Preparedness System in 1983 (Table 6). The ability to accomplish this is made possible by the high levels of program funding. This continued commitment to manning up to prescribed equipment and manpower levels based on predicted hazard levels is unprecedented across the prairie provinces.

2.11 Manitoba Initial Attack Response System (IARS)

The goal of Manitoba's initial attack response system is to ensure that all forest fires occurring within Manitoba's primary protection zone are given an appropriate initial attack response according to their risk of fire ignition, potential fire behaviour and the resource or human values at risk (Manitoba Initial Attack Response (IARS), 1990). Figure 1 reflects the forestry resource values the initial attack system has been designed to protect. The preparedness system is defined and directed at forestry values however initial attack is also done to protect human and real property values .

This protection task is accomplished through the manning of predetermined initial attack bases located throughout the provinces forested area. Major bases are located at Bissett, Paint Lake, and Snow Lake. The staffing and equipment level of each base is dependent upon the current fire hazards in a given area as determined by local weather and forest conditions (Manitoba Initial Attack Response System (IARS), 1991). These factors and others determine the alert response level which in turn sets the attack time objective for a given base on a given day. It is important to note that the IARS is meant to provide a guided thought process that allows for a structural but flexible approach to man-up. Both science (e.g. fire weather indices) and personal knowledge are used to determine the required attack time. The corresponding attack time objective varies accordingly depending on zone alert level, and means of transportation available. For example attack bases located in areas adjacent to adequate road networks may utilize truck transportation to arrive at a fire, while those located in remote areas will likely depend upon aircraft or boat transportation to reach a fire. Expected attack times and ranges for each transportation mode are provided in Table 4.

Table 11 : Travel time and distance objectives by initial attack type for Manitoba

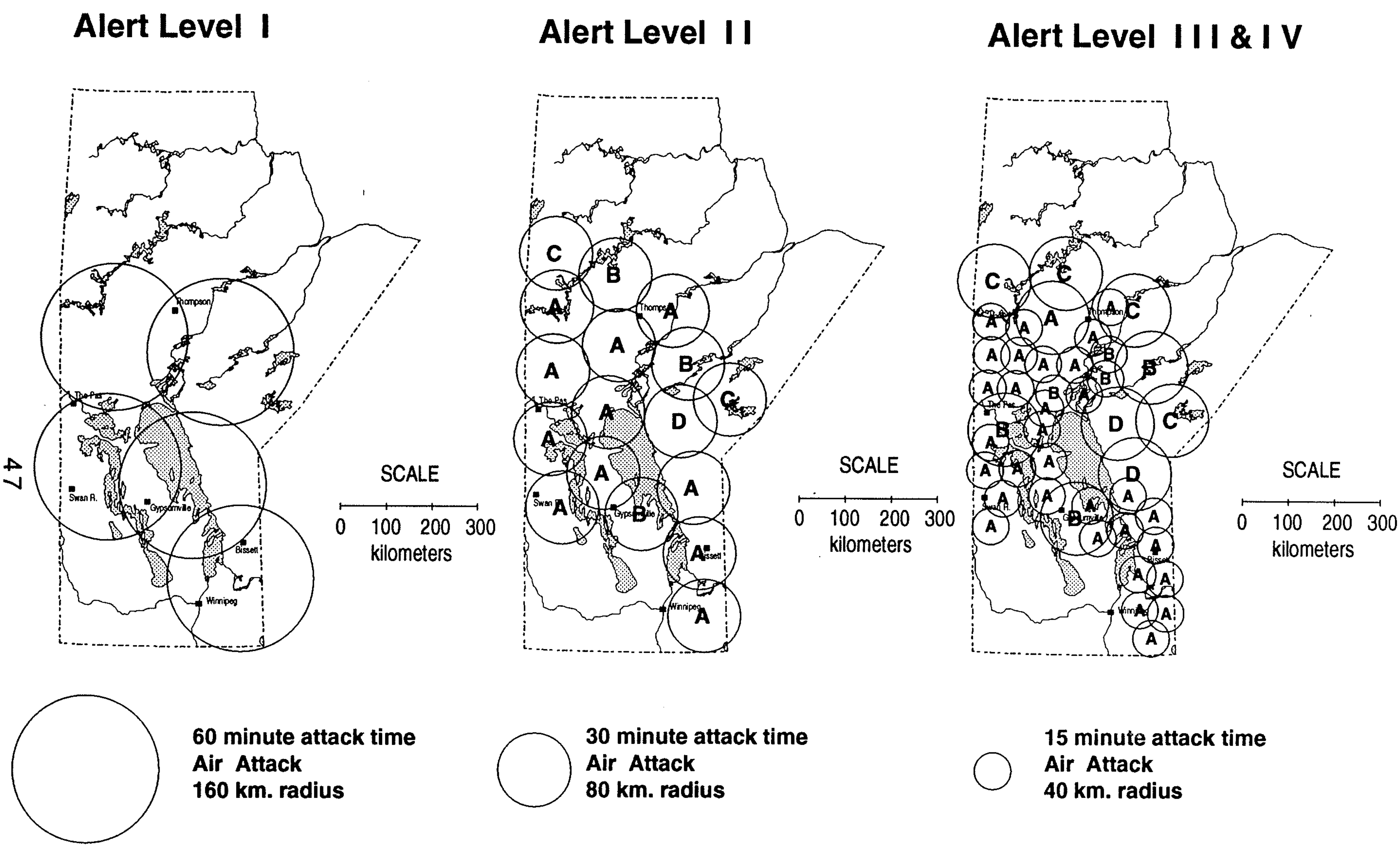
Initial attack type	60 minutes	30 minutes	15 minutes
Aircraft coverage	100 miles (160 km.)	50 miles (80 km.)	25 miles (40 km.)
Ground coverage	40 miles (64 km.)	20 miles (32 km.)	not applicable

When the system was originally implemented in 1990, three alert levels with time objectives were defined (level 1 - 60 minutes, level 2 - 30 minutes, level 3 - 15 minutes). After using the system in the 1990 season fire control officers commented that the system tended to reach the highest alert level to quickly, and that level one was too high a rating when no activity was occurring. As a result, fire control officers began to utilize level 0 as an indication of low fire activity midway through the 1990 season. Subsequently in 1991 a level four was added as well as a formal level 0. The net result was a five level initial attack response system.

It should also be noted that in its original form the system called for the coverage scenario of the Alberta model by placing resources throughout the province to achieve the 15 and 30 minute attack objectives. Due to the costs and lack of forward attack bases at many locations the system was revised to provide a theoretical coverage based on the minimum number of circles required to cover the protection area (Figures 7 and 8). While this tradeoff is less than ideal from a strategic placement stand point, it accounts for the basic machinery level required to cover the protection zone.

2.11.1 Determination of Alert Levels

Alert levels are determined through the application of the Fire Weather Index system as defined in the Canadian Forest Fire Danger Rating System (Canadian Forestry Service, 1987). All indices are calculated daily from the 1:00 p.m. actual weather readings for that day and the daily forecasts for the next day. Key components utilized include the Fine Fuel Moisture Code (FFMC), the Duff Moisture Code (DMC), and the Fire Weather Index (FWI). The FFMC has been chosen as it is indicative of man caused fires associated with early spring and late fall fine fuel and weather conditions. The DMC values have been selected due to their association with lightning caused fires during the summer period (Manitoba Initial Attack Response System, 1991), and the FWI was chosen because of its relationship to fire intensity and suppression effectiveness. The FFMC, FWI, and DMC are applied into the Initial Attack Response System through the use of a chart which plots one value against the other to determine the actual alert level(Figure 9).



note: resource placement is ranked from A to D with A having the highest priority and D the lowest

Figure 7 : Theoretical Air Attack coverage for Alert Levels I, II, III, & IV in Manitoba (Manitoba Initial Attack Response System 1991)

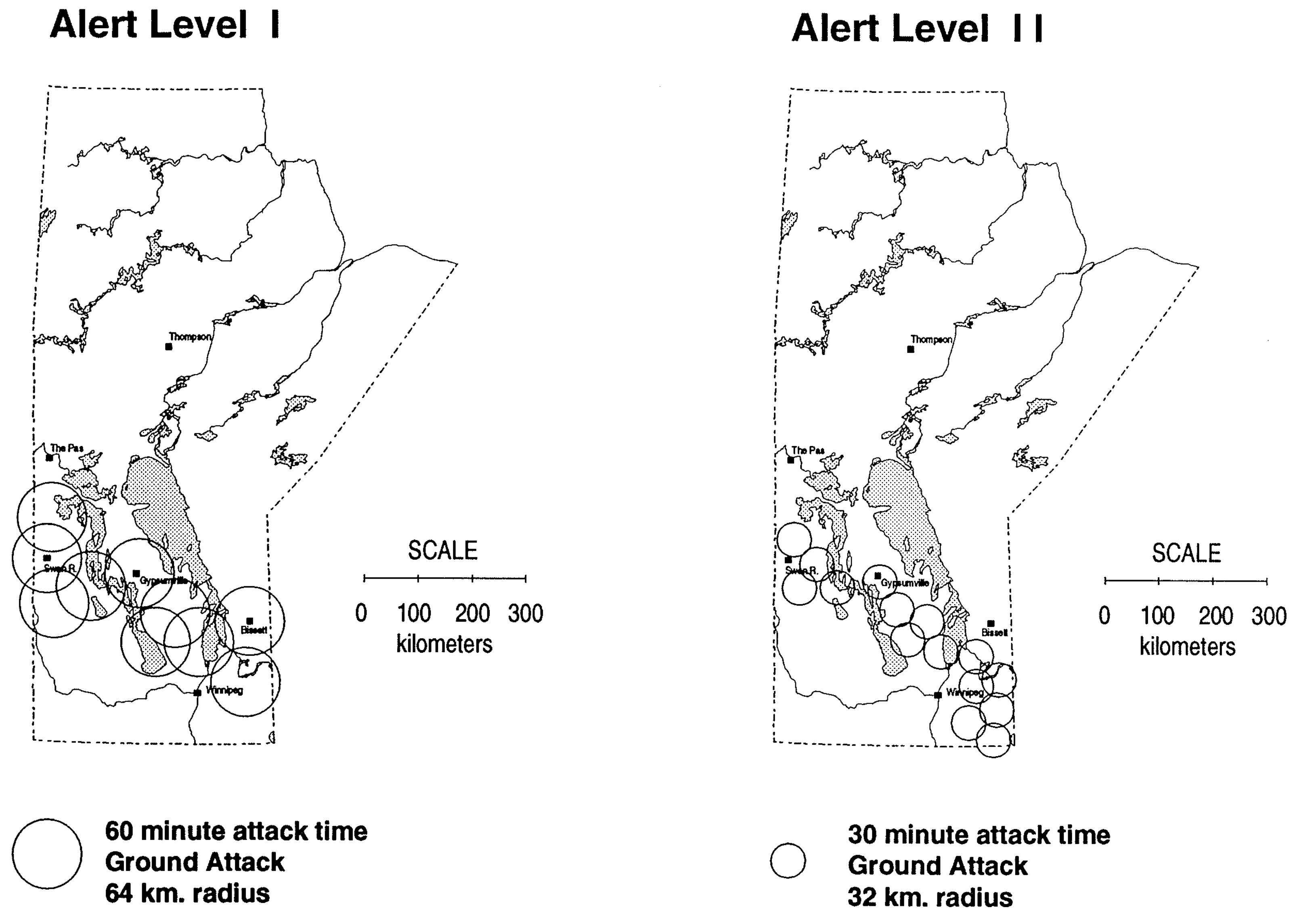
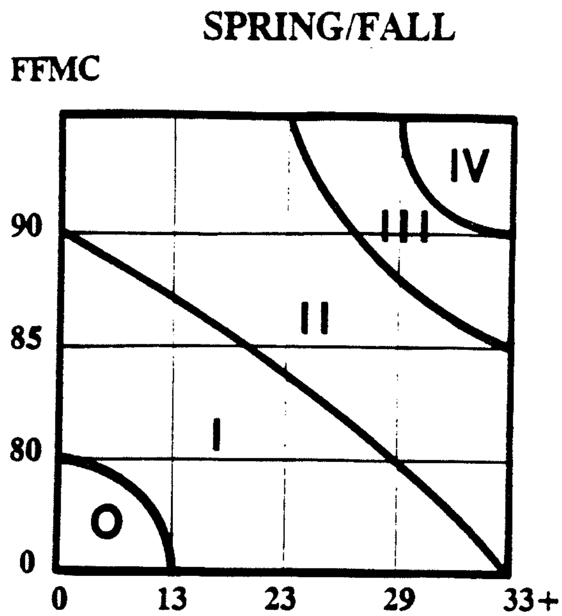


Figure 8 : Theoretical Ground Attack coverage for Alert Levels I, II in Manitoba (Manitoba Initial Attack Response System 1991)



* **NOTE: The Spring/Fall Chart is used prior to green up and after curing in the fall. Shifting between charts should be determined by the Regional Duty Officer in conjunction with Provicial H.Q.**

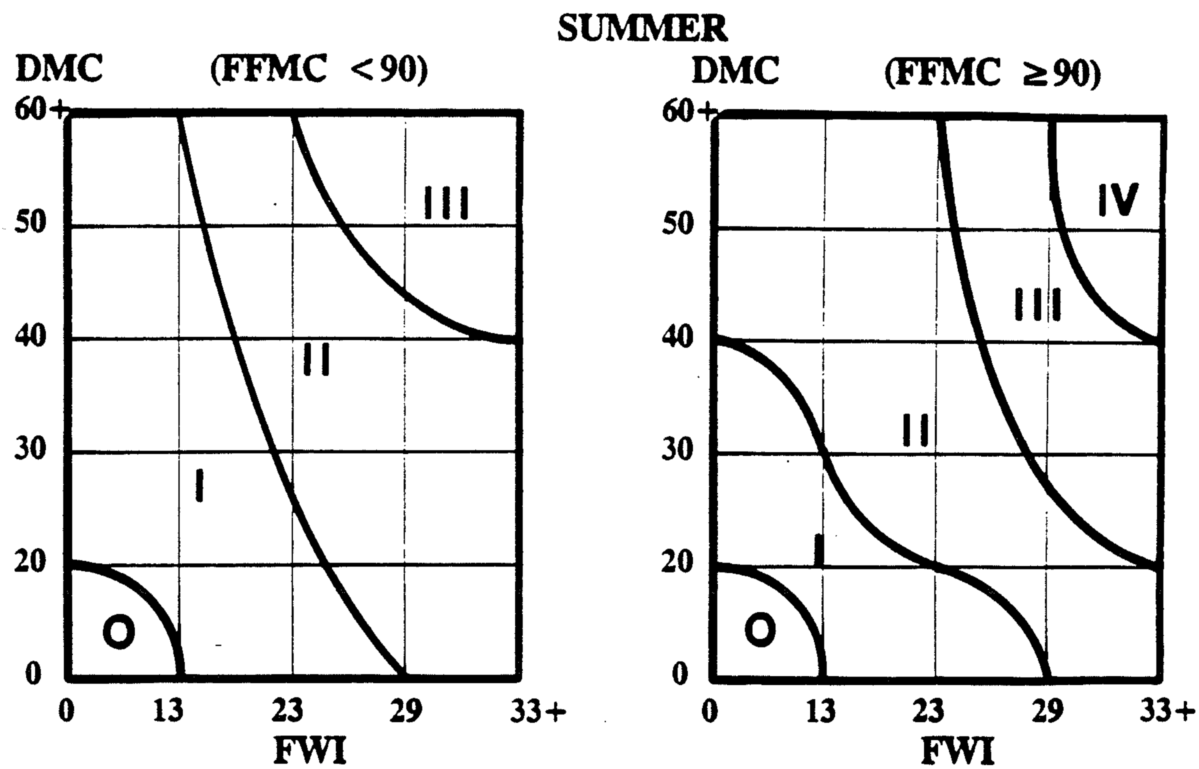


Figure 9 : Alert Levels as determined by calculated fire weather indices for the Manitoba Initial Attack Response System (Manitoba Initial Attack Response System, 1991)

The calculated alert level is then used as a starting point for the fire manager, from which he/she can adjust the alert level in either direction based on local knowledge and fire experience in a given area. This adjusted alert level is then used to set manpower and equipment requirements through the provincial duty officer. The level of resources obtained via the provincial duty officer is then based on the availability and equipment needs of the province as a whole. This balancing of risk at the provincial level is a key component of the system as human resources and machinery will be removed from a lower risk area and placed in a higher risk area in accordance with the hazard levels and values at risk. This balancing of risk is the fundamental difference between the Alberta preparedness system which mans-up to predetermined levels regardless of what may actually be required elsewhere and the Manitoba system which aims to optimize the usage and placement of the limited resources available by moving resources from lower risk areas to higher risk areas.

Chapter 3

Methods

3.1 Wildfire report data

This analysis utilized wildfire report data from 1990, 1991, and 1992 to compare actual initial attack response times and fire sizes with required initial attack response times and fire sizes. The wildfire report data was entered by Natural Resources staff during these fire seasons and was compiled into standardized data fields. Since 1991, the wildfire data was based on a micro computer system in the Fox Pro database format. Prior to this wildfire data was on a Manitoba Data Services mainframe system operated by Forestry Branch. For the purposes of this study all data was translated into the Microsoft Excel spreadsheet/database package and analyzed on a Macintosh SE-30 computer.

The wild fire report contained 97 data fields (Appendix D). Since the study was only concerned with the initial attack aspect of the wildfire report only those data fields pertinent to the analysis were reviewed and considered.

3.2 Data fields to be utilized

This comparison involved sorting the data and comparing the frequency distribution and averages at each alert level for all actioned fires for the following fields,

- region
- priority zone

- adjusted alert levels at detection
- time of detection and suppression
- size at detection arrival and extinguishment
- distance to fire
- initial attack base
- initial attack type (i.e. ground, air, loaded patrol, and water)
- number of fire fighters

All averaging and weighting was done in accordance with standard statistical methods as outlined in Huntsberg and Billingsley (1981). The distance distribution for all actioned fires was also reviewed to determine if the assumption of uniform initial attack circles based on current getaway and travel times was accurate. The effect of initial attack travel times on fire size at arrival was reviewed and documented. It should be noted that most comparisons involving initial attack time parameters have been limited to fires which were actioned on their detection date. This same day fires criteria has been employed in most instances involving time parameters to ensure that valid comparisons are made. It should also be noted that the following abbreviations have been employed through out: detection to dispatch (det/dis), dispatch to suppression (dis/supp), and detection to suppression (det/supp).

3.3 IFMIS size prediction data

The IFMIS system was utilized to obtain predicted growth sizes for all 1991 and 1992 fires, for the time period from detection to arrival of suppression crews and equipment. The comparison of IFMIS fire prediction data and wildfire report data was accomplished by the following methodology.

The IFMIS fuels database was verified by imputing the location of every fire as indicated on each fire report. The program then accessed the fuels database and displayed the fuel type of the cell in which the fire was located. This database fuel was then compared to the fuel type indicated on the fire report.

The fire growth predictions of the IFMIS program was analyzed by inputing the location, detection date, detection time, detection size, and correct fuel type into the Detection Assessment Module of the IFMIS program. The module then accessed historical weather data for the fire day and tabulated fire growth predictions with FWI indices, rate of spread (ROS), head fire intensity, predicted area and perimeter sizes at 15 minute intervals. All these calculations are internal to the IFMIS Fire Behaviour Prediction System (FBP) program and their formulas and assumptions were accepted as correct. It is important to note that the default set-up also affected the calculations. The set-ups used in this study were consistent and were as follows;

Fuels Cell type - .050 latitude X .100 longitude (this is the best resolution of the Manitoba database)

Smoke Report - Theoretical legal
- lat/long (degrees, minutes, seconds)

Influence range weather station - 200 km

Contour resolution - 100 km

Attack time objective size - 1.2 ha

Discovery size - .1 ha

Grass fuel weight - 3.0 t/ha

Run mode - real time

Local time - daylight savings time

FBP effects - (on) acceleration
- (on) BUI effect
- (on) green-up.

These selections were chosen to provide the best general treatment of all fires. Since specific date information regarding green-up time have not been incorporated the comparison may be weak in some spring fire season fuel types.

It should be noted that only those fires which represented a forest fuel type were included in the fuels test comparison, and that only those fires that have forest fuels, weather data, and were actioned on their detection day were compared in the IFMIS projection. Non-forest fuel fires were removed from both comparisons.

The 15, 30, 45,and 60 minute IFMIS predictions then had their slopes calculated from the detection size by the following method;

$$S15 = \frac{\text{predicted size - detection size}}{\text{15 minutes}} = \text{ha/min}$$

$$S30 = \frac{\text{predicted size 30 - detection size}}{\text{30 minutes}} = \text{ha/min}$$

$$S45 = \frac{\text{predicted size 45 - detection size}}{\text{45 minutes}} = \text{ha/min}$$

$$S60 = \frac{\text{predicted size 60 - detection size}}{\text{60 minutes}} = \text{ha/min.}$$

Once the four slopes were determined they were averaged to provide a general ha/min slope.

$$\text{general ha/min} = \frac{\text{S15 ha/min + S30 ha/min + S45 ha/min + S60 ha/min}}{4}$$

This general average slope was less than ideal but was chosen because the calculation and interpolation of slopes between slopes for a specific minute would have been time consuming and would have required each fire time to be manually calculated on an individual basis. The general slope method allowed computerization and quick calculation for the assessment of trends.

Once a general ha/min was determined, it was used to calculate a predicted size for a given time using the following formula:

predicted size at t = detected size + (general ha/min X t),

where t = the time from detection to suppression arrival

The predicted size for the time spanning detection to suppression arrival was used for the comparison.

Actual sizes as documented on the fire report were compared to predicted sizes determined by the preceding methods. These cross comparisons took into account fuel types, spread rates, and fire types as provided by the wildfire database. This breakdown revealed the types of fuels and fire conditions where the prediction data was strongest, and those areas where predictions were weak.

3.4 Daily Briefing Agendas, Planning Reports, and Helitac Operations Reports

All daily Briefing Agendas, Provincial Operating Plans, Daily Planning sheets, and Resource Request sheets were reviewed for each day of the 1990, 1991, and 1992 fire seasons (Appendix E). Attention was focused only on equipment and crew requests from the regions and subsequent resource deployment. Quantification of results was a simple indication of whether resources were refused or provided by headquarters. Specific reasons for refusal were not quantified due to the unique nature of most fire day situations. Attempts to correlate resource requests to fire times and sizes were done as the data permited, and were of a general nature.

Year-end regional helitac operation reports were also reviewed to gain qualitative input on the type of fire season a particular area experienced. This was used to better understand local anomalies or trends which may not have been apparent in the wildfire database. These reports also served to place the entire fire season within the context of particular weather, manpower, and operational concerns which existed in particular areas during the fire season. Time and size logs presented in these reports were compared by fire number to the wildfire report database as an error checking mechanism.

A glossary of selected Canadian forest fire terms has been provided in Appendix F to provide clarification of the technical forest fire terms found throughout the practicum.

Chapter 4

Results and Discussion

4.1 Forest priority zone analysis

Wildfire report data for 1990, 1991, and 1992 indicated that average response times were significantly longer than the time objectives stated by the operational guideline. Average response times by priority zone shown in Table 12 indicate that average response times from detection to suppression are fairly consistent at 54 minutes. The corresponding initial attack distances range from 30 km to 47 km, with average distances around 33 kilometers. General trends in Table 12 show marginally lower response time and distances in the red zone as compared to the other zones. Since averaging often obscures internal trends, further analysis through the use of frequency distributions was performed.

Breaking response times down into 15 minute intervals reveals patterns for initial attack responses for the past three years. The response time distribution shown in Table 13 represents fires which received action on the same day they were detected. Unless otherwise stated all comparisons have been limited to this criteria.

Table 13 shows that in 1990 and 1991 response time (all zones) were generally similar with approximately 20% of the fires being actioned within 15 minutes, 45% of the fires being actioned in 30 minutes, and 76% of the fires receiving action within one hour of detection. In 1992, a decrease in response

Table 12 : Initial attack times and distances by zone and year for all same day actioned fires

YEAR	1990					1991					1992					
FORESTRY PRIORITY ZONE	**# of fires**	detection to dispatch (h:mm)	dispatch to suppression (h:mm)	**detection to suppression (h:mm)**	avg distance (km.)	**# of fires**	detection to dispatch (h:mm)	dispatch to suppression (h:mm)	**detection to suppression (h:mm)**	avg distance (km.)	**# of fires**	detection to dispatch (h:mm)	dispatch to suppression (h:mm)	**detection to suppression (h:mm)**	avg distance (km.)	
red	*340*	0:21	0:28	**0:49**	30	*321*	0:25	0:25	**0:50**	32	*120*	0:25	0:26	**0:51**	38	**red**
orange	*13*	0:31	0:46	**1:17**	37	*32*	0:34	0:37	**1:11**	42	*17*	0:40	0:37	**1:17**	38	**orange**
yellow	*26*	0:21	0:28	**0:49**	47	*42*	0:27	0:31	**0:58**	42	*31*	0:47	0:28	**1:15**	43	**yellow**
green	*72*	0:33	0:28	**1:01**	28	*96*	0:34	0:30	**1:04**	30	*57*	0:41	0:32	**1:13**	30	**green**
white	*14*	0:44	0:36	**1:20**	36	*12*	0:30	0:34	**1:04**	34	*4*	0:51	0:17	**1:08**	30	**white**
all zones	*465*	0:24	0:29	**0:53**	31	*503*	0:27	0:27	**0:54**	33	*229*	0:33	0:28	**1:01**	37	**all zones**

Table 13 : All zones 1990, 1991, and 1992 response time (det/supp) comparison at 15 minute intervals

	1990					1991					1992				
det/supp time (h:mm)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)
0:15	89	**19.0%**	0.5	0.6	19.3	103	**20.5%**	1.4	1.7	20.0	23	**10.0%**	10.2	10.5	25.8
0:30	125	**45.7%**	1.3	2.1	22.8	123	**44.9%**	2.0	8.0	25.2	65	**38.4%**	2.8	3.9	26.5
0:45	93	**65.6%**	1.8	3.3	35.6	92	**63.2%**	4.7	8.8	35.0	40	**55.9%**	1.7	2.6	34.5
1:00	55	**77.4%**	1.3	1.4	35.8	61	**75.3%**	16.4	18.9	41.7	26	**67.2%**	1.4	2.7	31.0
1:15	26	**82.9%**	6.0	7.1	44.4	30	**81.3%**	1.2	6.7	49.6	16	**74.2%**	3.1	5.8	38.9
1:30	21	**87.4%**	41.6	43.0	44.1	23	**85.9%**	15.1	15.9	45.3	16	**81.2%**	1.1	3.0	38.4
1:45	9	**89.3%**	1.2	3.5	66.7	6	**87.1%**	27.0	29.2	59.3	14	**87.3%**	2.1	5.1	62.6
2:00	12	**91.9%**	21.2	34.4	37.7	16	**90.3%**	66.1	68.9	42.9	5	**89.5%**	1.1	1.9	51.2
2:15	4	**92.7%**	0.7	0.7	28.8	7	**91.7%**	0.5	15.6	22.4	5	**91.7%**	3.6	12.5	74.8
2:30	6	**94.0%**	3.3	35.4	44.8	12	**94.0%**	9.8	9.9	49.8	7	**94.8%**	5.5	6.5	58.1
2:45	3	**94.7%**	3.1	3.6	70.0	4	**94.8%**	0.4	0.5	62.5	3	**96.1%**	8.1	12.3	39.0
over 3:00	25	**100.0%**	25.1	61.9	44.0	26	**100.0%**	17.2	21.3	45.6	9	**100.0%**	3.2	8.1	64.1
totals	**468**		**5.1**	**8.6**	**31.4**	**503**		**7.9**	**11.4**	**33.2**	**229**		**3.2**	**4.8**	**36.5**

time efficiency is seen with only 10% of the fires receiving 15 minute action, and only 67% of the fires being actioned within the hour.

Possible reasons for the downward trend may be the nature of the fire season, and the initial attack distance. Because the 1992 fire season had less than half the number of red zone fires than 1990 and 1991, the larger fires in lower priority areas skew the 1992 time interval totals.

A review of Tables 14, 15, and 16 shows 1990 red zone fires at 343, 1991 red zone fires at 321 and 1992 red zone fires at 120. As a result the 1992 totals represent a larger portion of low priority fires than high priority fires. The net result is less efficient times with larger sizes and distances than previous years.

Red zone response times (Tables 14, 15, and 16) show that 1991 had the best 15 and 30 minute times, followed by 1990 with slightly lower values, and 1992 with significantly lower values. The 1992 red zone figures indicate an extremely poor response time at the 15 minute interval even though initial attack distances are generally lower than previous years. Overall trends indicate that 1992 response times are between 5-10% lower than the normal levels established in the previous two years.

A review of the remaining zones show 1990 and 1991 to have similar trends and 1992 to generally be less efficient. One anomaly in all three years is the lack of priority provided to 15 minute attacks in the orange zone, with an overwhelming response in the 45 to 60 minute time interval. A likely explanation for this may be improper response placement to facilitate 15 minute attack in this zone. Further analysis of original fire reports and regional comments would be required to determine the reasons.

General time and distance trends are shown for all zones and regions with shorter times over shorter distances and longer times for longer distances. This

Table 14 : 1990 detection to suppression response time distribution by zone with corresponding sizes and distances

	RED					ORANGE					YELLOW					GREEN					WHITE					ALL ZONES				
det/supp time (h:mm)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)
0:15	73	21.3%	0.4	0.6	17.2	1	7.7%	3.0	3.0	12.0	4	15.4%	0.4	0.5	37.5	11	15.3%	0.5	0.6	27.3						89	19.0%	0.5	0.6	19.3
0:30	94	48.7%	1.3	2.2	24.3						8	46.2%	0.9	1.0	33.4	20	43.1%	1.2	2.1	12.1	3	21.4%	0.3	3.7	21.7	125	45.7%	1.3	2.1	22.8
0:45	73	70.0%	1.2	1.6	36.7	2	23.1%	0.3	0.6	18.5	5	65.4%	0.9	1.1	64.8	10	56.9%	3.5	4.4	16.2	3	42.9%	14.0	48.3	36.7	93	65.6%	1.8	3.3	35.6
1:00	36	80.5%	0.7	0.8	36.9	6	69.2%	4.6	3.3	44.7	3	76.9%	2.4	2.4	45.3	9	69.4%	1.0	1.8	20.9	1	50.0%	5.0	8.0	50.0	55	77.4%	1.3	1.4	35.8
1:15	19	86.0%	2.3	3.4	51.5	1	76.9%	1.0	5.0	50.0	1	80.8%	0.1	0.1	72.0	4	75.0%	2.9	3.5	13.8	1	57.1%	100.0	100.0	0.0	26	82.9%	6.0	7.1	44.4
1:30	12	89.5%	71.2	73.7	37.1	1	84.6%	0.5	0.0	40.0	2	88.5%	3.6	3.6	50.0	5	81.9%	2.0	2.0	44.4	1	64.3%	0.8	2.0	120.0	21	87.4%	41.6	43.0	44.1
1:45	7	91.5%	0.9	2.9	61.4											1	83.3%	1.0	1.0	130.0	1	71.4%	4.0	10.0	40.0	9	89.3%	1.2	3.5	66.7
2:00	6	93.3%	1.6	9.3	35.5						1	92.3%	2.5	3.0	50.0	3	87.5%	13.7	34.2	61.7	2	85.7%	100.8	126.0	2.0	12	91.9%	21.2	34.4	37.7
2:15	4	94.5%	0.7	0.7	28.8																					4	92.7%	0.7	0.7	28.8
2:30	1	94.8%	1.0	130.0	35.0						1	96.2%	8.0	35.0	50.0	3	91.7%	2.2	5.7	59.3	1	92.9%	4.0	30.0	6.0	6	94.0%	3.3	35.4	44.8
2:45	2	95.3%	0.7	1.4	65.0						1	100.0%	8.0	8.0	80.0											3	94.7%	3.1	3.6	70.0
over 3:00	16	100.0%	22.9	79.4	34.4	2	100.0%	127.5	132.8	40.0						6	100.0%	1.2	1.6	60.2	1	100.0%	0.2	0.2	110.0	25	100.0%	25.1	61.9	44.0
totals	343		4.5	8.2	30.4	13		22.1	22.7	37.5	26		1.8	3.0	47.3	72		2.1	3.7	28.1	14		25.6	39.9	36.1	468		5.1	8.6	31.4

Table 15 : 1991 detection to suppression response time distribution by zone with corresponding sizes and distances

	RED					ORANGE					YELLOW					GREEN					WHITE					ALL ZONES				
det/supp time (h:mm)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)
0:15	86	26.8%	1.3	1.5	19.8	1	3.1%	0.3	0.5	40.0	4	9.5%	0.6	1.2	31.0	10	10.4%	3.4	3.7	19.3	2	16.7%	0.1	0.1	0.0	103	20.5%	1.4	1.7	20.0
0:30	84	53.0%	1.9	3.7	24.4	8	28.1%	0.8	72.0	38.5	10	33.3%	3.1	4.6	36.8	19	30.2%	2.1	2.8	18.8	2	33.3%	2.6	3.1	6.5	123	44.9%	2.0	8.0	25.2
0:45	54	69.8%	1.7	2.2	36.1	6	46.9%	37.5	88.9	38.3	8	52.4%	4.1	6.2	52.5	21	52.1%	3.8	4.6	27.0	3	58.3%	1.3	2.6	17.3	92	63.2%	4.7	8.8	35.0
1:00	32	79.8%	21.5	25.3	44.1	6	65.6%	16.9	17.9	36.3	11	78.6%	18.6	20.8	35.0	10	62.5%	0.4	0.8	40.7	2	75.0%	0.1	0.1	61.5	61	75.3%	16.4	18.9	41.7
1:15	12	83.5%	1.5	2.9	69.8	5	81.3%	1.4	2.1	66.2	2	83.3%	1.9	5.4	83.5	11	74.0%	0.6	13.3	13.9						30	81.3%	1.2	6.7	49.6
1:30	13	87.5%	26.2	27.2	51.8						2	88.1%	1.5	3.0	7.0	8	82.3%	0.5	0.8	44.3						23	85.9%	15.1	15.9	45.3
1:45	1	87.9%	0.4	0.4	40.0						1	90.5%	2.5	2.5	60.0	4	86.5%	39.8	43.0	64.0						6	87.1%	27.0	29.2	59.3
2:00	12	91.6%	4.2	7.1	49.5											3	89.6%	2.4	6.0	24.3	1	83.3%	1000	1000	20.0	16	90.3%	66.1	68.9	42.9
2:15	2	92.2%	0.6	2.6	33.5	1	84.4%	1.0	100.0	40.0	1	92.9%	0.8	1.0	12.0	2	91.7%	0.1	0.1	3.0	1	91.7%	0.6	3.0	32.0	7	91.7%	0.5	15.6	22.4
2:30	7	94.4%	1.7	1.8	53.6	2	90.6%	50.0	50.0	15.0	1	95.2%	0.1	0.2	54.0	2	93.8%	2.6	3.3	69.0						12	94.0%	9.8	9.9	49.8
2:45	2	95.0%	0.2	0.2	58.5											2	95.8%	0.7	0.8	66.5						4	94.8%	0.4	0.5	62.5
over 3:00	16	100.0%	4.5	5.6	31.0	3	100.0%	110.0	130.0	45.0	2	100.0%	1.5	2.1	80.0	4	100.0%	8.9	14.7	55.3	1	100.0%	4.0	12.0	173.0	26	100.0%	17.2	21.3	45.6
totals	321		4.8	6.1	32.1	32		24.1	56.8	41.6	42		6.8	8.4	42.0	96		3.9	6.3	29.8	12		84.5	85.8	34.4	503		7.9	11.4	33.2

Table 16: 1992 detection to suppression response time distribution by zone with corresponding sizes and distances

	RED					ORANGE					YELLOW					GREEN					WHITE					ALL ZONES				
det/supp time (h:mm)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)
0:15	14	11.7%	15.3	15.3	14.3	1	5.9%	0.1	0.1	25.0	4	12.9%	5.2	6.4	90.5	4	7.0%	0.2	0.2	1.5						23	10.0%	10.2	10.5	25.8
0:30	37	42.5%	1.0	1.3	35.0	5	35.3%	2.5	3.3	24.6	8	38.7%	8.2	11.1	20.0	15	33.3%	4.3	6.7	9.9						65	38.4%	2.8	3.9	26.5
0:45	24	62.5%	0.7	1.2	37.3	2	47.1%	12.6	16.1	17.5	4	51.6%	0.3	1.9	47.8	9	49.1%	2.6	3.8	28.0	1	25.0%	2.0	2.0	7.0	40	55.9%	1.7	2.6	34.5
1:00	10	70.8%	1.0	1.4	26.6	3	64.7%	3.4	3.7	61.7	3	61.3%	0.6	0.7	31.7	9	64.9%	1.6	4.6	20.0	1	50.0%	0.1	0.1	80.0	26	67.2%	1.4	2.7	31.0
1:15	9	78.3%	0.6	3.7	43.7						3	71.0%	0.4	1.6	21.7	4	71.9%	10.9	13.5	41.3						16	74.2%	3.1	5.8	38.9
1:30	7	84.2%	0.5	0.7	30.6	1	70.6%	0.2	0.2	10.0	3	80.6%	3.7	9.7	47.7	4	78.9%	0.4	3.2	56.8	1	75.0%	0.5	0.5	20.0	16	81.2%	1.1	3.0	38.4
1:45	6	89.2%	1.5	6.7	80.8	1	76.5%	0.9	1.0	80.0	2	87.1%	3.0	5.0	41.0	4	86.0%	3.2	4.0	54.5	1	100.0%	0.5	4.0	12.0	14	87.3%	2.1	5.1	62.6
2:00	5	93.3%	1.1	1.9	51.2																					5	89.5%	1.1	1.9	51.2
2:15	1	94.2%	7.0	7.0	190.0	2	88.2%	0.7	1.9	65.0	1	90.3%	8.0	50.0	40.0	1	87.7%	1.8	2.0	14.0						5	91.7%	3.6	12.5	74.8
2:30	5	98.3%	6.7	8.1	45.4											2	91.2%	2.5	2.5	90.0						7	94.8%	5.5	6.5	58.1
2:45						1	94.1%	16.0	16.0	30.0	1	93.5%	8.0	15.0	37.0	1	93.0%	0.4	6.0	50.0						3	96.1%	8.1	12.3	39.0
over 3:00	2	100.0%	0.6	3.1	60.0	1	100.0%	20.0	55.0	35.0	2	100.0%	0.5	0.5	83.0	4	100.0%	1.6	2.7	64.0						9	100.0%	3.2	8.1	64.1
totals	**120**		**2.9**	**3.7**	**37.8**	**17**		**5.1**	**8.0**	**38.4**	**31**		**4.0**	**7.6**	**43.3**	**57**		**3.1**	**5.0**	**29.8**	**4**		**0.8**	**1.7**	**29.8**	**229**		**3.2**	**4.8**	**36.5**

relationship is graphically shown for 1990, 1991, and 1992 totals in Figure 10. There appears to be a predictable trend until the 60 km/1:45 time interval is reached, after which time the pattern changes.

4.2 Alert level analysis

Alert level data for the 1990, 1991 and 1992 fire seasons were analysed by zone and adjusted alert level at detection. Because 1990 alert level data was not part of the wildfire report, it was derived by finding the alert level at the base that actioned the fire from the daily situation reports. The data was also left in the 4 alert level system with a maximum alert level of 3 rather than being prorated to the level 4 maximum system used in 1991 and 1992. Tables 17, 18 and 19 show average time and distances when alert levels are cross-referenced by priority zone.

4.2.1 1990 alert response overview

The 1990 comparison by zone and alert level (Table 17) shows a logical progression with longer response times at low alerts and shorter response times at high alerts. It also shows the best response times were achieved in the red and yellow zones. The shortest attack distances are also found to occur in the red and green zones which is in keeping with high priority resources and community protection. It should be noted that the orange zone has a noticeably poor response time which is more comparable to white zone fires, than to red zone fires. Possible reasons for this orange zone anomaly may be due to the small sample size or to resource positioning factors.

4.2.2 1991 alert response overview

The 1991 fire season (Table 18) reflects a ranked response system as detection to suppression times generally decrease as higher alert levels are

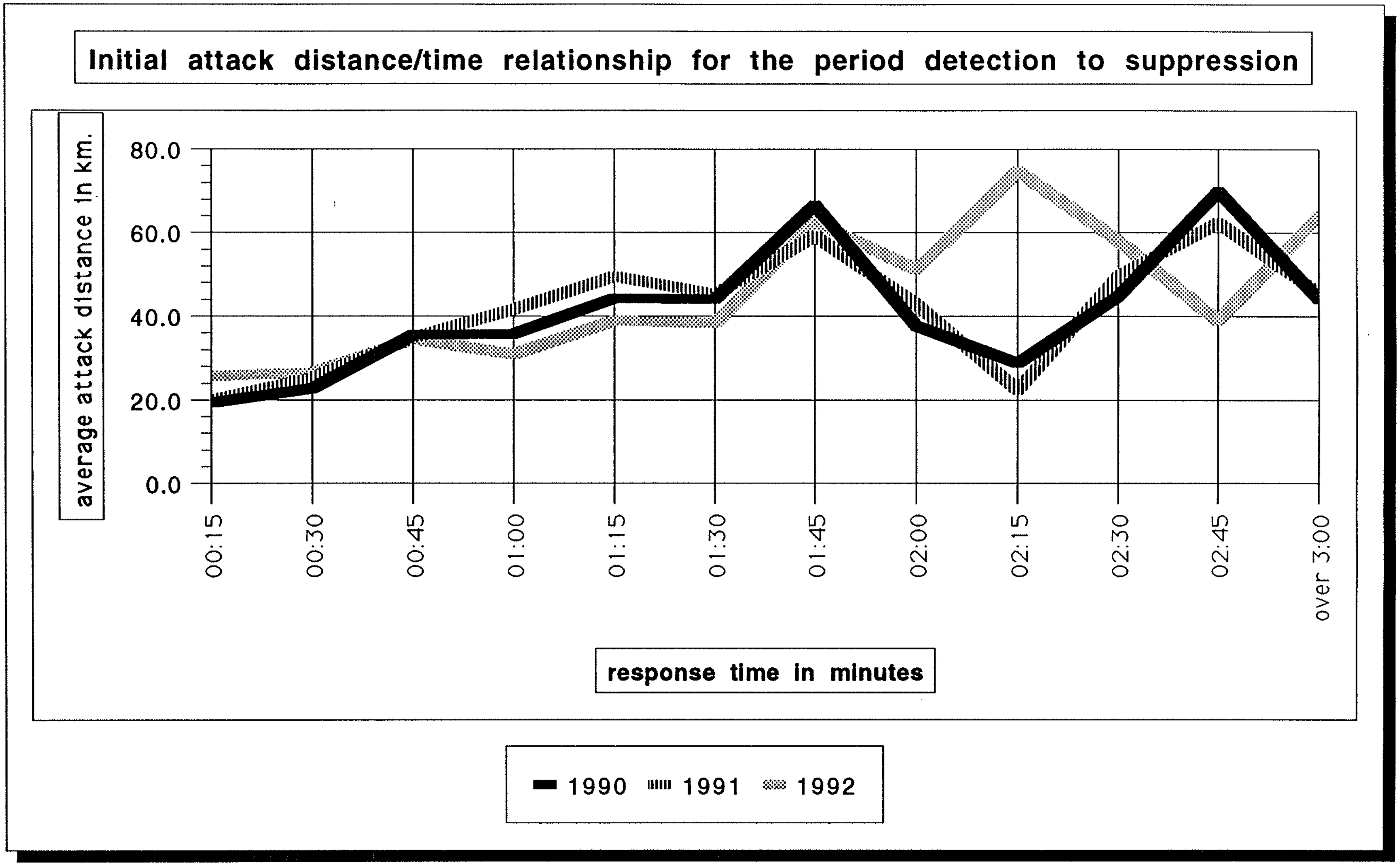


Figure 10 : Initial attack distance/time relationship for the period detection to suppression 1990, 1991, 1992.

Table 17: 1990 initial attack times and distances by zone and alert level for all same day actioned fires

adjusted alert level at detection	0					1					2					3					all levels				
FORESTRY PRIORITY ZONE	# of fires	detection to dispatch (h:mm)	dispatch to suppression (h:mm)	detection to suppression (h:mm)	avg distance (km.)	# of fires	detection to dispatch (h:mm)	dispatch to suppression (h:mm)	detection to suppression (h:mm)	avg distance (km.)	# of fires	detection to dispatch (h:mm)	dispatch to suppression (h:mm)	detection to suppression (h:mm)	avg distance (km.)	# of fires	detection to dispatch (h:mm)	dispatch to suppression (h:mm)	detection to suppression (h:mm)	avg distance (km.)	# of fires	detection to dispatch (h:mm)	dispatch to suppression (h:mm)	detection to suppression (h:mm)	avg distance (km.)
red	73	0:32	0:27	0:59	22	81	0:20	0:26	0:46	30	109	0:18	0:31	0:49	38	77	0:15	0:28	0:43	27	340	0:21	0:28	0:49	30
orange	3	1:20	0:40	2:00	20	3	0:15	1:16	1:31	45	7	0:17	0:36	0:53	42						13	0:31	0:46	1:17	37
yellow	7	0:08	0:15	0:23	18	3	0:05	0:29	0:34	62	15	0:32	0:34	1:06	57	1	0:00	0:15	0:15	65	26	0:21	0:28	0:49	47
green	6	0:22	0:29	0:51	32	20	0:38	0:33	1:11	23	34	0:28	0:24	0:52	30	12	0:44	0:30	1:14	30	72	0:33	0:28	1:01	28
white	7	0:26	0:37	1:03	40	2	1:12	0:52	2:04	23	5	1:00	0:28	1:28	36						14	0:44	0:36	1:20	36
all zones	96	0:31	0:27	0:58	24	109	0:24	0:29	0:53	30	170	0:22	0:30	0:52	38	90	0:19	0:28	0:47	28	465	0:24	0:29	0:53	31

Table 18: 1991 initial attack times and distances by zone and alert level for all same day actioned fires

adjusted alert level at detection	0					1					2					3					4					all levels				
FORESTRY PRIORITY ZONE	# of fires	detection to dispatch (h:mm)	dispatch to suppression (h:mm)	detection to suppression (h:mm)	avg distance (km.)	# of fires	detection to dispatch (h:mm)	dispatch to suppression (h:mm)	detection to suppression (h:mm)	avg distance (km.)	# of fires	detection to dispatch (h:mm)	dispatch to suppression (h:mm)	detection to suppression (h:mm)	avg distance (km.)	# of fires	detection to dispatch (h:mm)	dispatch to suppression (h:mm)	detection to suppression (h:mm)	avg distance (km.)	# of fires	detection to dispatch (h:mm)	dispatch to suppression (h:mm)	detection to suppression (h:mm)	avg distance (km.)	# of fires	detection to dispatch (h:mm)	dispatch to suppression (h:mm)	detection to suppression (h:mm)	avg distance (km.)
red	90	0:29	0:26	0:55	23	56	0:35	0:31	1:06	35	72	0:20	0:25	0:45	41	63	0:17	0:17	0:34	29	40	0:22	0:26	0:48	38	321	0:25	0:25	0:50	32
orange	12	0:44	0:36	1:20	28	11	0:42	0:42	1:24	55	3	0:21	0:31	0:52	39	5	0:06	0:36	0:42	48	1	0:00	0:20	0:20	35	32	0:34	0:37	1:11	42
yellow	4	1:22	0:40	2:02	14	15	0:35	0:39	1:14	45	15	0:12	0:26	0:38	46	6	0:12	0:21	0:33	20	2	0:02	0:25	0:27	115	42	0:27	0:31	0:58	42
green	16	0:57	0:31	1:28	27	35	0:24	0:26	0:50	20	31	0:40	0:32	1:12	41	5	0:19	0:21	0:40	61	9	0:20	0:36	0:56	19	96	0:34	0:30	1:04	30
white	4	0:02	0:38	0:40	8	2	0:22	0:20	0:42	61	5	0:55	0:41	1:36	51	1	0:30	0:15	0:45	5						12	0:30	0:34	1:04	34
all zones	126	0:35	0:28	1:03	23	119	0:32	0:31	1:03	34	126	0:25	0:28	0:53	42	80	0:17	0:18	0:35	31	52	0:20	0:27	0:47	37	503	0:27	0:27	0:54	33

Table 19: 1992 initial attack times and distances by zone and alert level for all same day actioned fires

adjusted alert level at detection	0					1					2					3					4					all levels				
FORESTRY PRIORITY ZONE	# of fires	detection to dispatch (h:mm)	dispatch to suppression (h:mm)	detection to suppression (h:mm)	avg distance (km.)	# of fires	detection to dispatch (h:mm)	dispatch to suppression (h:mm)	detection to suppression (h:mm)	avg distance (km.)	# of fires	detection to dispatch (h:mm)	dispatch to suppression (h:mm)	detection to suppression (h:mm)	avg distance (km.)	# of fires	detection to dispatch (h:mm)	dispatch to suppression (h:mm)	detection to suppression (h:mm)	avg distance (km.)	# of fires	detection to dispatch (h:mm)	dispatch to suppression (h:mm)	detection to suppression (h:mm)	avg distance (km.)	# of fires	detection to dispatch (h:mm)	dispatch to suppression (h:mm)	detection to suppression (h:mm)	avg distance (km.)
red	25	0:35	0:28	1:03	29	58	0:20	0:22	0:42	32	31	0:20	0:29	0:49	50	2	1:11	0:21	1:32	46	4	0:46	0:50	1:36	80	120	0:25	0:26	0:51	38
orange	6	1:19	0:32	1:51	38	3	0:13	0:31	0:44	37	8	0:20	0:43	1:03	39											17	0:40	0:37	1:17	38
yellow	2	0:37	1:00	1:37	34	8	0:41	0:34	1:15	25	12	1:11	0:22	1:33	50	7	0:18	0:25	0:43	56	2	0:35	0:24	0:59	39	31	0:47	0:28	1:15	43
green	8	0:45	0:25	1:10	6	30	0:56	0:31	1:27	37	11	0:15	0:31	0:46	16	7	0:17	0:42	0:59	35	1	0:01	0:31	0:32	110	57	0:41	0:32	1:13	30
white	2	0:55	0:22	1:17	46						1	0:35	0:05	0:40	7	1	1:00	0:20	1:20	20						4	0:51	0:17	1:08	30
all zones	43	0:44	0:29	1:13	27	99	0:33	0:26	0:59	33	63	0:29	0:29	0:58	42	17	0:26	0:31	0:57	44	7	0:36	0:40	1:16	72	229	0:33	0:28	1:01	37

reached. Once again averaging obscures the finer patterns as time differences between the alert levels appear longer than would be expected. One important aberration which even averaging shows is the expected reduction in times from level 0 to level 3, with an unexpected upturn in times and distances at level 4. This anomaly will be investigated further when frequency distributions are discussed. Similar decreasing trends are found in all zone totals with the upturn at level 4. It is worth noting that while orange and yellow zones appear to show a proper level 4 progression their applicability to the overall analysis is marginal due to their small sample size. Corresponding distance relationships only partially reflect what one would expect.

4.2.3 1992 alert response overview

The 1992 alert response comparison by priority zone indicates the opposite results one would expect with red zone response times increasing with increased alert levels rather than decreasing (Table 19). When all zones are considered, similar trends to 1991 are found with largest times at the lowest level, decreasing to a minimum at level 3 and increasing again at level 4. It is important to note that the two fire seasons were very different in nature with 1991 having more 3 and 4 level days than the 1992 fire season. A comparison of alert level days for each season by fire occurrence is found in Table 20.

Table 20: Percentage of alert level days by year for same day actioned fires

	1990	%	1991	%	1992	%
Level 0	96	21	126	25	43	19
1	109	23	119	24	99	43
2	170	37	126	25	63	28
3	90	19	80	16	17	7
4	n/a	n/a	52	10	7	3
Total	465	100	503	100	229	100

Results show the 1992 season to have had very few fire starts at level 4 days as compared to the 1991 season. It is important to note that any relationship of fire starts on high level and low level days is dependent upon the total number of high and low days which occurred in the season. In general high level days are the exception, with most days having low to moderate alert levels.

A breakdown of averaged alert level days for the past three seasons is provided in Table 21. It should be noted that these values are derived on an annual basis by the fire intelligence officer via a manual tabulation of key weather sites in each region. While they do not represent an integrated and weighted tabulation by district and alert level day, they do provide an overall general indication of the relative number of alert level days for the entire season.

Table 21 : Seasonal alert levels days by region

1990

	NE	NW	SE	EA	IL	WE	WS	AVG	%
0/I	72	55	71	62	67	82	69	69	55
II	47	58	37	51	47	38	40	46	38
III	3	9	14	9	8	2	13	9	7

1991

	NE	NW	SE	EA	IL	WE	WS	AVG	%
0/I	74	72	93	44	72	84	66	72	59
II	40	36	16	45	36	28	29	33	27
III	7	10	10	24	8	10	17	12	10
IV	1	4	3	9	6	0	10	5	4

1992

	NE	NW	WE	CE	EA	AVG	%
0/I	81	98	112	104	99	99	81
II	32	21	10	14	19	19	16
III	8	3	0	4	4	4	3
IV	1	0	0	0	0	0	0

The reduced number of level 3 and 4 days in the 1992 season partially accounts for the high averages which result from the small sample size. A review of the four fires in question revealed that one was a boat accessed fire with a response time of over two hours, thereby skewing the 1992 data set to show a higher average size.

4.3 Detailed frequency analysis

4.3.1 Attack times

A detailed frequency analysis at 15 minute intervals was conducted to reveal internal trends not found by averaging. The results as displayed in Tables 22, 23 and 24 indicate that the best 15 minute response times (all zones) occurred in 1991, with response time percentages better than 1990 at the 15 minute interval and better than the 1992 season at all intervals. The 1990 data in Table 22 shows progressive improvements as alert levels increase with the 15 minute time improving from 15.9% to 18.4%, dipping to 14.3%, and 25.1% as one goes from levels 0 to 3. The 1991 data also displays consistent results regarding increasing alert levels. For example, a 15 minute response at level 0 is achieved 16.7% of the time, improving to 18.5% at level 1, dipping slightly to 12.7% at level 2, and then increasing to 37.5% at level 3, and falling short to 26.9% at level 4. Similar trends for all 15 minute intervals up to the one hour mark show an increasing efficiency to level 3, and a decreased efficiency at level 4. This trend is a finer resolution of the general trend found when only averages were considered in Tables 17, 18 and 19.

The 1992 data show a similar trend, but efficiency was lower and begins to fall off at alert level 3 rather than level 4. For example, the 15 minute response interval remains constant near the 9% mark from levels 0 to 2, peaking at 17.6% and falling off to 14.3% at level 4. The 30, 45, and 60 minute intervals show a peak at level 2 and a falling off at subsequent levels. It should be noted that the data set at levels 3 and 4 are small, however, one must question why these times are so poor considering only a few fires started at these levels,

Table 22 : 1990 detection to suppression response time distribution by alert level with corresponding sizes and distances

ALERT	0					1					2					3					ALL LEVELS				
det/supp time (h:mm)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)
0:15	14	**15.9%**	0.4	0.7	13.9	19	**18.4%**	0.4	0.5	14.4	24	**14.3%**	0.6	0.8	27.2	25	**28.1%**	0.3	0.4	23.8	82	**18.3%**	0.4	0.6	21.0
0:30	21	**39.8%**	4.2	7.4	17.4	23	**40.8%**	0.6	0.6	23.6	50	**44.0%**	0.6	1.2	26.2	27	**58.4%**	0.6	0.9	23.7	121	**45.3%**	1.2	2.1	23.6
0:45	20	**62.5%**	5.7	11.0	28.2	22	**62.1%**	0.7	1.3	36.0	36	**65.5%**	1.0	1.2	41.4	13	**73.0%**	0.6	1.0	35.9	91	**65.6%**	1.9	3.4	36.4
1:00	12	**76.1%**	2.0	2.7	34.4	11	**72.8%**	0.8	1.0	31.5	19	**76.8%**	1.7	1.3	50.5	9	**83.1%**	0.4	0.6	27.9	51	**77.0%**	1.3	1.4	38.6
1:15	4	**80.7%**	7.0	10.1	10.0	7	**79.6%**	2.0	3.5	47.0	10	**82.7%**	0.7	1.2	53.8	4	**87.6%**	1.9	1.9	62.0	25	**82.6%**	2.3	3.4	46.2
1:30	6	**87.5%**	141.3	146.3	46.7	5	**84.5%**	2.8	2.8	67.0	6	**86.3%**	1.6	1.6	35.7	3	**91.0%**	0.2	0.3	32.7	20	**87.1%**	43.6	45.1	46.4
1:45	2	**89.8%**	0.3	0.3	21.5	3	**87.4%**	1.8	3.9	50.3	2	**87.5%**	0.6	0.6	175.0	2	**93.3%**	2.1	9.1	28.0	9	**89.1%**	1.2	3.5	66.7
2:00	2	**92.0%**	3.0	25.5	71.0	3	**90.3%**	0.4	0.4	28.7	6	**91.1%**	8.0	18.5	37.3						11	**91.5%**	5.0	14.8	41.1
2:15	2	**94.3%**	0.1	0.1	10.0						1	**91.7%**	0.6	0.7	65.0	1	**94.4%**	2.0	2.0	30.0	4	**92.4%**	0.7	0.7	28.8
2:30	1	**95.5%**	0.4	6.0	115.0	2	**92.2%**	2.5	80.0	20.5	3	**93.5%**	4.7	15.4	37.7						6	**93.8%**	3.3	35.4	44.8
2:45											3	**95.2%**	3.1	3.6	70.0						3	**94.4%**	3.1	3.6	70.0
over 3:00	4	100.0%	76.3	86.3	24.5	8	100.0%	1.7	2.7	48.1	8	100.0%	0.8	3.1	55.1	5	100.0%	60.6	231.0	35.4	25	100.0%	25.1	61.9	44.0
totals	**88**		**16.1**	**19.8**	**25.8**	**103**		**0.9**	**2.9**	**31.9**	**168**		**1.2**	**2.2**	**39.1**	**89**		**4.0**	**13.9**	**28.8**	**448**		**4.6**	**8.1**	**32.8**

Table 23: 1991 detection to suppression response time distribution by alert level with corresponding sizes and distances

ALERT	0					1					2					3					4					ALL LEVELS				
det/supp time (h:mm)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)
0:15	21	16.7%	2.8	3.6	7.3	22	18.5%	1.7	1.9	24.9	16	12.7%	0.2	0.3	25.3	30	37.5%	0.4	0.5	22.0	14	26.9%	2.5	2.7	21.0	103	20.5%	1.4	1.7	20.0
0:30	34	43.7%	4.6	8.8	14.8	19	34.5%	2.6	3.4	20.9	39	43.7%	0.4	0.5	31.5	17	58.8%	1.2	35.3	31.9	14	53.8%	0.2	0.2	30.7	123	44.9%	2.0	8.0	25.2
0:45	19	58.7%	7.1	9.1	18.2	24	54.6%	9.6	22.3	28.1	26	64.3%	1.2	1.8	50.6	15	77.5%	1.7	2.0	30.7	8	69.2%	1.2	2.4	52.8	92	63.2%	4.7	8.8	35.0
1:00	16	71.4%	48.1	55.6	34.6	16	68.1%	12.8	14.1	45.6	14	75.4%	0.8	1.4	40.8	10	90.0%	1.0	1.3	45.9	5	78.8%	0.9	1.3	46.0	61	75.3%	16.4	18.9	41.7
1:15	6	76.2%	1.5	4.2	61.8	12	78.2%	0.7	1.3	46.7	7	81.0%	1.7	2.2	44.1	3	93.8%	0.3	0.4	27.7	2	82.7%	2.3	72.0	82.5	30	81.3%	1.2	6.7	49.6
1:30	5	80.2%	62.4	64.1	42.6	8	84.9%	3.9	4.9	53.6	6	85.7%	0.8	1.0	44.3	2	96.3%	0.1	0.1	55.0	2	86.5%	0.3	0.8	12.0	23	85.9%	15.1	15.9	45.3
1:45	1	81.0%	0.1	0.1	109.0	2	86.6%	76.3	81.3	31.5	1	86.5%	4.0	6.0	110.0						2	90.4%	2.7	3.2	37.0	6	87.1%	27.0	29.2	59.3
2:00	4	84.1%	251.3	254.0	30.0	2	88.2%	1.8	1.9	33.0	6	91.3%	6.9	12.5	42.7	2	98.8%	1.5	2.0	75.0	2	94.2%	2.2	2.2	47.5	16	90.3%	66.1	68.9	42.9
2:15	5	88.1%	0.6	21.2	24.4	1	89.1%	0.1	0.1	3.0	1	92.1%	0.6	3.0	32.0											7	91.7%	0.5	15.6	22.4
2:30	4	91.3%	7.4	7.4	25.8	4	92.4%	20.1	20.2	50.3	2	93.7%	2.6	3.3	69.0						2	98.1%	1.2	1.2	77.5	12	94.0%	9.8	9.9	49.8
2:45	1	92.1%	0.1	0.1	57.0	1	93.3%	0.1	0.1	13.0	2	95.2%	0.8	0.9	90.0											4	94.8%	0.4	0.5	62.5
over 3:00	10	100.0%	17.1	21.9	29.4	8	100.0%	33.8	40.3	47.3	6	100.0%	0.8	2.2	77.7	1	100.0%	0.1	0.1	1.0	1	100.0%	0.1	0.1	46.0	26	100.0%	17.2	21.3	45.6
totals	126		21.0	25.0	23.3	119		9.0	12.5	34.1	126		1.1	1.7	41.9	80		0.9	8.3	30.9	52		1.3	4.3	37.2	503		7.9	11.4	33.2

Table 24: 1992 detection to suppression response time distribution by alert level with corresponding sizes and distances

ALERT	0					1					2					3					4					ALL LEVELS				
det/supp time (h:mm)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)
0:15	4	9.3%	53.1	53.1	16.0	9	9.1%	0.2	0.2	12.2	6	9.5%	3.6	4.4	66.7	3	17.6%	0.1	0.1	5.7	1	14.3%	0.1	0.1	2.0	23	10.0%	10.2	10.5	25.8
0:30	9	30.2%	3.0	4.7	14.7	27	36.4%	1.6	1.9	19.7	25	49.2%	4.2	6.2	32.8	2	29.4%	0.6	0.7	45.0	2	42.9%	1.0	2.0	75.0	65	38.4%	2.8	3.9	26.5
0:45	5	41.9%	0.6	0.8	17.2	22	58.6%	2.4	3.3	30.4	8	61.9%	1.1	2.1	29.6	4	52.9%	0.3	0.4	70.0	1	57.1%	3.0	10.0	110.0	40	55.9%	1.7	2.6	34.5
1:00	5	53.5%	0.4	0.4	39.6	15	73.7%	1.7	3.5	31.2	4	68.3%	2.1	3.1	17.0	2	64.7%	0.3	1.2	36.0						26	67.2%	1.4	2.7	31.0
1:15	4	62.8%	0.6	0.6	20.5	4	77.8%	0.6	0.6	17.8	6	77.8%	7.3	14.3	56.2	2	76.5%	0.8	1.0	66.5						16	74.2%	3.1	5.8	38.9
1:30	6	76.7%	2.1	4.6	22.7	5	82.8%	0.6	3.5	49.4	3	82.5%	0.4	0.7	43.7	2	88.2%	0.3	0.3	50.0						16	81.2%	1.1	3.0	38.4
1:45	2	81.4%	2.8	4.5	9.5	7	89.9%	2.3	3.8	59.0	4	88.9%	1.6	7.6	92.5						1	71.4%	1.0	5.0	75.0	14	87.3%	2.1	5.1	62.6
2:00	2	86.0%	1.8	2.8	12.5	2	91.9%	0.6	1.0	70.5											1	85.7%	1.0	2.0	90.0	5	89.5%	1.1	1.9	51.2
2:15	2	90.7%	3.8	3.8	135.0	1	92.9%	1.8	2.0	14.0	2	92.1%	4.4	26.6	45.0											5	91.7%	3.6	12.5	74.8
2:30	1	93.0%	33.0	40.0	65.0	4	97.0%	1.3	1.3	67.0	1	93.7%	0.1	0.2	72.0	1	94.1%	0.1	0.1	2.0						7	94.8%	5.5	6.5	58.1
2:45											3	98.4%	8.1	12.3	39.0											3	96.1%	8.1	12.3	39.0
over 3:00	3	100.0%	7.0	19.0	25.3	3	100.0%	1.4	2.2	120.3	1	100.0%	0.1	0.1	0.0	1	100.0%	2.0	3.0	60.0	1	100.0%	1.0	6.0	80.0	9	100.0%	3.2	8.1	64.1
totals	43		7.7	9.5	26.8	99		1.6	2.4	33.3	63		3.6	6.6	41.9	17		0.4	0.7	44.4	7		1.2	3.9	72.4	229		3.2	4.8	36.5

in that season. While it is difficult to speculate on this point, the response system may have been affected by the complacency of a slow fire year (as indicated by candid remarks of building arks, and swimming, on daily resource request sheets), location of resources on high level days, or the transport mode used to reach the fires.

In order to properly assess response times against stated objectives, frequency distributions must be further broken down by priority zone. This has been done at 15 minute frequency intervals for all three fire seasons for the time spanning detection to suppression and the details can be found in Appendix G. For the pupose of comparison and evaluation, a 3 year weighted average of each zone and alert level has been compiled and is displayed in Table 25. Results show red zone efficiency peaks at 77% at level 1 and steady decreases to a 33% efficiency at level 4. The orange zone show the lowest efficiency across all alert levels, a trend which is in keeping with earlier results. Yellow and green zones show better efficiencies than red and orange zones at levels 3 and 4 but one must remember the criteria is 30 minutes as compared to 15 minutes.

Average attack distances do not appear to logically correlate with red zone alert levels in any of the three fire seasons. For example, the shortest attack distance totals are found at the lower alert level in 1990 and 1991 increasing to larger attack distances at the higher level (Appendix G tables G1, G6). In 1991 and 1992, there appears to be a bulge in the attack distance between the level 2 and level 3 ranges (Appendix G tables G6, G11). The extreme distances in the 1992 level 4 range appear to be out of character with the way the system was designed and likely is created by the small data set rather than indicating a major misplacement of suppression resources.

Detected and initial size averages appear to be constant over both fire

Table 25 : Percentage of time alert level standards were met (3 year wt. avg) for all fires actioned on their detection day

ZONE	level 0		level 1		level 2		level 3		level 4	
	attack time objective (minutes)	% of time objective was met	attack time objective (minutes)	% of time objective was met	attack time objective (minutes)	% of time objective was met	attack time objective (minutes)	% of time objective was met	attack time objective (minutes)	% of time objective was met
red	60	72%	60	77%	30	48%	15	36%	15	33%
orange	60	63%	60	69%	30	41%	15	20%	15	n/a
yellow	60	89%	60	69%	30	47%	30	51%	30	50%
green	60	68%	60	66%	30	47%	30	44%	30	22%
white	60	63%	60	100%	30	70%	30	n/a	30	n/a

note:these tables were derived from data in tables G1 through G15 of appendix G

:n/a denotes that no fires were actioned under these zone and alert conditions seasons with a trend which finds total 1991, and 1992 detection sizes decreasing as level 3 is approached and rebounding upward slightly at level 4 (Appendix G tables G1,G2.G3). In the 1990 season the detection sizes improve until level 2 then upturn at level 3. This trend appears to parallel the % time interval trend between levels 3 and 4 that was discussed earlier. It should be noted that the 1992 fire season displays better detection and suppression size data than the 1991 season, despite the fact that the response times were poorer.

4.3.2 Detection analysis

Frequency distributions by detection size were done for all fires occurring in 1990, 1991, and 1992. The results as shown in Appendix H, have been broken down to show the number of fires, cumulative % by detection method, and forest priority zone.

Using the .5 hectare objective stated in Fire Program Policy PO 15/02, a percentage efficiency rating by zone was constructed and is shown in Table 26. The data shows that the red zone meets the objective 68% of the time based on a three year weighted average. When looking at individual years, a slight decreasing red zone trend from 70% to 68% to 62% is found in successive years. The data also shows that the red zone attains the best efficiency with regards to meeting the objective and the white zone the least.

Comparative data for the first hour from detection have been extracted from Appendix H and graphically displayed in Figures 11 through 15. Figure 11, for the red priority zone, shows that overall efficiency in the red zone is approximately 25% at 15 minutes, 50% at 30 minutes, 70% at 45 minutes, and approximately 80% at 60 minutes. It also shows that the 1990 and 1991 seasons generally had better response times than the 1992 season. Based on Figure 11,

Table 26 : Percentage of time the .5 hectare detection size objective was met by priority zone

	RED	ORANGE	YELLOW	GREEN	WHITE	ALL ZONES
1990	70%	40%	43%	42%	32%	60%
1991	68%	43%	40%	57%	35%	60%
1992	62%	45%	46%	47%	22%	52%
3 year wt. average	68%	43%	43%	51%	32%	59%

note: comprehensive frequency data used to derive these figures can be found in Tables H1, H3, and H5 of appendix H

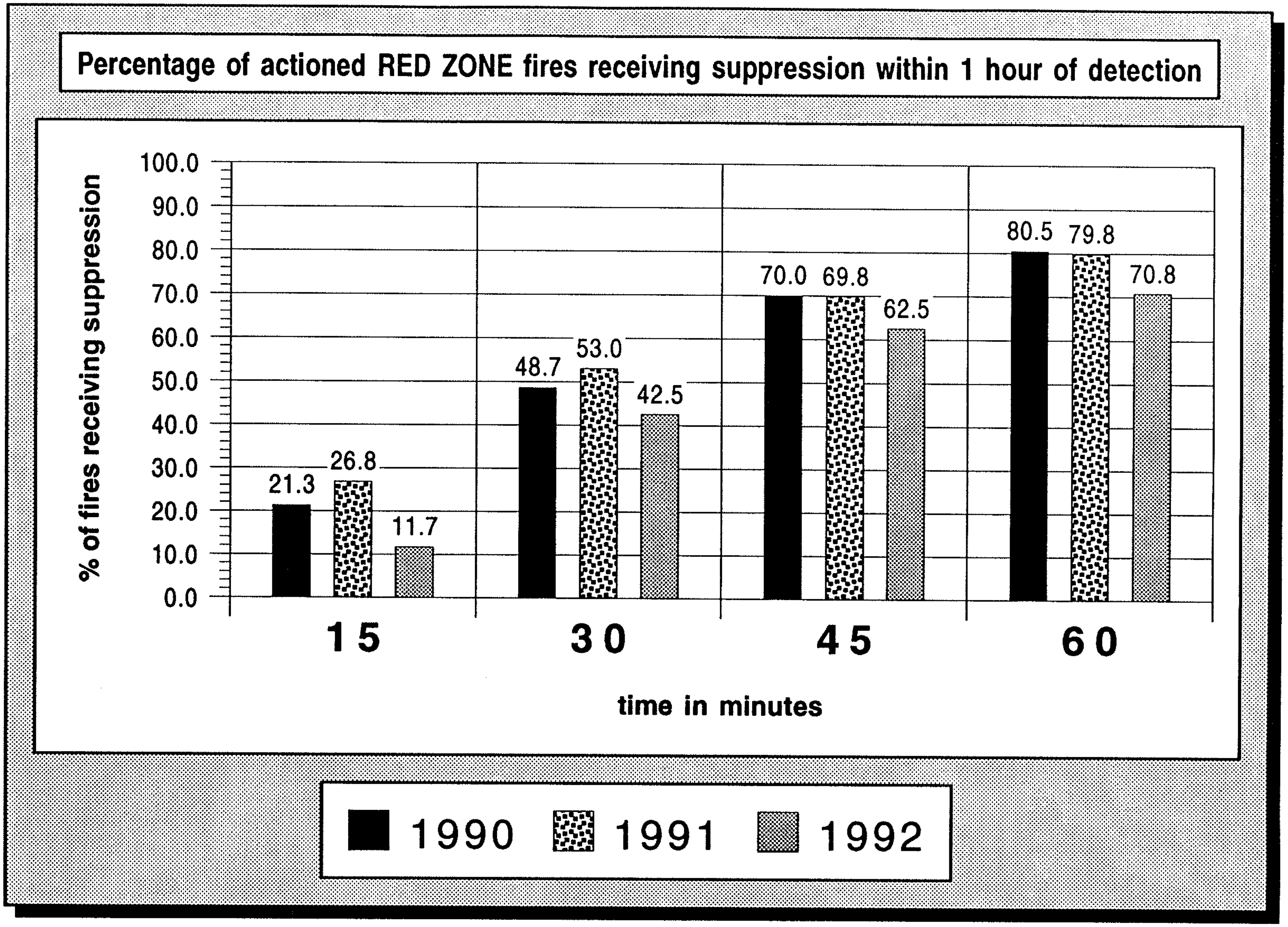


Figure 11 : Percentage breakdown of actioned RED ZONE fires receiving suppression within one hour of detection, 1990, 1991, 1992

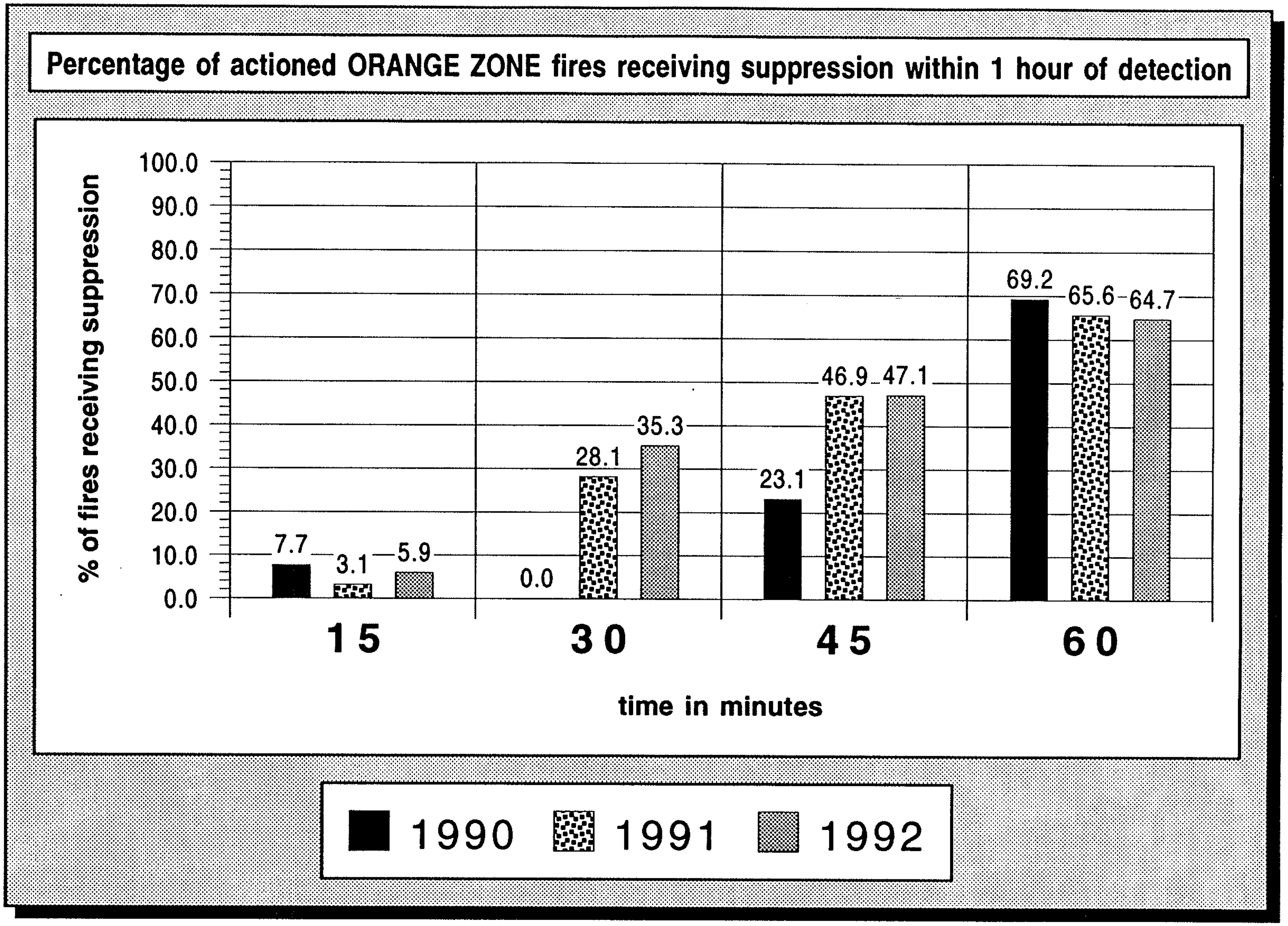


Figure 12 : Percentage breakdown of actioned ORANGE ZONE fires receiving suppression within one hour of detection, 1990, 1991, 1992

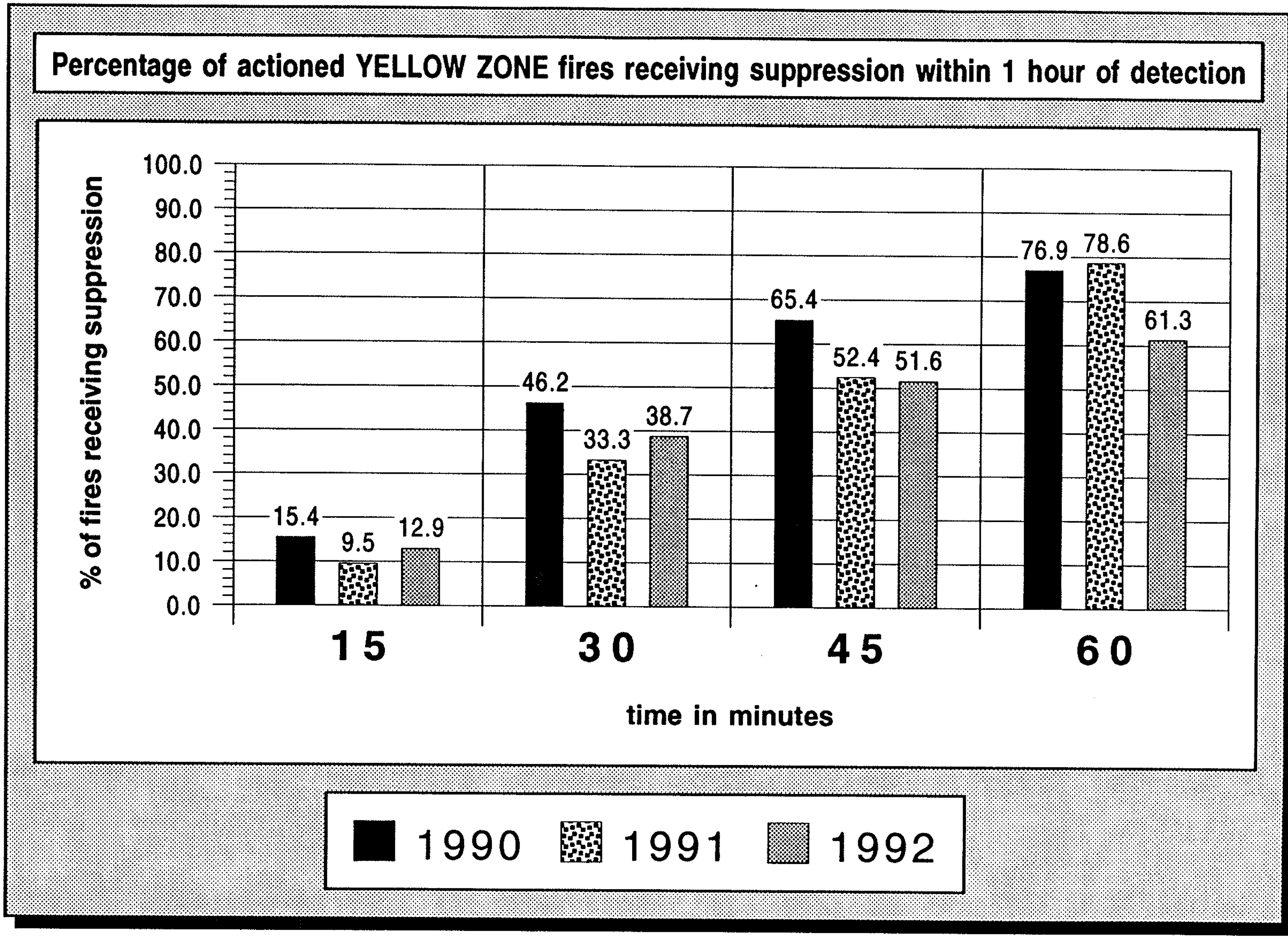


Figure 13 : Percentage breakdown of actioned YELLOW ZONE fires receiving suppression within one hour of detection, 1990, 1991, 1992

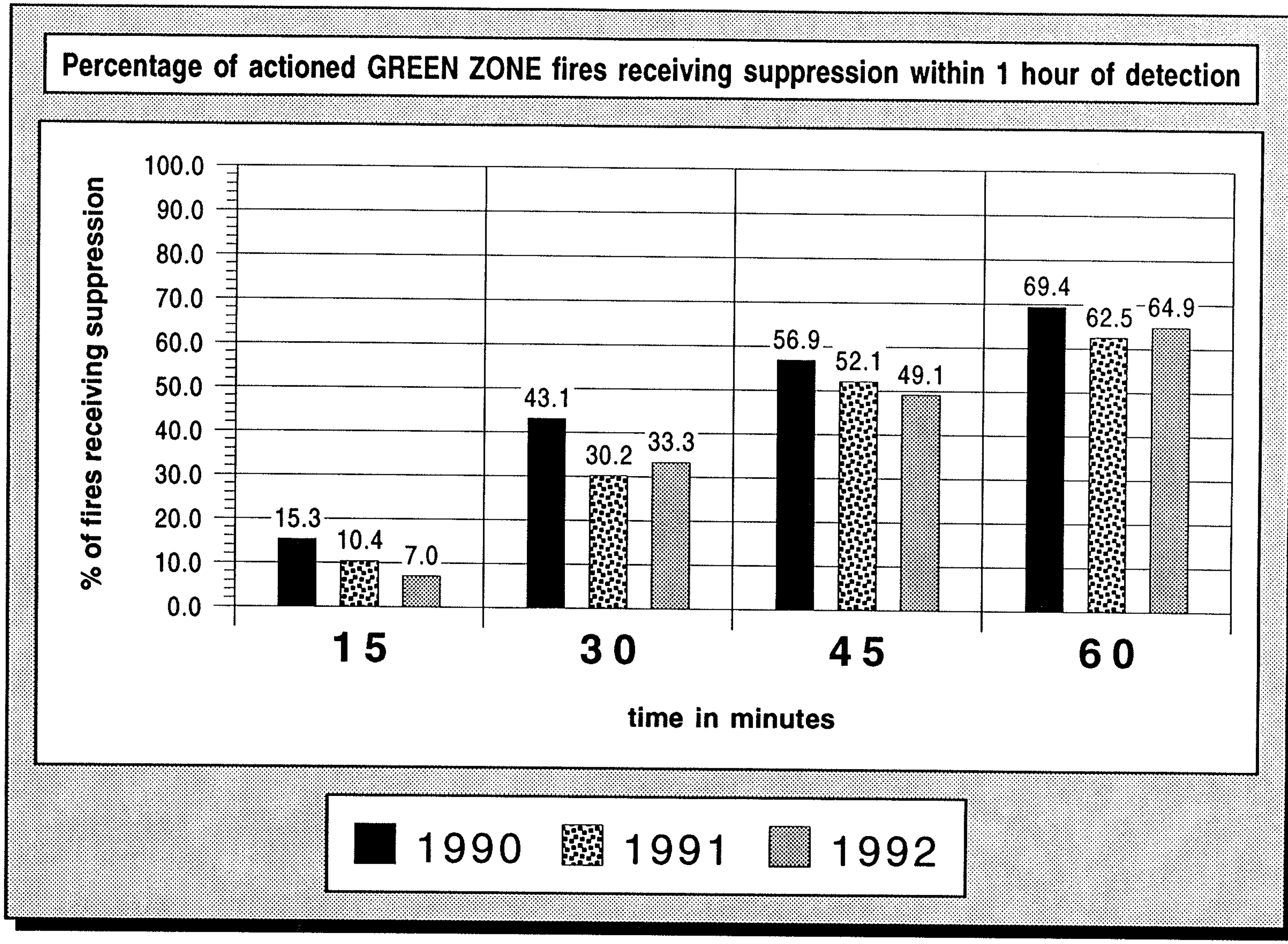


Figure 14 : Percentage breakdown of actioned GREEN ZONE fires receiving suppression within one hour of detection, 1990, 1991, 1992

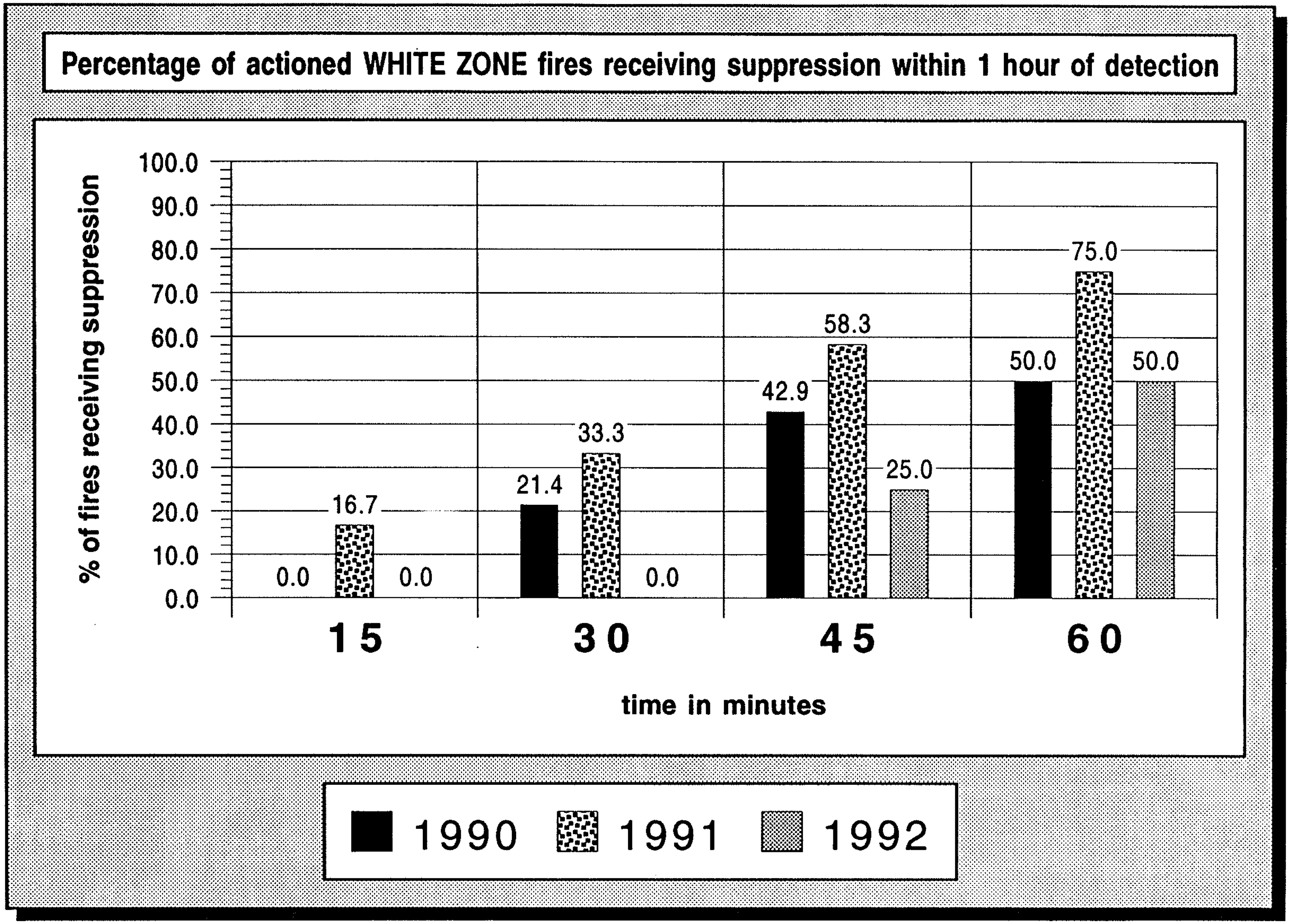


Figure 15 : Percentage breakdown of actioned WHITE ZONE fires receiving suppression within one hour of detection, 1990, 1991, 1992

the 1991 season produced the best red zone response times with efficiencies of 27% at 15 minutes, 53% at 30 minutes, 70% at 45 minutes and 80% at 60 minutes.

Figure 12 displays orange zone data which once again show a significant drop in efficiency from the red zone data displayed in Figure 11. A comparison between 1990, 1991, and 1992 figures shows small increases or no change in efficiencies in the last two seasons for actioned fires in this zone.

Yellow zone data in Figure 13 displays response efficiencies that exceed the orange zone and challenged red zone figures in the 1990 season. However, a general decline in yellow zone response efficiency can be seen over the past two fire seasons at the 45 and 60 minute intervals.

Green zone response times in Figure 14 show a declining trend at the 15 and 45 minute intervals with slight increases in the 30 and 60 minute time frames. White zone data in figure 15 was sporadic due to the limited number of fires which were actioned in the white zone, however the 1991 season shows the best results for those fires which received action in this zone.

Table 27 shows efficiencies in meeting detection size objectives by the method of detection. A ranking from most efficient to least efficient is as follows: railway, contract aircraft, loaded patrol, public coop, tower, designated air patrol, ground patrol, aircraft coop, and 1-800 line. In addition, general trends appear to show a decreasing trend in efficiency for most methods since 1990. These decreasing trends may indicate a decrease in performance, or a relationship to a slow wet fire year. However it is clear that based on the past three years, the .5 hectare detection size objective is only attained about 59% of the time.

Table 28 isolates all same day actioned fires by detection method and time

Table 27 : Percentage of time the .5 hectare detection size objective was met by detection method

	tower	designated air patrol	ground patrol	public cooperation	aircraft cooperation	railway	contract aircraft	loaded helicopter patrol	1-800 line	all detection methods
1990	68%	55%	5%	63%	58%	80%	56%			60%
1991	55%	60%	41%	62%	55%	71%	71%	66%	0%	60%
1992	41%	36%	54%	56%	48%	0%	79%	62%	25%	52%
3 year wt. average	57%	55%	55%	61%	55%	75%	69%	66%	25%	59%

note: comprehensive frequency data used to derive these figures can be found in Tables H2, H4, and H6 of appendix

Table 28 : Time, size, and distance breakdown by detection method for all same day actioned fires 1990, 1991, 1992

	1990								1991								1992							
detection method	# fires	avg detection size (ha.)	avg initial size (ha.)	avg final size (ha.)	avg det/dis (h:mm)	avg dis/supp (h:mm)	avg det/supp (h:mm)	avg distance (km.)	# fires	avg detection size (ha.)	avg initial size (ha.)	avg final size (ha.)	avg det/dis (h:mm)	avg dis/supp (h:mm)	avg det/supp (h:mm)	avg distance (km.)	# fires	avg detection size (ha.)	avg initial size (ha.)	avg final size (ha.)	avg det/dis (h:mm)	avg dis/supp (h:mm)	avg det/supp (h:mm)	avg distance (km.)
tower	27	0.9	6.1	7.7	**0:10**	0:26	**0:36**	22.1	38	2.6	4.5	15.1	**0:21**	0:25	**0:46**	27.2	20	4.9	6.6	8.0	**0:18**	0:19	**0:37**	30.1
designated air patrol	148	2.5	3.8	14.4	**0:15**	0:26	**0:41**	37.7	84	13.2	13.8	28.9	**0:18**	0:34	**0:52**	46.0	26	1.5	4.4	17.9	**0:30**	0:35	**1:05**	71.1
ground patrol	41	10.7	33.3	45.2	**0:25**	0:28	**0:53**	17.6	47	20.3	25.3	37.0	**0:27**	0:24	**0:51**	19.0	20	6.4	9.2	9.7	**0:28**	0:33	**1:01**	31.5
public cooperation	160	8.9	10.3	12.5	**0:29**	0:27	**0:56**	25.0	165	5.4	9.4	21.1	**0:36**	0:28	**1:04**	25.3	108	3.7	5.4	14.5	**0:39**	0:26	**1:05**	28.1
aircraft cooperation	59	1.8	3.5	32.7	**0:32**	0:43	**1:15**	46.6	45	1.2	1.7	2.3	**0:32**	0:41	**1:13**	48.9	27	1.0	1.2	1.4	**0:44**	0:28	**1:12**	39.8
railway	5	0.3	1.3	1.5	**0:27**	0:42	**1:09**	26.8	7	1.1	3.8	5.5	**0:11**	0:15	**0:26**	13.1	1	16.0	16.0	16.0	**0:40**	2:00	**2:40**	30.0
contract aircraft	25	1.1	2.3	3.1	**0:37**	0:28	**1:05**	30.8	42	3.9	4.2	5.7	**0:29**	0:22	**0:51**	28.5	14	0.3	0.8	0.9	**0:13**	0:33	**0:46**	53.1
loaded helicopter patrol	n/a	n/a	n/a	n/a	**n/a**	n/a	**n/a**	n/a	74	9.5	18.7	28.2	**0:22**	0:18	**0:40**	42.2	11	2.3	3.1	4.4	**0:20**	0:28	**0:48**	33.0
1 - 800 line	n/a	n/a	n/a	n/a	**n/a**	n/a	**n/a**	n/a	1	12.0	12.0	25.0	**0:03**	0:41	**0:44**	110.0	2	1.0	2.0	2.6	**0:47**	0:27	**1:14**	9.5
all detection methods	**465**	**5.1**	**8.6**	**17.7**	**0:24**	**0:29**	**0:53**	**31.3**	**503**	**7.9**	**11.4**	**21.3**	**0:27**	**0:27**	**0:54**	**33.2**	**229**	**3.2**	**4.8**	**10.9**	**0:33**	**0:28**	**1:01**	**36.5**

and provides for a more detailed analysis. The detection to dispatch times have increased for most methods over the past 3 years, going from 24 minutes in 1990, to 27 minutes in 1991, to 33 minutes in 1992. Noticable differences can be found in tower detection going from 10, to 21, to 18 minutes since 1990. and for public cooperation from 29, to 36, to 39 minutes over the same period. It is also important to note that loaded patrols show a detection to dipatch interval which should theoretically be zero due to the 'detect the fires as you find them' nature of loaded patrols. This observation unveils a logic error in the way the fire report collects data pertaining to loaded helicopter patrols. The data shows that under the loaded patrol detection to dispatch field, dispatch must always occur before detection. In addition to this inconsistency, is the fact that loaded patrols which detect and action more than one fire in the course of one patrol, create a time log, and a distance from where dilemma. A more comprehensive reporting structure and format, which takes into account the hop about time and distance nature of loaded patrols, is required if better understanding and evaluation of this detection method is required. In addition to this, no documentation exists for time and efforts expended on loaded patrols and no fires were detected. Appendix Tables H4 and H6 hint at poor documentation with regards to TIP line reported fires, since TIP operator logs document 35 calls in 1990, 123 calls in 1991, and 37 calls in 1992. Fire report data only show 1 and 4 calls in 1991 and 1992 and it is suspected that those calls have been incorrectly coded as public cooperation on the fire report.

4.3.3 Distance analysis

Initial attack distances from the responding attack base were broken down by alert level at 10 km intervals. In 1990 (Table 29) fires within 10 km of the attack showed proper trends with dispatch to suppression times decreasing from

Table 29 : Frequency distribution of initial attack times and sizes by distance and alert level 1990

1990	0					1					2					3					ALL LEVELS				
attack distance (km.)	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg detection size (ha.)	avg initial size (ha.)	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg detection size (ha.)	avg initial size (ha.)	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg detection size (ha.)	avg initial size (ha.)	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg detection size (ha.)	avg initial size (ha.)	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg detection size (ha.)	avg initial size (ha.)
10	40	0:26	0:18	9.8	11.6	39	0:18	0:17	0.7	1.6	31	0:13	0:22	0.5	0.6	19	0:07	0:12	0.5	0.8	129	0:17	0:18	3.5	4.3
20	17	0:23	0:27	4.0	4.7	17	0:17	0:24	0.9	1.0	33	0:21	0:27	1.1	1.6	21	0:11	0:17	0.5	0.8	88	0:18	0:24	1.5	1.9
30	13	0:54	0:30	21.9	24.8	10	0:32	0:41	0.9	2.3	19	0:16	0:19	0.7	1.4	17	0:25	1:02	0.8	1.9	59	0:29	0:37	5.4	6.9
40	8	0:58	0:43	107.8	111.1	9	0:24	0:30	1.1	16.1	17	0:22	0:26	0.7	0.7	14	0:39	0:29	22.0	82.8	48	0:33	0:31	24.8	45.9
50	11	0:21	0:27	10.3	30.2	11	0:16	0:33	0.7	1.5	27	0:31	0:39	1.9	3.9	9	0:13	0:21	0.2	0.2	58	0:23	0:33	3.0	7.9
60						11	0:20	0:44	0.8	0.8	11	0:22	0:40	1.2	1.3	3	0:10	0:21	0.5	0.5	25	0:19	0:39	0.9	1.0
70	2	0:03	0:19	1.1	1.6	5	1:12	0:59	1.2	1.3	14	0:19	0:34	0.7	1.0	4	0:53	0:38	0.7	1.6	25	0:34	0:38	0.8	1.2
80	1	0:15	0:45	0.5	0.5	2	0:02	0:37	2.1	2.7	7	0:38	0:35	7.1	15.7						10	0:29	0:37	5.5	11.6
90	1	0:05	0:55	0.2	0.2						2	0:08	0:26	0.2	0.8	1	0:05	0:05	0.4	0.6	4	0:06	0:28	0.3	0.6
100	1	0:00	2:00	1.0	1.0						5	0:07	0:47	1.9	2.0						6	0:05	0:59	1.7	1.8
110											1	3:30	0:30	0.2	0.2						1	3:30	0:30	0.2	0.2
120	2	0:52	1:07	0.6	4.0	3	0:22	0:54	4.9	5.0						2	0:13	0:49	2.6	2.6	7	0:28	0:56	3.0	4.0
130											2	1:05	1:17	1.0	1.0						2	1:05	1:17	1.0	1.0
140																									
over 150						1	0:10	0:30	0.3	0.3	1	0:08	1:36	0.1	0.1						2	0:09	1:03	0.2	0.2
TOTAL	**96**	**0:31**	**0:27**	**18.0**	**21.9**	**109**	**0:24**	**0:29**	**0.9**	**2.8**	**170**	**0:22**	**0:30**	**1.2**	**2.2**	**90**	**0:19**	**0:28**	**3.9**	**13.7**	**465**	**0:24**	**0:29**	**5.1**	**8.6**

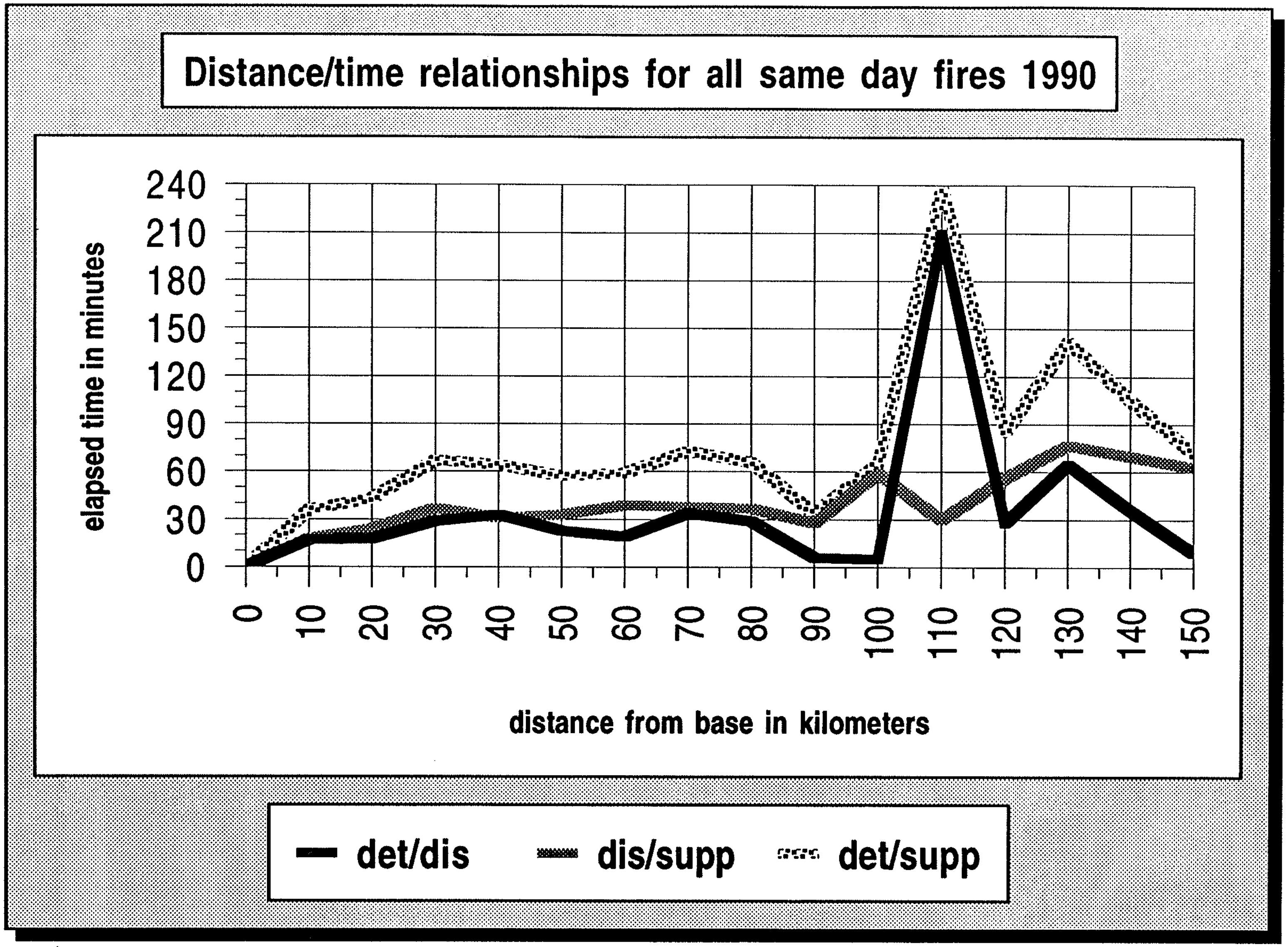


Figure 16: Distance/time relationships for the periods detection to dispatch, dispatch to suppression, and detection to suppression for all same day actioned fires in 1990

18, to 17, to 22, to 12 minutes as the alert level rose from 0 to level 3. At the 20 km distance, attack times once again demonstrated decreasing times as higher alert levels were reached. After the 30 km attack distance dispatch to suppression, times appear to stabilize across all levels remaining fairly constant until the 80 km distance is reached (Figure 16).

It is worth noting that detection to dispatch times generally equate dispatch to suppression times until approximately the 40 km distance after which time it becomes the lesser of the two time components. The detection to dispatch period also appears to be more variable than the dispatch to suppression with the final detection to suppression curve mirroring the detection to dispatch curve. In 1990, the average detection to dispatch time component only exceeded the dispatch to suppression time once at the 110 km distance.

Detection sizes at these distance intervals show some of the best results at the 1990 level 3 until the 30 km attack distance is reached, after which point it is skewed by some particularly large fire sizes. An overall detection size/distance trend could not be found in the 1990 data.

In 1991 overall trends show good dispatch to suppression times until the 30 km radius is attained after which point it increases gradually and levels off (Table 30). Table 30 shows dispatch to suppression times for distances under 30 km generally improving until level 3 is reached at which point level 4 times show increases. This upturn at level 4 trend parallels earlier ones found by zone and alert level in previous sections.

As was found with 1990, the 1991 data in Figure 17 show that detection to dispatch times mirror final times with the dispatch to suppression time increasing generally then leveling off. Figure 17 also shows that average detection to dispatch times are beginning to exceed dispatch to suppression times

Table 30 : Frequency distribution of initial attack times and sizes by distance and alert level 1991

1991	0					1					2					3					4					ALL LEVELS				
attack distance (km.)	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg detection size (ha.)	avg initial size (ha.)	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg detection size (ha.)	avg initial size (ha.)	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg detection size (ha.)	avg initial size (ha.)	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg detection size (ha.)	avg initial size (ha.)	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg detection size (ha.)	avg initial size (ha.)	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg detection size (ha.)	avg initial size (ha.)
10	51	0:24	0:19	4.2	5.0	43	0:22	0:24	8.4	9.1	38	0:15	0:21	0.6	1.3	23	0:28	0:11	0.2	0.4	15	0:10	0:18	0.4	0.6	170	0:21	0:20	3.6	4.2
20	28	0:15	0:25	44.2	49.2	14	0:24	0:31	2.3	2.8	14	0:25	0:22	1.3	1.7	9	0:09	0:14	2.9	4.7	9	0:07	0:24	0.2	15.9	74	0:17	0:24	17.8	22.0
30	16	1:16	0:25	44.4	54.7	12	0:26	0:21	25.5	51.0	10	0:27	0:23	0.5	1.3	15	0:12	0:15	1.7	1.9	5	0:19	0:11	0.2	0.2	58	0:36	0:20	18.1	26.4
40	7	1:07	1:07	3.6	18.4	11	0:25	0:39	3.3	3.9	9	0:32	0:28	0.4	0.8	12	0:08	0:19	0.4	0.4	6	0:20	0:39	1.1	1.2	45	0:27	0:36	1.7	4.2
50	12	0:48	0:39	37.6	41.5	10	1:41	0:41	25.5	30.6	13	0:20	0:35	0.4	0.7	10	0:14	0:28	0.4	0.6	3	2:23	0:22	0.2	0.2	48	0:50	0:35	14.9	17.1
60	4	1:00	0:37	0.6	1.6	8	0:38	0:52	0.8	1.0	7	0:38	0:31	1.5	2.1	3	0:08	0:45	1.1	189.5	5	0:14	0:36	1.4	1.4	27	0:33	0:40	1.1	22.4
70	2	0:42	0:45	1.5	3.0	2	0:35	0:40	0.5	0.8	7	0:18	0:36	3.2	6.1	3	0:26	0:26	0.2	0.5						14	0:26	0:36	1.9	3.7
80	1	1:00	0:15	0.5	0.5	6	0:19	0:39	3.8	4.1	8	0:16	0:32	0.3	0.5						4	0:23	0:50	8.1	8.1	19	0:21	0:37	3.1	3.3
90						3	0:12	0:21	2.6	3.6	6	0:35	0:47	1.5	1.7	2	0:06	0:18	0.1	0.2	2	0:17	0:22	1.1	1.1	13	0:22	0:33	1.5	1.8
100	1	0:05	1:20	0.1	0.1	2	0:29	0:36	5.1	6.1	4	0:53	0:16	0.4	0.5	1	1:00	1:00	1.0	1.0						8	0:42	0:34	1.6	1.9
110	2	0:15	1:05	0.6	4.1	1	0:16	0:37	1.0	1.5	4	0:22	0:29	4.3	4.8											7	0:19	0:40	2.8	4.1
120						4	0:43	0:31	6.4	6.4	3	0:51	0:53	1.8	2.0	1	0:00	0:20	2.0	2.1	1	0:01	0:53	2.0	2.0	9	0:36	0:39	3.9	3.9
130	1	0:45	0:15	0.2	0.2	2	1:34	1:08	2.0	6.0	1	1:46	0:38	5.0	5.0											4	1:24	0:47	2.3	4.3
140						1	0:06	0:24	0.5	5.0						1	0:03	0:46	0.2	0.2						2	0:04	0:35	0.4	2.6
over 150	1	0:01	1:04	0.1	0.2						2	1:22	0:35	2.1	6.1						2	0:01	0:58	4.5	9.5	5	0:33	0:50	2.7	6.3
TOTAL	126	0:35	0:28	21.0	25.0	119	0:32	0:31	9.0	12.5	126	0:25	0:28	1.1	1.7	80	0:17	0:18	0.9	8.3	52	0:20	0:27	1.3	4.3	503	0:27	0:27	7.9	11.4

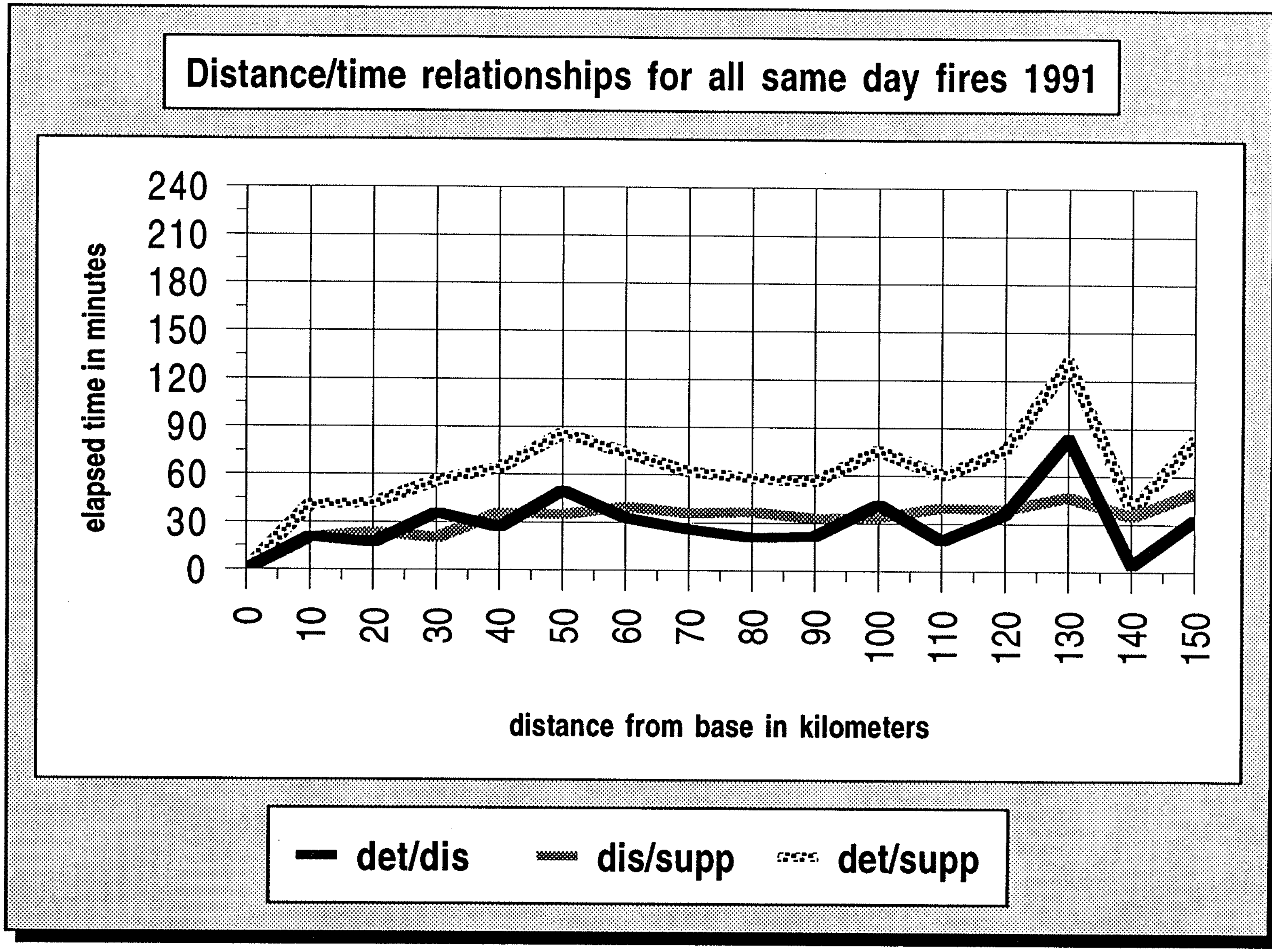


Figure 17: Distance/time relationships for the periods detection to dispatch, dispatch to suppression, and detection to suppression for all same day actioned fires in 1991

at the 30, 50, 100, and 130 km distances. Overall trends show shorter dispatch to suppression times, but longer detection to dispatch times than 1990.

The 1992 distance alert data is shown in Table 31, and overall trends indicate sizable increases in detection to dispatch times at 33 minutes for 1992, as compared to 27 in 1991, and 24 in 1990. Analysis by alert level shows proper progressions until the 50 km distance is reached after which time level 3 times increase. Due to a lack of level 4 days, a comprehensive comparison to previous years is weakened. Using total trends by alert level, a general 30 minute dispatch to suppression time is found.

Figure 18 shows the common mirroring of detection to dispatch and total times also occurs in 1992. It also shows average detection to dispatch times surpassing travel times at the 10, 40, 80, and 150 km marks. It is worth noting that the dispatch to suppression line is not as flat as in the 1990 and 1991 seasons which may indicate better distance and time information, or less data skewed by misleading loaded patrol data occur in 1990 and 1991.

4.4 Transportation mode and initial attack response

Transportation mode data was extracted from the 1990, 1991, and 1992 wildfire report databases to provide a profile to understand how they relate to initial attack objectives. A synopsis of results are provided in Table 32 .

In all three seasons reviewed, the ground vehicle provides the best dispatch to suppression response times. The helicopter follows a close second, with boat and aircraft transport times following. The apparent efficiency of the ground vehicle over the helicopter results from the large number of ground attacks, coupled with the fact that every district office has immediate ground transportation on hand to service the area. As a result it is the most widespread

Table 31 : Frequency distribution of initial attack times and sizes by distance and alert level 1992

1992 — Alert level 0

attack distance (km.)	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg detection size (ha.)	avg initial size (ha.)
10	19	0:36	0:26	12.0	12.3
20	7	0:38	0:29	0.7	1.2
30	4	0:24	0:28	5.4	8.4
40	4	1:49	0:33	5.6	14.6
50	2	0:10	0:42	1.1	1.6
60	2	0:15	0:30	5.1	12.6
70	1	2:00	0:30	33.0	40.0
80	3	0:58	0:25	0.2	0.2
90					
100					
110					
120					
130					
140					
over 150	1	1:05	1:00	7.0	7.0
TOTAL	**43**	**0:44**	**0:29**	**7.7**	**9.5**

1992 — Alert level 1

attack distance (km.)	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg detection size (ha.)	avg initial size (ha.)
10	35	0:37	0:18	1.6	2.3
20	14	0:26	0:23	0.6	0.8
30	15	0:32	0:20	3.2	4.0
40	6	0:14	0:38	1.0	1.1
50	7	0:20	0:33	0.6	0.7
60	9	0:32	0:29	1.1	1.8
70	3	0:18	0:38	2.4	10.1
80	1	0:12	0:28	0.1	0.1
90	2	0:12	0:35	4.6	5.1
100					
110	2	0:52	0:57	0.5	0.5
120	1	0:35	0:45	0.5	11.0
130	1	0:32	1:00	0.1	0.1
140					
over 150	3	1:55	1:10	2.3	3.0
TOTAL	**99**	**0:33**	**0:26**	**1.6**	**2.4**

1992 — Alert level 2

attack distance (km.)	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg detection size (ha.)	avg initial size (ha.)
10	17	0:43	0:16	2.8	4.2
20	7	0:09	0:17	5.1	6.1
30	10	0:15	0:30	7.4	10.0
40	6	0:48	0:33	4.9	14.0
50	9	0:30	0:49	2.8	4.8
60	2	0:44	0:27	1.1	3.6
70	3	0:08	0:23	0.7	1.4
80	4	0:36	0:44	1.2	8.3
90	1	0:20	0:45	1.0	1.2
100					
110	1	0:55	0:50	5.0	29.0
120					
130	1	0:03	1:28	0.3	0.3
140					
over 150	2	0:00	0:17	0.6	0.8
TOTAL	**63**	**0:29**	**0:29**	**3.6**	**6.6**

1992 — Alert level 3

attack distance (km.)	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg detection size (ha.)	avg initial size (ha.)
10	5	0:43	0:13	0.1	0.5
20	2	0:31	0:16	0.3	0.4
30					
40	1	0:10	0:20	0.1	0.1
50	2	0:10	0:20	0.6	0.7
60	2	0:20	1:40	1.1	1.8
70	1	0:20	0:30	0.4	0.4
80	2	0:40	0:25	0.1	0.1
90	1	0:03	0:32	1.0	1.0
100					
110					
120					
130	1	0:02	1:08	1.5	1.8
140					
over 150					
TOTAL	**17**	**0:26**	**0:31**	**0.4**	**0.7**

1992 — Alert level 4

attack distance (km.)	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg detection size (ha.)	avg initial size (ha.)
10	1	0:00	0:14	0.1	0.1
20					
30					
40					
50					
60					
70	1	0:05	0:25	1.0	2.0
80	3	1:24	0:31	1.0	4.3
90	1	0:00	2:00	1.0	2.0
100					
110	1	0:01	0:31	3.0	10.0
120					
130					
140					
over 150					
TOTAL	**7**	**0:36**	**0:40**	**1.2**	**3.9**

1992 — ALL LEVELS

attack distance (km.)	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg detection size (ha.)	avg initial size (ha.)
10	77	0:38	0:19	4.3	5.0
20	30	0:25	0:23	1.7	2.1
30	29	0:25	0:24	4.9	6.7
40	17	0:48	0:34	3.4	8.8
50	20	0:23	0:39	1.6	2.6
60	15	0:29	0:38	1.6	3.5
70	9	0:24	0:30	4.9	8.6
80	13	0:51	0:32	0.7	3.6
90	5	0:09	0:53	2.4	2.9
100					
110	4	0:40	0:49	2.2	10.0
120	1	0:35	0:45	0.5	11.0
130	3	0:12	1:12	0.6	0.7
140					
over 150	6	1:08	0:50	2.5	2.9
TOTAL	**229**	**0:33**	**0:28**	**3.2**	**4.8**

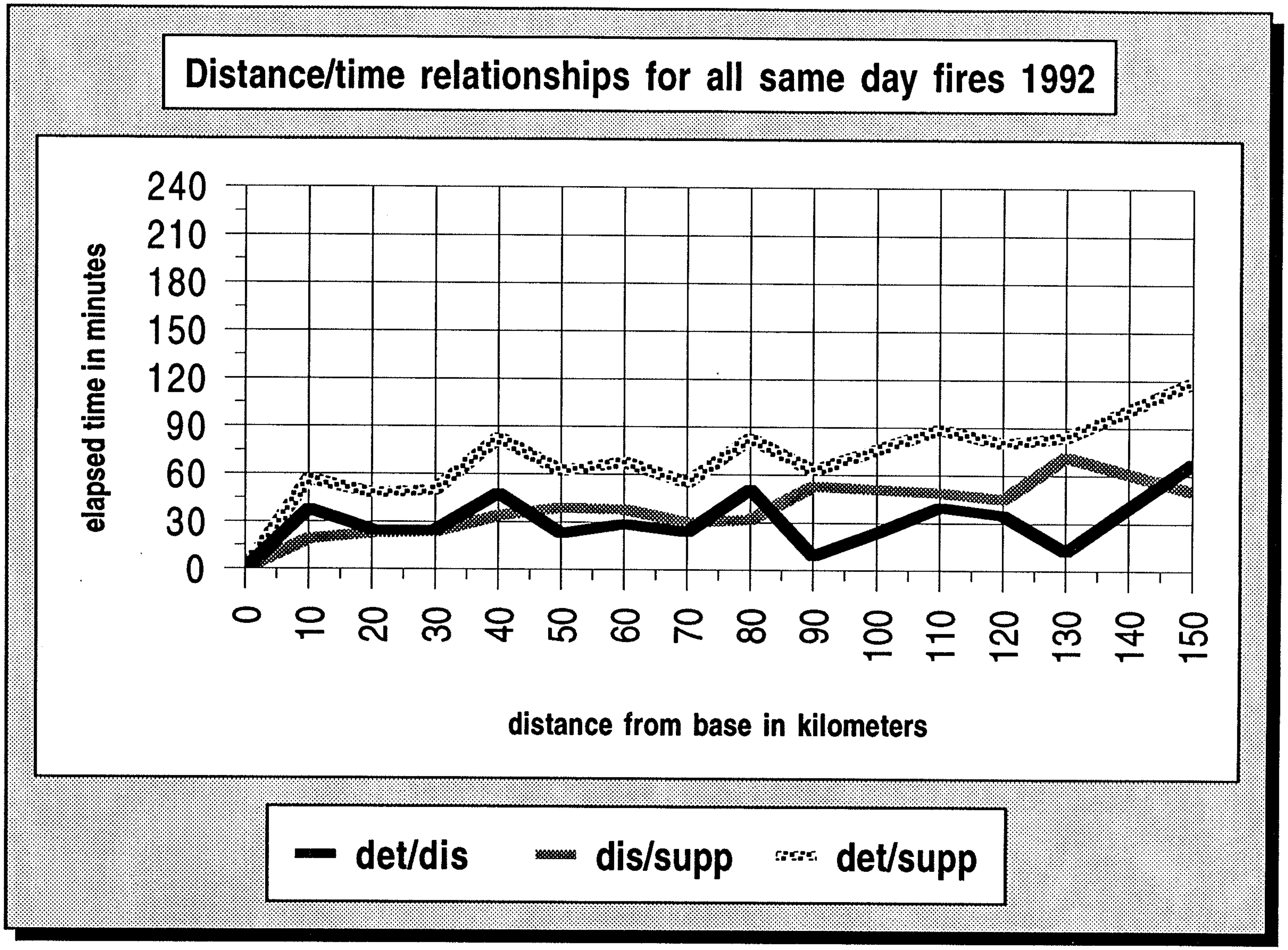


Figure 18: Distance/time relationships for the periods detection to dispatch, dispatch to suppression, and detection to suppression for all same day actioned fires in 1992

Table 32:Initial attack response times, sizes, number of firefighters and distances by initial attack transport method

Year	TRANSPORT MODE	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg det/supp (hh:mm)	avg initial size (ha)	avg final size (ha)	avg distance (km.)	avg speed km/ hr	avg # firefighters
1990	not documented	14	0:17	0:32	**0:49**	*25.9*	*31.1*	11	20	3
	helicopter	239	0:23	0:29	**0:52**	*7.9*	*17.0*	41	83	5
	aircraft	17	0:47	1:00	**1:47**	*3.4*	*5.3*	55	55	6
	ground vehicle	174	0:22	0:25	**0:47**	*9.7*	*20.8*	20	48	5
	boat	21	0:25	0:40	**1:05**	*0.5*	*0.5*	10	14	4
	all transport modes	**465**	**0:24**	**0:29**	**0:53**	***8.6***	***17.7***	**31**	**64**	**5**
1991	not documented	10	0:22	0:13	**0:35**	*1.4*	*1.9*	28	124	3
	medium helicopter	135	0:28	0:26	**0:54**	*6.0*	*7.4*	54	123	5
	aircraft	18	0:50	0:47	**1:37**	*1.0*	*2.2*	36	46	4
	ground vehicle	212	0:26	0:26	**0:52**	*18.2*	*34.3*	21	47	5
	boat	37	0:28	0:31	**0:59**	*4.4*	*12.1*	11	20	4
	light helicopter	91	0:24	0:29	**0:53**	*9.8*	*21.3*	40	82	4
	all transport modes	**503**	**0:27**	**0:27**	**0:54**	***11.4***	***21.3***	**33**	**73**	**5**
1992	not documented	3	3:20	0:23	**3:43**	*8.4*	*8.4*	20	52	5
	medium helicopter	59	0:23	0:33	**0:56**	*2.2*	*8.6*	72	131	5
	aircraft	11	0:48	0:44	**1:32**	*10.3*	*22.9*	46	62	11
	ground vehicle	109	0:32	0:23	**0:55**	*6.8*	*13.9*	23	58	6
	boat	29	0:35	0:31	**1:06**	*1.4*	*2.9*	10	18	5
	light helicopter	18	0:38	0:33	**1:11**	*3.2*	*6.4*	41	74	5
	all transport modes	**229**	**0:33**	**0:28**	**1:01**	***4.8***	***10.9***	**36**	**73**	**6**

and most efficient form of initial attack in areas where road networks exist to facilitate access to the fire site.

Attack distances remain generally constant over the three seasons with ground vehicles averaging about 21 km, helicopter and aircraft around 50 km, and boat transportation remains consistent at a 10 km attack range. Crude speed calculations (km/hr) find helicopters travel between 75 to 130 km/hr, ground vehicles around 50 km/hr and boats speeds of about 18 km/hr. The general consistency of these speeds as shown in Table 32 should provide a good basis for the determination of appropriate attack zones for various transportation modes. It should be noted that getaway and travel times have been combined when calculating speeds.

No apparent trends can be found between transportation mode and size data for the three years, except that boat attacks consistently produce the lowest average sizes. This unexpected result can likely be attributed to two factors unique to boat attacks. The first and most obvious being that a boat accessible fire must always have an adequate water source, and that many boat accessible fires occur on small islands which even when left to burn are limited by the size of the island.

The average number of firefighters per initial attack remains constant at approximately five firefighters, with an exception shown in the 1992 aircraft column which represents sustained action firefighters, documented in the initial attack data field. Another interesting point worth noting is that average detection to dispatch times are increasing in subsequent years. In 1990 detection to dispatch averaged 24 minutes, which increase to 27 minutes in 1991 and increased to 33 minutes in 1992. Travel times (dispatch to suppression) have been broken down by transport method (Tables 33, 34 and 35) at 10 km distance

Table 33: Frequency distribution of dispatch to suppression times by distance and method of transport 1990

1990	not documented		helicopter		aircraft		ground vehicle		boat		all methods	
attack distance (km.)	# fires	avg dis/supp (hh:mm)	# fires	avg dis/supp (hh:mm)	# fires	avg dis/supp (hh:mm)	# fires	avg dis/supp (hh:mm)	# fires	avg dis/supp (hh:mm)	# fires	avg dis/supp (hh:mm)
10	10	0:34	30	0:13	2	0:50	75	0:17	12	0:19	129	0:18
20	1	0:35	39	0:17	4	0:27	37	0:21	7	1:10	88	0:24
30	1	0:06	32	0:40	1	0:15	25	0:35	1	2:00	60	0:38
40			33	0:29	1	0:30	13	0:36	1	0:15	48	0:31
50	1	0:45	44	0:32	1	0:15	14	0:34			60	0:32
60												
70	1	0:25	19	0:34	2	1:52	3	0:20			25	0:38
80			7	0:30	1	1:00	2	0:47			10	0:37
90			3	0:19			1	0:55			4	0:28
100			4	0:51			2	1:15			6	0:59
110												
120			4	0:57	3	0:55					7	0:56
130												
140												
over 150												
TOTAL	**14**	**0:32**	**242**	**0:29**	**17**	**1:00**	**174**	**0:25**	**21**	**0:40**	**468**	**0:29**

Table 34 : Frequency distribution of dispatch to suppression times by distance and method of transport 1991

1991	not documented		medium helicopter		aircraft		ground vehicle		boat		light helicopter		all methods	
attack distance (km.)	# fires	avg dis/supp (hh:mm)	# fires	avg dis/supp (hh:mm)	# fires	avg dis/supp (hh:mm)	# fires	avg dis/supp (hh:mm)	# fires	avg dis/supp (hh:mm)	# fires	avg dis/supp (hh:mm)	# fires	avg dis/supp (hh:mm)
10	7	0:06	14	0:14	4	0:47	104	0:18	24	0:26	17	0:23	170	0:20
20	1	0:15	12	0:20	5	0:34	38	0:20	9	0:42	9	0:26	74	0:24
30			17	0:17	2	0:45	18	0:21			21	0:19	58	0:20
40			15	0:24	1	0:30	13	0:41	3	0:46	13	0:43	45	0:36
50			19	0:23	2	1:15	22	0:43			5	0:29	48	0:35
60			12	0:30	1	0:38	6	0:49			8	0:50	27	0:40
70			8	0:33	1	0:30	2	1:00	1	0:20	2	0:32	14	0:36
80			7	0:54			5	0:42			7	0:18	19	0:37
90														
100			4	0:17			2	1:10			2	0:34	8	0:34
110			4	0:37			1	1:00			2	0:37	7	0:40
120														
130			2	0:26	1	1:30					1	0:47	4	0:47
140														
over 150	1	0:45	4	0:51									5	0:50
TOTAL	**10**	**0:13**	**135**	**0:26**	**18**	**0:47**	**212**	**0:26**	**37**	**0:31**	**91**	**0:29**	**503**	**0:27**

Table 35 : Frequency distribution of dispatch to suppression times by distance and method of transport 1992

1992	not documented		medium helicopter		aircraft		ground vehicle		boat		light helicopter		all methods	
attack distance (km.)	# fires	avg dis/supp (hh:mm)	# fires	avg dis/supp (hh:mm)	# fires	avg dis/supp (hh:mm)	# fires	avg dis/supp (hh:mm)	# fires	avg dis/supp (hh:mm)	# fires	avg dis/supp (hh:mm)	# fires	avg dis/supp (hh:mm)
10	2	0:05	6	0:19	1	0:10	45	0:15	22	0:28	1	0:10	77	0:19
20			3	0:14	1	1:30	20	0:19	5	0:31	1	0:04	30	0:23
30			6	0:20	2	1:05	17	0:23			4	0:16	29	0:24
40			3	0:14	1	0:10	9	0:38	1	1:15	3	0:36	17	0:34
50			8	0:43	2	0:42	5	0:33	1	0:55	4	0:36	20	0:39
60	1	1:00	6	0:23			5	0:33			3	1:11	15	0:38
70			6	0:25	2	0:45					1	0:30	9	0:30
80			6	0:27	2	0:35	4	0:40			1	0:28	13	0:32
90			3	0:59			2	0:45					5	0:53
100														
110			2	0:43			2	0:55					4	0:49
120			1	0:45									1	0:45
130			3	1:12									3	1:12
140														
over 150			6	0:50									6	0:50
TOTAL	**3**	**0:23**	**59**	**0:33**	**11**	**0:44**	**109**	**0:23**	**29**	**0:31**	**18**	**0:33**	**229**	**0:28**

Table 36: Frequency distribution of dispatch to suppression times by distance and method of transport (weighted average 1990, 1991, 1992)

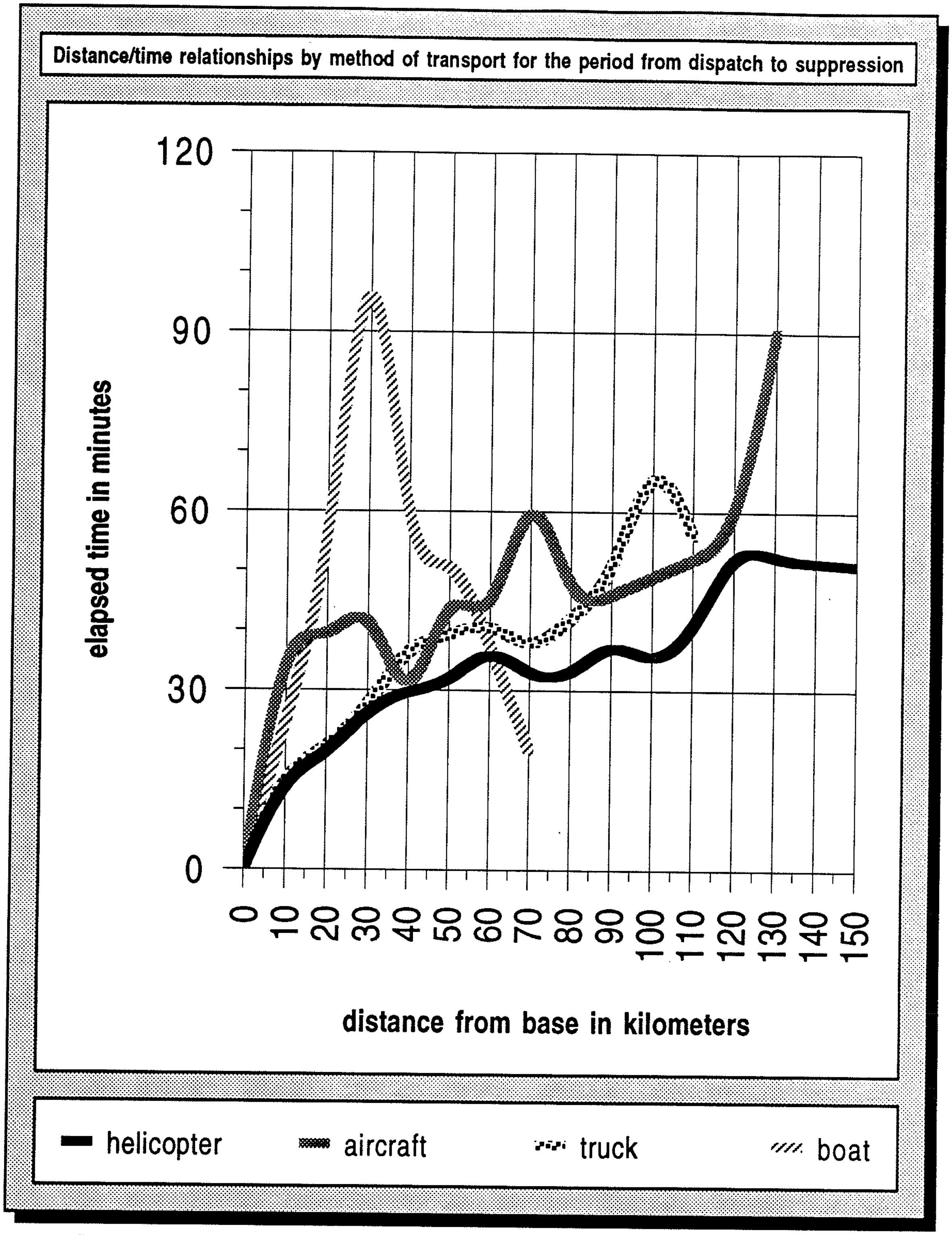
3yr wt.	not documented		helicopter		aircraft		ground vehicle		boat		all methods	
attack distance (km.)	# fires	avg dis/supp (hh:mm)	# fires	avg dis/supp (hh:mm)	# fires	avg dis/supp (hh:mm)	# fires	avg dis/supp (hh:mm)	# fires	avg dis/supp (hh:mm)	# fires	avg dis/supp (hh:mm)
10	19	0:20	68	0:16	7	0:42	224	0:17	58	0:25	376	0:19
20	2	0:25	64	0:19	10	0:37	95	0:20	21	0:49	192	0:24
30	1	0:06	80	0:27	5	0:47	60	0:27	1	2:00	147	0:28
40			67	0:30	3	0:23	35	0:38	5	0:46	110	0:33
50	1	0:45	80	0:31	5	0:50	41	0:39	1	0:55	128	0:34
60	1	1:00	29	0:38	1	0:38	11	0:42			42	0:40
70	1	0:25	36	0:32	5	1:09	5	0:36	1	0:20	48	0:36
80			28	0:32	3	0:43	11	0:42			42	0:35
90			6	0:39			3	0:48			9	0:42
100			10	0:34			4	1:12			14	0:45
110			8	0:39			3	0:56			11	0:43
120			5	0:55	3	0:55					8	0:55
130			6	0:52	1	1:30					7	0:58
140												
over 150	1	0:45	10	0:51							11	0:50
TOTAL	**27**	**0:24**	**545**	**0:29**	**46**	**0:51**	**495**	**0:25**	**87**	**0:34**	**1200**	**0:28**

note : medium and light helicopter data from 1991 and 1992 has been combined to facilitate a direct comparison with 1990 data intervals from the base. General 'all method' trends show an expected increase in travel times as the distance from the base increases, while trends between transportation methods and between the individual methods and years are difficult to determine. When a three year weighted average of the data from Tables 33, 34 and 35 are compiled, as shown in Table 36, and graphed in Figure 19, some interesting trends are revealed.

Figure 19 shows that initial attack travel times for helicopters and trucks are near identical until the 30 minute/30 km point is reached. After this point, helicopters deliver the best travel times of all transportation methods. Boats and fixed wing (otter) display the longest response times initially until the 10 km mark at which point boat times continue to rise and aircraft gradually resembles a truck response.

It is possible that the general trend to the 30 to 50 km mark found in Figures 16, 17 and 18 is related to the split seen in Figure 19. If this is the case, it would appear to indicate that even under the best preparations, the 15 minute level 4 alert could only hope to be met at a 10 km distance from the attack base. In this regard the trucks faster getaway time equates the helicopters faster speed as long as the fire is road accessible. This documented 15 minute 10 km radius attack circle is quite different from the theoretical 15 minute 40 km attack circle for helicopters in Figure 7 and the documented 30 minute, 30 kilometer circle falls short of the theoretical 80 km as well. With regards to truck transport, the 30 minute, 32 kilometer circle outlined in Figure 8 equates the 30 minute, 30 kilometer observation found in Figure 19. In fact, the 60 minute, 64 kilometer attack circle found in Figure 8 appears to be reached in 40 minutes as shown by Figure 19.

No manipulation of the current wildfire data was capable of determining



note: a line smoother utility has been used to smooth out peaks and dips in order to display general trends

Figure 19 : Distance/time relationships by method of transport for the period from dispatch to suppression (1990, 1991, and 1992)

the precise reason for less than optimal helicopter travel times but some areas may be considered. For instance, getaway times may be the factor or a hesitation to dispatch and commit resources may be involved, but proof is difficult since these times have not been documented in the database. What is clear however is that these areas should be reviewed, and that the effectiveness of ground transportation should not be underestimated when bases are servicing road accessible fires.

4.5 Regional transportation profile

Tables 37 through 39 provide a transportation profile for each region. The regional breakdowns show trends one would expect. For example, the average attack distances in northern regions is greater than attack distances found in southern regions. Attack times are generally longer in the north due to increased detection to dispatch times. On average the dispatch to suppression arrival is consistently near 30 minutes regardless of region. Southern regions which utilize ground transport generally have better response times than northern regions using helicopters.

One unexpected result was the consistent increase in the detection to dispatch time for ground vehicles from 1990 onward. The 1990 detection to suppression time of 22 minutes increased to 26 minutes in 1991, and rose to 32 minutes in 1992. This gradual increase of 4 minutes per year appears marginal, but because it is occurring in one of the larger data sets, I feel it is worth mentioning.

The regional transportation profile data provides the first indications of the limitations of the wildfire report database. For example, consequences of improper input values are shown in figures like the 1990 southeast regions boat

Table 37: 1990 Regional attack time, distance, and size breakdown by transport method

NORTHEAST REGION									
TRANSPORT MODE	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg det/supp (hh:mm)	avg initial size (ha)	avg final size (ha)	avg distance (km.)	avg speed km/ hr	avg # firefighters
not documented	3	0:20	0:35	0:55	1.3	1.4	40	68	5
helicopter	82	0:26	0:28	0:54	17.7	39.9	41	89	5
aircraft	12	0:56	1:00	1:56	4.5	7.2	65	65	7
ground vehicle	13	0:12	0:21	0:33	0.9	1.9	13	35	7
boat	12	0:28	0:25	0:53	0.4	0.4	7	16	3
all transport modes	**122**	**0:27**	**0:30**	**0:57**	**12.5**	**27.8**	**37**	**73**	**6**

NORTHWEST REGION									
TRANSPORT MODE	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg det/supp (hh:mm)	avg initial size (ha)	avg final size (ha)	avg distance (km.)	avg speed km/ hr	avg # firefighters
not documented	3	0:10	0:10	0:20	0.7	0.7	0	0	2
helicopter	58	0:18	0:34	0:52	1.4	1.6	44	77	5
aircraft	2	0:09	1:50	1:59	0.2	0.2	44	24	3
ground vehicle	39	0:29	0:21	0:50	0.4	0.7	23	65	5
boat	2	0:15	2:20	2:35	1.2	1.4	18	8	8
all transport modes	**104**	**0:21**	**0:32**	**0:53**	**1.0**	**1.2**	**34**	**68**	**5**

SOUTHEAST REGION									
TRANSPORT MODE	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg det/supp (hh:mm)	avg initial size (ha)	avg final size (ha)	avg distance (km.)	avg speed km/ hr	avg # firefighters
not documented	4	0:22	0:40	1:02	88.0	106.0	0	0	3
helicopter									
aircraft									
ground vehicle	14	0:10	0:36	0:46	64.5	165.4	25	40	3
boat	1	0:05	0:15	0:20	1.1	1.1	35	140	4
all transport modes	**19**	**0:12**	**0:36**	**0:48**	**66.1**	**144.3**	**20**	**37**	**3**

SOUTHWEST REGION									
TRANSPORT MODE	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg det/supp (hh:mm)	avg initial size (ha)	avg final size (ha)	avg distance (km.)	avg speed km/ hr	avg # firefighters
not documented									
helicopter									
aircraft									
ground vehicle	1	0:15	0:25	0:40	2.5	3.0	15	36	3
boat									
all transport modes	**1**	**0:15**	**0:25**	**0:40**	**2.5**	**3.0**	**15**	**36**	**3**

EASTERN REGION									
TRANSPORT MODE	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg det/supp (hh:mm)	avg initial size (ha)	avg final size (ha)	avg distance (km.)	avg speed km/ hr	avg # firefighters
not documented	1	0:01	1:09	1:10	2.5	3.0	10	9	5
helicopter	67	0:24	0:31	0:55	3.2	5.0	44	84	4
aircraft	2	0:47	0:32	1:19	0.4	0.5	12	21	5
ground vehicle	40	0:16	0:20	0:36	5.4	15.1	16	49	5
boat	3	0:30	1:09	1:39	0.4	0.4	12	10	3
all transport modes	**113**	**0:21**	**0:29**	**0:50**	**3.8**	**8.3**	**33**	**68**	**4**

INTERLAKE REGION									
TRANSPORT MODE	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg det/supp (hh:mm)	avg initial size (ha)	avg final size (ha)	avg distance (km.)	avg speed km/ hr	avg # firefighters
not documented	2	0:30	0:42	1:12	0.9	1.0	0	0	2
helicopter	2	4:22	0:56	5:18	38.3	109.8	55	59	2
aircraft	1	0:18	0:15	0:33	2.5	2.5	50	200	0
ground vehicle	27	0:24	0:30	0:54	18.0	21.7	31	60	6
boat									
all transport modes	**32**	**0:39**	**0:32**	**1:11**	**17.7**	**25.3**	**31**	**60**	**6**

Table 37: continued

	WESTERN REGION								
TRANSPORT MODE	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg det/supp (hh:mm)	avg initial size (ha)	avg final size (ha)	avg distance (km.)	avg speed km/ hr	avg # firefighters
not documented									
helicopter	4	0:33	0:23	0:56	1.6	2.5	42	105	5
aircraft									
ground vehicle	10	0:43	0:27	1:10	0.5	0.5	18	39	3
boat									
all transport modes	**14**	**0:40**	**0:26**	**1:06**	**0.8**	**1.1**	**25**	**58**	**4**

	WHITESHELL REGION								
TRANSPORT MODE	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg det/supp (hh:mm)	avg initial size (ha)	avg final size (ha)	avg distance (km.)	avg speed km/ hr	avg # firefighters
not documented	1	0:00	0:06	0:06	0.1	0.1	24	240	6
helicopter	26	0:08	0:16	0:24	2.7	5.3	23	84	4
aircraft									
ground vehicle	30	0:22	0:26	0:48	1.4	1.8	14	32	5
boat	3	0:26	0:16	0:42	0.3	0.3	6	20	4
all transport modes	**60**	**0:16**	**0:21**	**0:37**	**1.9**	**3.2**	**17**	**57**	**4**

	ALL REGIONS								
TRANSPORT MODE	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg det/supp (hh:mm)	avg initial size (ha)	avg final size (ha)	avg distance (km.)	avg speed km/ hr	avg # firefighters
not documented	14	0:17	0:32	0:49	25.9	31.1	11	20	3
helicopter	239	0:23	0:29	0:52	7.9	17.0	41	83	5
aircraft	17	0:47	1:00	1:47	3.4	5.3	55	55	6
ground vehicle	174	0:22	0:25	0:47	9.7	20.8	20	48	5
boat	21	0:25	0:40	1:05	0.5	0.5	10	14	4
all transport modes	**465**	**0:24**	**0:29**	**0:53**	**8.6**	**17.7**	**31**	**64**	**5**

Table 38: 1991 Regional attack time, distance, and size breakdown by transport method

NORTHEAST REGION

TRANSPORT MODE	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg det/supp (hh:mm)	avg initial size (ha)	avg final size (ha)	avg distance (km.)	avg speed km/ hr	avg # firefighters
not documented	3	1:03	0:18	1:21	4.1	5.4	58	190	5
medium helicopter	38	0:20	0:28	0:48	2.6	4.3	68	146	5
aircraft	10	0:56	0:50	1:46	1.6	3.8	39	47	5
ground vehicle	26	0:40	0:33	1:13	1.6	5.3	6	10	5
boat	30	0:25	0:30	0:55	5.2	14.8	9	17	5
light helicopter	12	0:22	0:21	0:43	1.2	1.5	34	95	4
all transport modes	**119**	**0:30**	**0:30**	**1:00**	**2.9**	**6.9**	**33**	**71**	**5**

NORTHWEST REGION

TRANSPORT MODE	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg det/supp (hh:mm)	avg initial size (ha)	avg final size (ha)	avg distance (km.)	avg speed km/ hr	avg # firefighters
not documented	2	0:10	0:10	0:20	0.1	0.1	8	45	2
medium helicopter	24	0:16	0:24	0:40	25.8	29.8	60	146	7
aircraft									
ground vehicle	37	0:32	0:25	0:57	7.8	11.2	24	56	5
boat	2	0:06	0:20	0:26	0.2	0.2	19	56	5
light helicopter	32	0:21	0:32	0:53	2.1	2.5	47	85	5
all transport modes	**97**	**0:24**	**0:27**	**0:51**	**10.1**	**12.5**	**40**	**88**	**5**

SOUTHEAST REGION

TRANSPORT MODE	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg det/supp (hh:mm)	avg initial size (ha)	avg final size (ha)	avg distance (km.)	avg speed km/ hr	avg # firefighters
not documented									
medium helicopter									
aircraft									
ground vehicle	9	0:23	0:26	0:49	10.3	53.6	16	35	5
boat									
light helicopter	1	0:04	0:20	0:24	10.0	362.0	26	78	2
all transport modes	**10**	**0:21**	**0:26**	**0:47**	**10.3**	**84.5**	**17**	**39**	**5**

SOUTHWEST REGION

TRANSPORT MODE	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg det/supp (hh:mm)	avg initial size (ha)	avg final size (ha)	avg distance (km.)	avg speed km/ hr	avg # firefighters
not documented	2	0:05	0:05	0:10	0.1	0.1	0	0	0
medium helicopter									
aircraft									
ground vehicle									
boat									
light helicopter									
all transport modes	**2**	**0:05**	**0:05**	**0:10**	**0.1**	**0.1**	**0**	**0**	**0**

EASTERN REGION

TRANSPORT MODE	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg det/supp (hh:mm)	avg initial size (ha)	avg final size (ha)	avg distance (km.)	avg speed km/ hr	avg # firefighters
not documented	1	0:08	0:30	0:38	1.5	2.0	82	164	4
medium helicopter	62	0:38	0:27	1:05	1.2	1.7	48	104	5
aircraft	8	0:44	0:44	1:28	0.2	0.3	34	45	3
ground vehicle	35	0:16	0:16	0:32	6.6	10.2	19	66	5
boat	4	0:27	0:37	1:04	0.5	0.5	19	30	4
light helicopter	23	0:18	0:28	0:46	2.5	29.2	39	82	3
all transport modes	**133**	**0:28**	**0:26**	**0:54**	**2.8**	**8.6**	**37**	**85**	**4**

INTERLAKE REGION

TRANSPORT MODE	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg det/supp (hh:mm)	avg initial size (ha)	avg final size (ha)	avg distance (km.)	avg speed km/ hr	avg # firefighters
not documented									
medium helicopter	2	2:07	0:45	2:52	8.1	8.3	33	43	8
aircraft									
ground vehicle	50	0:38	0:34	1:12	59.7	95.5	32	55	8
boat	1	3:00	1:30	4:30	2.2	2.4	32	21	6
light helicopter	9	0:41	0:37	1:18	3.6	8.0	49	79	4
all transport modes	**62**	**0:44**	**0:36**	**1:20**	**48.9**	**78.5**	**34**	**58**	**7**

Table 38: continued

WESTERN REGION									
TRANSPORT MODE	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg det/supp (hh:mm)	avg initial size (ha)	avg final size (ha)	avg distance (km.)	avg speed km/ hr	avg # firefighters
not documented									
medium helicopter	1	0:20	0:05	0:25	0.1	0.1	6	72	4
aircraft									
ground vehicle	19	0:16	0:30	0:46	3.7	4.4	30	61	4
boat									
light helicopter	5	0:19	0:49	1:08	141.2	141.3	43	53	5
all transport modes	**25**	**0:17**	**0:32**	**0:49**	**31.1**	**31.6**	**32**	**60**	**4**

WHITESHELL REGION									
TRANSPORT MODE	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg det/supp (hh:mm)	avg initial size (ha)	avg final size (ha)	avg distance (km.)	avg speed km/ hr	avg # firefighters
not documented	2	0:00	0:09	0:09	0.1	0.2	3	16	4
medium helicopter	8	0:08	0:10	0:18	0.7	0.8	27	163	5
aircraft									
ground vehicle	36	0:10	0:16	0:26	4.0	28.3	11	38	4
boat									
light helicopter	9	0:44	0:11	0:55	0.5	3.0	20	100	2
all transport modes	**55**	**0:15**	**0:14**	**0:29**	**2.8**	**19.1**	**14**	**66**	**4**

ALL REGIONS									
TRANSPORT MODE	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg det/supp (hh:mm)	avg initial size (ha)	avg final size (ha)	avg distance (km.)	avg speed km/ hr	avg # firefighters
not documented	10	0:22	0:13	0:35	1.4	1.9	28	124	3
medium helicopter	135	0:28	0:26	0:54	6.0	7.4	54	123	5
aircraft	18	0:50	0:47	1:37	1.0	2.2	36	46	4
ground vehicle	212	0:26	0:26	0:52	18.2	34.3	21	47	5
boat	37	0:28	0:31	0:59	4.4	12.1	11	20	4
light helicopter	91	0:24	0:29	0:53	9.8	21.3	40	82	4
all transport modes	**503**	**0:27**	**0:27**	**0:54**	**11.4**	**21.3**	**33**	**73**	**5**

Table 39: 1992 Regional attack time, distance, and size breakdown by transport method

NORTHEAST REGION									
TRANSPORT MODE	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg det/supp (hh:mm)	avg initial size (ha)	avg final size (ha)	avg distance (km.)	avg speed km/ hr	avg # firefighters
not documented	2	4:50	0:32	5:22	12.6	12.6	30	55	6
medium helicopter	35	0:24	0:35	0:59	2.0	11.7	83	140	5
aircraft	8	0:51	0:46	1:37	14.1	31.1	47	60	14
ground vehicle	18	1:01	0:18	1:19	0.8	1.0	4	13	6
boat	21	0:27	0:32	0:59	1.6	3.8	11	20	5
light helicopter	3	0:25	1:15	1:40	2.1	20.6	34	27	9
all transport modes	**87**	**0:41**	**0:33**	**1:14**	**3.0**	**9.7**	**43**	**72**	**6**

NORTHWEST REGION									
TRANSPORT MODE	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg det/supp (hh:mm)	avg initial size (ha)	avg final size (ha)	avg distance (km.)	avg speed km/ hr	avg # firefighters
not documented									
medium helicopter	15	0:22	0:21	0:43	1.8	3.4	46	130	5
aircraft	2	0:32	0:50	1:22	0.6	0.6	63	75	5
ground vehicle	30	0:29	0:30	0:59	10.2	4.9	34	68	5
boat	4	0:16	0:14	0:30	0.4	0.4	10	41	4
light helicopter	6	0:31	0:32	1:03	1.4	1.4	40	75	4
all transport modes	**57**	**0:27**	**0:27**	**0:54**	**6.0**	**3.7**	**37**	**83**	**5**

WESTERN REGION									
TRANSPORT MODE	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg det/supp (hh:mm)	avg initial size (ha)	avg final size (ha)	avg distance (km.)	avg speed km/ hr	avg # firefighters
not documented	0								
medium helicopter	1	0:00	0:10	0:10	25.0	38.4	45	270	5
aircraft	0								
ground vehicle	13	0:32	0:25	0:57	4.0	62.7	30	71	6
boat	0								
light helicopter	3	0:57	0:29	1:26	13.9	14.0	62	126	4
all transport modes	**17**	**0:34**	**0:25**	**0:59**	**7.0**	**52.7**	**36**	**93**	**5**

CENTRAL REGION									
TRANSPORT MODE	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg det/supp (hh:mm)	avg initial size (ha)	avg final size (ha)	avg distance (km.)	avg speed km/ hr	avg # firefighters
not documented									
medium helicopter									
aircraft									
ground vehicle	24	0:26	0:21	0:47	14.0	18.3	21	59	5
boat									
light helicopter									
all transport modes	**24**	**0:26**	**0:21**	**0:47**	**14.0**	**18.3**	**21**	**59**	**5**

EASTERN REGION									
TRANSPORT MODE	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg det/supp (hh:mm)	avg initial size (ha)	avg final size (ha)	avg distance (km.)	avg speed km/ hr	avg # firefighters
not documented	1	0:20	0:05	0:25	0.1	0.2	1	12	5
medium helicopter	8	0:25	0:49	1:14	1.0	1.1	80	98	5
aircraft	1	1:00	0:10	1:10	0.1	2.0	5	30	2
ground vehicle	24	0:18	0:20	0:38	1.3	4.1	21	62	5
boat	4	1:35	0:42	2:17	1.5	0.7	4	6	4
light helicopter	6	0:42	0:17	0:59	0.3	0.6	37	129	4
all transport modes	**44**	**0:30**	**0:26**	**0:56**	**1.1**	**2.6**	**31**	**71**	**5**

ALL REGIONS									
TRANSPORT MODE	# fires	avg det/dis (hh:mm)	avg dis/supp (hh:mm)	avg det/supp (hh:mm)	avg initial size (ha)	avg final size (ha)	avg distance (km.)	avg speed km/ hr	avg # firefighters
not documented	3	3:20	0:23	3:43	8.4	8.4	20	52	5
medium helicopter	59	0:23	0:33	0:56	2.2	8.6	72	131	5
aircraft	11	0:48	0:44	1:32	10.3	22.9	46	62	11
ground vehicle	109	0:32	0:23	0:55	6.8	13.9	23	58	6
boat	29	0:35	0:31	1:06	1.4	2.9	10	18	5
light helicopter	18	0:38	0:33	1:11	3.2	6.4	41	74	5
all transport modes	**229**	**0:33**	**0:28**	**1:01**	**4.8**	**10.9**	**36**	**73**	**6**

attack which covered 35 km in 20 minutes at a speed of 140 km/hr, or the medium helicopter ride the Western Region experienced in 1992 when a medium lift helicopter travelled 45 km in 10 minutes at a speed of 270 km/hr! Further investigation into this fire revealed that the Western Region anomaly was a fire picked up by a medium helicopter as it was being moved from The Pas to Swan River, with the distance from base being recorded from Swan River and the time from dispatch from The Pas. Such time/distance incongruities are similar to the loaded patrol log dilemma. The identification of the circumstances which produces such mistakes is necessary to determine how to correctly document the situation in the existing report or in a supplementary reporting structure.

4.6 District transportation profile

A detailed breakdown of all same day initial attacks by district is provided in Tables 40, 41 , and 42. The 1990 and 1991 data sets provide a breakdown of fires, times, and distances in the district which the fire occurred. Unfortunately, it was not until 1992 that the wildfire report began to identify which districts initial attack forces actioned the fire. While it can generally be assumed that districts actioned their own fires in 1990 and 1991, one should be aware that the major helitac bases at Bissett, Paint Lake, and Snow Lake often action fires in adjacent districts. Since the 1990 and 1991 reports failed to recognize each district as a potential initial attack base for fire reporting purposes, the comparison may show some districts as actioning fires which they themselves did not action.

The district breakdowns by transportation mode present a visual indication of the transportation resources mix utilized in different areas of the

Table 40: 1990 Initial attack response times and distances by district, for fires that were actioned on the same day that they were detected

INITIAL ATTACK DISTRICT	NOT DOCUMENTED					HELICOPTER					AIRCRAFT					VEHICLE					BOAT					ALL FIRES				
	# fires	det/dis (avg hh:mm)	dis/supp (avg hh:mm)	det/supp (avg hh:mm)	avg distance (km.)	# fires	det/dis (avg hh:mm)	dis/supp (avg hh:mm)	det/supp (avg hh:mm)	avg distance (km.)	# fires	det/dis (avg hh:mm)	dis/supp (avg hh:mm)	det/supp (avg hh:mm)	avg distance (km.)	# fires	det/dis (avg hh:mm)	dis/supp (avg hh:mm)	det/supp (avg hh:mm)	avg distance (km.)	# fires	det/dis (avg hh:mm)	dis/supp (avg hh:mm)	det/supp (avg hh:mm)	avg distance (km.)	# fires	det/dis (avg hh:mm)	dis/supp (avg hh:mm)	det/supp (avg hh:mm)	avg distance (km.)
Thompson						16	0:12	0:25	0:37	44						4	0:11	0:15	0:26	9						20	0:12	0:23	0:35	37
Leaf Rapids						2	0:45	0:57	1:42	45																2	0:45	0:57	1:42	45
Gillam						2	1:43	0:30	2:13	43						1	0:00	0:15	0:15	60						3	1:09	0:25	1:34	49
Norway House						22	0:20	0:17	0:37	33	2	1:27	1:25	2:52	105	4	0:11	0:14	0:25	10						28	0:24	0:22	0:46	35
Lynn Lake						26	0:23	0:22	0:45	34	1	0:45	0:45	1:30	120	4	0:17	0:37	0:54	8	1	1:30	0:10	1:40	5	32	0:25	0:24	0:49	32
Gods Lake											3	0:15	0:21	0:36	22						4	0:11	0:17	0:28	6	7	0:12	0:19	0:31	13
Island Lake	1	0:45	0:45	1:30	42	2	2:07	0:22	2:29	68	6	1:09	1:13	2:22	65						7	0:29	0:32	1:01	7	16	0:57	0:47	1:44	39
Wabowden	2	0:07	0:30	0:37	39	12	0:27	0:57	1:24	64																14	0:24	0:53	1:17	61
The Pas	3	0:10	0:10	0:20	0	14	0:25	1:07	1:32	36						13	0:15	0:21	0:36	9						30	0:19	0:42	1:01	21
Cranberry Portage						23	0:18	0:20	0:38	49	2	0:09	1:50	1:59	44	11	1:14	0:23	1:37	37						36	0:34	0:26	1:00	45
Flin Flon						1	0:10	0:30	0:40	155						12	0:09	0:16	0:25	19	2	0:15	2:20	2:35	18	15	0:10	0:33	0:43	28
Snow Lake						17	0:06	0:15	0:21	33						1	0:05	0:05	0:10	65						18	0:06	0:14	0:20	35
Grand Rapids						3	0:47	1:31	2:18	60						2	0:07	0:40	0:47	43						5	0:31	1:11	1:42	53
Piney	1	0:00	0:45	0:45	0											8	0:11	0:40	0:51	27	1	0:05	0:15	0:20	35	10	0:09	0:38	0:47	25
Steinbach																6	0:08	0:32	0:40	21						6	0:08	0:32	0:40	21
Portage	3	0:30	0:38	1:08	0																					3	0:30	0:38	1:08	0
Brandon																1	0:15	0:25	0:40	15						1	0:15	0:25	0:40	15
Lac du Bonnet						13	0:30	0:28	0:58	33						7	0:11	0:21	0:32	13						20	0:23	0:25	0:48	26
Lake Winnipeg East						33	0:30	0:37	1:07	56	2	0:47	0:32	1:19	12	2	0:22	0:15	0:37	2	3	0:30	1:09	1:39	12	40	0:30	0:38	1:08	48
Pine Falls	1	0:01	1:09	1:10	10	9	0:06	0:26	0:32	31						21	0:17	0:20	0:37	18						31	0:13	0:23	0:36	21
Bissett						10	0:05	0:26	0:31	33						4	0:12	0:26	0:38	31						14	0:07	0:26	0:33	33
Grand Beach																4	0:18	0:14	0:32	14						4	0:18	0:14	0:32	14
Birds Hill						2	1:13	0:14	1:27	43						2	0:15	0:17	0:32	6						4	0:44	0:16	1:00	24
Selkirk											1	0:18	0:15	0:33	50											1	0:18	0:15	0:33	50
Riverton	1	0:15	0:40	0:55	0											7	0:15	0:35	0:50	30						8	0:15	0:36	0:51	26
Hodgson	1	0:45	0:45	1:30	0	1	6:30	1:30	8:00	40						10	0:36	0:34	1:10	36						12	1:06	0:39	1:45	33
Gypsumville						1	2:14	0:22	2:36	70						8	0:20	0:20	0:40	21						9	0:33	0:20	0:53	27
Lundar																2	0:07	0:40	0:47	48						2	0:07	0:40	0:47	48
Winnipegosis						1	1:30	0:30	2:00	50																1	1:30	0:30	2:00	50
Roblin						2	0:07	0:17	0:24	44																2	0:07	0:17	0:24	44
Mafeking						1	0:30	0:30	1:00	30						9	0:47	0:27	1:14	16						10	0:46	0:28	1:14	18
Swan River North																1	0:02	0:28	0:30	35						1	0:02	0:28	0:30	35
Whitemouth						3	0:01	0:13	0:14	19						9	0:46	0:29	1:15	21						12	0:35	0:25	1:00	21
Seven Sisters						9	0:10	0:15	0:25	22						4	0:05	0:12	0:17	9						13	0:09	0:14	0:23	18
Rennie	1	0:00	0:06	0:06	24	9	0:05	0:19	0:24	26						6	0:10	0:30	0:40	16						16	0:07	0:22	0:29	22
West Hawk Lake						3	0:01	0:10	0:11	8						5	0:28	0:10	0:38	7	2	0:30	0:15	0:45	3	10	0:20	0:11	0:31	6
Falcon Lake						1	1:10	0:10	1:20	12						3	0:07	0:06	0:13	7	1	0:20	0:20	0:40	12	5	0:22	0:10	0:32	9
Hadashville						1	0:05	0:25	0:30	60						3	0:06	1:15	1:21	12						4	0:06	1:02	1:08	24
ALL BASES	14	0:17	0:32	0:49	11	239	0:23	0:29	0:52	41	17	0:47	1:00	1:47	55	174	0:22	0:25	0:47	20	21	0:25	0:40	1:05	10	465	0:24	0:29	0:53	31

Table 41: 1991 Initial Attack Response times and distances by district for fires that were actioned on the day they were detected

INITIAL ATTACK DISTRICT	NOT DOCUMENTED # fires	det/dis (avg hh:mm)	dis/supp (avg hh:mm)	det/supp (avg hh:mm)	avg distance (km.)	MEDIUM HELICOPTER # fires	det/dis (avg hh:mm)	dis/supp (avg hh:mm)	det/supp (avg hh:mm)	avg distance (km.)	AIRCRAFT # fires	det/dis (avg hh:mm)	dis/supp (avg hh:mm)	det/supp (avg hh:mm)	avg distance (km.)
Thompson						21	0:26	0:28	0:54	77					
Leaf Rapids						1	0:00	0:15	0:15	40					
Gillam	1	2:45	0:45	3:30	173										
Norway House						1	0:07	1:28	1:35	60	3	1:15	0:48	2:03	44
Lynn Lake	1	0:25	0:00	0:25	1	3	0:20	0:20	0:40	71	1	0:15	1:15	1:30	8
God's Lake											1	0:30	0:30	1:00	40
Island Lake	1	0:00	0:10	0:10	0						3	0:58	0:53	1:51	30
Wabowden						12	0:11	0:25	0:36	54	2	0:57	0:45	1:42	59
The Pas	1	0:15	0:05	0:20	0	1	0:00	0:10	0:10	40					
Cranberry Portage						6	0:04	0:30	0:34	102					
Flin Flon	1	0:05	0:15	0:20	15	5	0:39	0:24	1:03	64					
Snow Lake						10	0:15	0:16	0:31	39					
Grand Rapids						2	0:12	0:55	1:07	40					
Piney															
Steinbach															
Manitou	2	0:05	0:05	0:10	0										
Lac du Bonnet						5	0:03	0:12	0:15	19					
Lake Winnipeg East	1	0:08	0:30	0:38	82	47	0:31	0:31	1:02	54	8	0:44	0:44	1:28	34
Pine Falls						3	0:13	0:16	0:29	44					
Bissett						6	2:16	0:20	2:36	26					
Grand Beach						1	0:40	0:20	1:00	100					
Hecla						1	1:30	0:30	2:00	65					
Riverton															
Hodgson						1	2:45	1:00	3:45	0					
Gypsumville															
Lundar															
Winnipegosis															
Mafeking						1	0:20	0:05	0:25	6					
Grandview/Garland															
Swan River N															
Hadashville	1	0:00	0:06	0:06	0	2	0:00	0:00	0:00	17					
Seven Sisters						3	0:14	0:16	0:30	34					
Rennie	1	0:00	0:13	0:13	5	2	0:11	0:15	0:26	27					
West Hawk						1	0:00	0:00	0:00	29					
Falcon Lake															
ALL BASES	**10**	**0:22**	**0:13**	**0:35**	**28**	**135**	**0:28**	**0:26**	**0:54**	**54**	**18**	**0:50**	**0:47**	**1:37**	**36**

INITIAL ATTACK DISTRICT	GROUND VEHICLE # fires	det/dis (avg hh:mm)	dis/supp (avg hh:mm)	det/supp (avg hh:mm)	avg distance (km.)	BOAT # fires	det/dis (avg hh:mm)	dis/supp (avg hh:mm)	det/supp (avg hh:mm)	avg distance (km.)
Thompson	3	0:07	0:05	0:12	2					
Leaf Rapids										
Gillam										
Norway House	1	0:30	1:30	2:00	1	3	0:25	0:51	1:16	8
Lynn Lake	10	1:09	0:51	2:00	7					
God's Lake	7	0:28	0:25	0:53	5	5	0:38	0:31	1:09	9
Island Lake	4	0:23	0:16	0:39	2	21	0:23	0:27	0:50	9
Wabowden	1	0:03	0:28	0:31	30	1	0:10	0:10	0:20	1
The Pas	14	0:35	0:19	0:54	17					
Cranberry Portage	7	0:19	0:25	0:44	26	1	0:07	0:30	0:37	34
Flin Flon	5	0:14	0:19	0:33	16	1	0:05	0:10	0:15	3
Snow Lake	4	0:09	0:13	0:22	17					
Grand Rapids	7	1:06	0:50	1:56	47					
Piney	5	0:14	0:31	0:45	16					
Steinbach	4	0:34	0:21	0:55	15					
Manitou										
Lac du Bonnet	9	0:07	0:22	0:29	24					
Lake Winnipeg East	1	0:05	0:30	0:35	3	4	0:27	0:37	1:04	19
Pine Falls	21	0:22	0:13	0:35	16					
Bissett	2	0:07	0:20	0:27	26					
Grand Beach	2	0:10	0:17	0:27	24					
Hecla	1	0:30	0:30	1:00	50					
Riverton	2	0:37	0:30	1:07	48					
Hodgson	22	0:39	0:42	1:21	37					
Gypsumville	24	0:40	0:23	1:03	25	1	3:00	1:30	4:30	32
Lundar	1	0:00	2:00	2:00	20					
Winnipegosis	2	0:15	0:37	0:52	5					
Mafeking	15	0:14	0:27	0:41	31					
Grandview/Garland	1	1:00	1:00	2:00	70					
Swan River N	1	0:20	0:25	0:45	30					
Hadashville	16	0:11	0:21	0:33	16					
Seven Sisters	7	0:10	0:15	0:25	5					
Rennie	6	0:05	0:09	0:14	6					
West Hawk	3	0:15	0:14	0:29	6					
Falcon Lake	4	0:09	0:10	0:19	7					
ALL BASES	**212**	**0:26**	**0:26**	**0:52**	**21**	**37**	**0:28**	**0:31**	**0:59**	**11**

INITIAL ATTACK DISTRICT	LIGHT HELICOPTER # fires	det/dis (avg hh:mm)	dis/supp (avg hh:mm)	det/supp (avg hh:mm)	avg distance (km.)	ALL FIRES # fires	det/dis (avg hh:mm)	dis/supp (avg hh:mm)	det/supp (avg hh:mm)	avg distance (km.)
Thompson	1	0:06	0:24	0:30	136	25	0:23	0:25	0:48	71
Leaf Rapids						1	0:00	0:15	0:15	40
Gillam	1	1:15	0:55	2:10	32	2	2:00	0:50	2:50	103
Norway House	5	0:29	0:25	0:54	22	13	0:37	0:46	1:23	25
Lynn Lake	1	0:10	0:05	0:15	4	16	0:50	0:40	1:30	18
God's Lake						13	0:32	0:27	0:59	9
Island Lake						29	0:26	0:28	0:54	10
Wabowden	4	0:08	0:12	0:20	31	20	0:14	0:24	0:38	46
The Pas	15	0:17	0:30	0:47	36	31	0:24	0:23	0:47	26
Cranberry Portage	6	0:08	0:06	0:14	62	20	0:11	0:21	0:32	60
Flin Flon						12	0:23	0:20	0:43	35
Snow Lake	1	1:30	2:00	3:30	40	15	0:19	0:22	0:41	33
Grand Rapids	10	0:29	0:44	1:13	53	19	0:41	0:47	1:28	49
Piney	1	0:04	0:20	0:24	26	6	0:12	0:29	0:41	18
Steinbach						4	0:34	0:21	0:55	15
Manitou						2	0:05	0:05	0:10	0
Lac du Bonnet	6	0:05	0:11	0:16	28	20	0:05	0:16	0:21	24
Lake Winnipeg East	12	0:17	0:40	0:57	49	73	0:29	0:34	1:03	48
Pine Falls	3	0:52	0:20	1:12	32	27	0:24	0:14	0:38	21
Bissett	2	0:06	0:16	0:22	19	10	1:24	0:19	1:43	25
Grand Beach						3	0:20	0:18	0:38	49
Hecla						2	1:00	0:30	1:30	58
Riverton	2	0:27	0:22	0:49	73	4	0:32	0:26	0:58	60
Hodgson	3	0:55	1:05	2:00	40	26	0:45	0:45	1:30	36
Gypsumville	4	0:38	0:24	1:02	45	29	0:45	0:26	1:11	28
Lundar						1	0:00	2:00	2:00	20
Winnipegosis	1	0:30	0:30	1:00	30	3	0:20	0:35	0:55	13
Mafeking	3	0:16	1:05	1:21	46	19	0:14	0:32	0:46	32
Grandview/Garland						1	1:00	1:00	2:00	70
Swan River N	1	0:16	0:20	0:36	50	2	0:18	0:22	0:40	40
Hadashville	2	0:15	0:17	0:32	32	21	0:10	0:18	0:28	17
Seven Sisters						10	0:11	0:15	0:26	14
Rennie	5	1:09	0:07	1:16	14	14	0:28	0:10	0:38	12
West Hawk	2	0:10	0:17	0:27	23	6	0:11	0:12	0:23	16
Falcon Lake						4	0:09	0:10	0:19	7
ALL BASES	**91**	**0:24**	**0:29**	**0:53**	**40**	**503**	**0:27**	**0:27**	**0:54**	**33**

Table 42: 1992 Initial Attack Response times and distances by attack base for fires that were actioned on the same day that they were detected

INITIAL ATTACK BASE	NOT DOCUMENTED					MEDIUM HELICOPTER					AIRCRAFT				
	# of fires	det/dis (hh:mm)	dis/supp (avg hh:mm)	det/supp (avg hh:mm)	avg distance (km.)	# of fires	det/dis (hh:mm)	dis/supp (avg hh:mm)	det/supp (avg hh:mm)	avg distance (km.)	# of fires	det/dis (hh:mm)	dis/supp (avg hh:mm)	det/supp (avg hh:mm)	avg distance (km.)
no base indicated						1	0:30	0:15	0:45	30					
Paint Lake						19	0:22	0:30	0:52	85					
Thompson						3	1:15	0:41	1:56	220					
Wabowden	1	0:30	1:00	1:30	60	1	0:02	0:36	0:38	65					
Cross Lake						2	0:05	0:42	0:47	16					
Island Lake						1	2:00	1:30	3:30	166					
God's Narrows															
Oxford House															
Leaf Rapids	1	9:10	0:05	9:15	0										
Pukatawagan						1	0:10	0:15	0:25	6	3	1:03	0:53	1:56	40
Lynn Lake						6	0:08	0:47	0:55	53	3	0:56	0:41	1:37	41
Nelson House						1	0:02	0:13	0:15	15					
Gillam						1	0:35	0:05	0:40	7	2	0:25	0:45	1:10	64
The Pas															
Cranberry Portage						2	0:43	0:16	0:59	40					
Cold Lake															
Snow Lake/Wekusko						11	0:16	0:23	0:39	50	1	0:10	0:55	1:05	45
Grand Rapids															
Cormorant											1	.0:55	0:45	1:40	80
Moose Lake						1	0:45	0:15	1:00	30					
Mafeking															
Swan River						1	0:00	0:10	0:10	45					
Hodgson															
Gypsumville															
Riverton															
Piney															
Grand Beach															
Lac du Bonnet						1	0:08	0:15	0:23	18					
Pine Falls															
Bissett						7	0:27	0:54	1:21	89					
Berens River															
Little Grand Rapids	1	0:20	0:05	0:25	1						1	1:00	0:10	1:10	5
Rennie															
Nutimik Lake															
Falcon Lake															
Hadashville															
ALL BASES	3	3:20	0:23	3:43	20	59	0:23	0:33	0:56	72	11	0:48	0:44	1:32	46

INITIAL ATTACK BASE	GROUND VEHICLE					BOAT					LIGHT HELICOPTER				
	# of fires	det/dis (hh:mm)	dis/supp (avg hh:mm)	det/supp (avg hh:mm)	avg distance (km.)	# of fires	det/dis (hh:mm)	dis/supp (avg hh:mm)	det/supp (avg hh:mm)	avg distance (km.)	# of fires	det/dis (hh:mm)	dis/supp (avg hh:mm)	det/supp (avg hh:mm)	avg distance (km.)
no base indicated	6	0:29	0:18	0:47	7	1	0:22	0:28	0:50	16					
Paint Lake	1	0:00	0:05	0:05	2	1	0:00	0:15	0:15	10					
Thompson															
Wabowden															
Cross Lake						2	0:32	0:52	1:24	13					
Island Lake	4	2:45	0:11	2:56	4	13	0:23	0:27	0:50	10	1	0:15	0:10	0:25	1
God's Narrows	1	0:15	0:15	0:30	3	1	0:20	0:30	0:50	2					
Oxford House	5	0:33	0:28	1:01	4	4	0:45	0:45	1:30	13					
Leaf Rapids											1	0:30	2:45	3:15	60
Pukatawagan	1	2:20	0:10	2:30	2										
Lynn Lake	4	0:17	0:20	0:37	3						1	0:30	0:50	1:20	40
Nelson House															
Gillam	1	1:00	0:20	1:20	20										
The Pas	3	0:28	0:31	0:59	62										
Cranberry Portage	13	0:24	0:24	0:48	20	3	0:15	0:10	0:25	8					
Cold Lake	2	0:25	0:25	0:50	33										
Snow Lake/Wekusko	2	0:52	0:50	1:42	79						4	0:35	0:22	0:57	34
Grand Rapids	6	0:50	0:40	1:30	51						1	0:40	1:25	2:05	50
Cormorant											1	0:10	0:20	0:30	55
Moose Lake	4	0:11	0:26	0:37	14										
Mafeking	11	0:30	0:22	0:52	27						1	2:00	0:30	2:30	65
Swan River	1	0:07	0:58	1:05	75						2	0:26	0:29	0:55	60
Hodgson	7	0:49	0:27	1:16	21										
Gypsumville	11	0:14	0:19	0:33	21										
Riverton	2	0:05	0:10	0:15	28										
Piney	2	0:20	0:17	0:37	26										
Grand Beach	1	0:11	0:07	0:18	7										
Lac du Bonnet	3	0:41	0:20	1:01	20										
Pine Falls	5	0:15	0:12	0:27	28										
Bissett	2	0:13	0:49	1:02	35	1	0:10	0:45	0:55	3	3	0:42	0:24	1:06	44
Berens River	2	0:10	0:17	0:27	3										
Little Grand Rapids						3	2:03	0:42	2:45	4					
Rennie	1	0:15	0:10	0:25	2						3	0:42	0:09	0:51	29
Nutimik Lake	1	0:04	0:08	0:12	4										
Falcon Lake	3	0:06	0:09	0:15	4										
Hadashville	4	0:32	0:37	1:09	47										
ALL BASES	109	0:32	0:23	0:55	23	29	0:35	0:31	1:06	10	18	0:38	0:33	1:11	41

INITIAL ATTACK BASE	ALL FIRES				
	# of fires	det/dis (hh:mm)	dis/supp (avg hh:mm)	det/supp (avg hh:mm)	avg distance (km.)
no base indicated	8	0:28	0:19	0:47	11
Paint Lake	21	0:19	0:28	0:47	78
Thompson	3	1:15	0:41	1:56	220
Wabowden	2	0:16	0:48	1:04	63
Cross Lake	4	0:18	0:47	1:05	14
Island Lake	19	0:58	0:26	1:24	17
God's Narrows	2	0:17	0:22	0:39	3
Oxford House	9	0:38	0:35	1:13	8
Leaf Rapids	2	4:50	1:25	6:15	30
Pukatawagan	5	1:08	0:37	1:45	26
Lynn Lake	14	0:22	0:38	1:00	35
Nelson House	1	0:02	0:13	0:15	15
Gillam	4	0:36	0:28	1:04	39
The Pas	3	0:28	0:31	0:59	62
Cranberry Portage	18	0:24	0:21	0:45	20
Cold Lake	2	0:25	0:25	0:50	33
Snow Lake/Wekusko	18	0:24	0:27	0:51	49
Grand Rapids	7	0:48	0:47	1:35	51
Cormorant	2	0:32	0:32	1:04	68
Moose Lake	5	0:18	0:24	0:42	17
Mafeking	12	0:37	0:23	1:00	31
Swan River	4	0:14	0:31	0:45	60
Hodgson	7	0:49	0:27	1:16	21
Gypsumville	11	0:14	0:19	0:33	21
Riverton	2	0:05	0:10	0:15	28
Piney	2	0:20	0:17	0:37	26
Grand Beach	1	0:11	0:07	0:18	7
Lac du Bonnet	4	0:33	0:18	0:51	19
Pine Falls	5	0:15	0:12	0:27	28
Bissett	13	0:27	0:45	1:12	64
Berens River	2	0:10	0:17	0:27	3
Little Grand Rapids	5	1:30	0:28	1:58	4
Rennie	4	0:35	0:09	0:44	22
Nutimik Lake	1	0:04	0:08	0:12	4
Falcon Lake	3	0:06	0:09	0:15	4
Hadashville	4	0:32	0:37	1:09	47
ALL BASES	229	0:33	0:28	1:01	36

Table 43: Resource requests and placement by region for 1990, 1991, and 1992

Year	REGION	# reported days	# helicopter placements	# waterbomber placements	# of days with no requests	% of total days	# of days with requests	% of total days	helicopters: requests approved	helicopters: requests denied	waterbombers: requests approved	waterbombers: requests denied	helicopter placements/day	CL-215 placements/day
1990	Northeast	112	468	140	80	71.4%	32	28.6%	29	1	2	0	4.18	1.25
	Northwest	108	322	105	89	82.4%	19	17.6%	14	3	1	1	2.98	0.97
	Western	127	66	0	114	89.8%	13	10.2%	8	5	0	0	0.52	0.00
	Interlake	132	95	0	111	84.1%	21	15.9%	3	19	0	0	0.72	0.00
	Eastern	132	332	146	102	77.3%	30	22.7%	21	4	1	4	2.52	1.11
	Southeast	132	27	0	124	93.9%	8	6.1%	6	2	0	0	0.20	0.00
	Southwest	0	0	0	0	0.0%	0	0.0%	0	0	0	0	0.00	0.00
	Whiteshell	130	105	0	107	82.3%	23	17.7%	8	14	0	1	0.81	0.00
	Province	**132**	**1415**	**391**					**89**	**48**	**4**	**1**	**11.93**	**3.33**
1991	Northeast	117	250	113	82	70.1%	35	29.9%	22	8	2	3	2.14	0.97
	Northwest	115	200	166	104	90.4%	11	9.6%	10	1	2	0	1.74	1.44
	Western	123	63	0	106	86.2%	17	13.8%	10	7	0	0	0.51	0.00
	Interlake	123	74	0	114	92.7%	9	7.3%	6	3	0	0	0.60	0.00
	Eastern	123	300	289	112	91.1%	11	8.9%	9	0	1	1	2.44	2.35
	Southeast	123	43	0	122	99.2%	1	0.8%	1	0	0	0	0.35	0.00
	Southwest	0	0	0	0	0.0%	0	0.0%	0	0	0	0	0.00	0.00
	Whiteshell	125	104	0	111	88.8%	14	11.2%	6	6	0	2	0.83	0.00
	Province	**125**	**1034**	**568**					**64**	**25**	**5**	**6**	**8.61**	**4.76**
1992	Northeast	117	323	174	99	84.6%	18	15.4%	13	5	0	0	2.76	1.49
	Northwest	124	134	173	124	100.0%	0	0.0%	0	0	0	0	1.08	1.40
	Western	124	79	0	121	97.6%	3	2.4%	1	2	0	0	0.64	0.00
	Central	124	43	0	124	100.0%	0	0.0%	0	0	0	0	0.35	0.00
	Eastern	124	137	228	119	96.0%	5	4.0%	1	4	0	0	1.10	1.84
	Province	**124**	**716**	**575**					**15**	**11**	**0**	**0**	**5.93**	**4.72**

province. It shows that helicopter transportation constitutes the largest portion of initial attack transport modes, followed closely by ground transport. Aircraft and boat transport appear to be relegated to unique fire roles in specific districts under unique circumstances.

4.7 Resource requests and strategic placement

All daily briefing and situation reports were reviewed to provide a general synopsis of what occurred over the past three fire seasons. Table 43 provides resource placement by region and year, complete with the corresponding documented resources requests.

For the purpose of this comparison a resource placement was considered to be a helicopter, or waterbomber available in a given region on a given day. A request refers to a written request documented on the daily planning sheet. For example, Table 43 shows in 1990 a total of 1415 helicopter placements were made with a total of 89 helicopter requests approved and 48 helicopter requests denied. A helicopter placement/day is calculated by dividing the number of placements by the number of days the region reported. For exsample, in 1990 in the Northeast region, placements were calculated as follows;

$$\frac{\textbf{468 placements}}{\textbf{112 days}} = \textbf{4.18 helicopter placements/day.}$$

In other words the region averaged a documented total of 4.18 helicopters for every day of the fire season.

The helicopter and CL-215 placement days can then be used as a means of comparing one region's equipment levels to another. It should be noted that while the number of placements method does not differentiate between light and medium helicopters, or consider alert levels, it does provide an overall indicator of total cost. For example, if one averages the rate of a contract medium helicopter with a casual light helicopter the following results occur:

contract medium = $1200/hr
(includes availability)

casual hire light = $600/hr

combined total $1800/hr

average = $1800/2 = $900/hr
Based on 4 hr minimums/day

4 X $900 = $3600 for every helicopter placement

Utilizing this average cost of $3600/day, cost calculations can be done based on helicopter placements. Results are shown in Table 44.

Table 44: Helicopter placement figures as compared to actual expenditures

	# helicopter placements	cost/placement	estimated cost	actual helicopter costs/season
1990	1415	$3600	$5,094,000	$4,946,704
1991	1034	$3600	$3,722,400	$3,700,522
1992	716	$3600	$2,577,600	$2,562,248

Since the above cost estimates are close to actual costs one can assume that daily planning sheets are fairly indicative of resources being utilized. Helicopter placements/day decline from a total of 11.93/day in 1990 to 8.61/day in 1991 and to 5.93/day in 1992. Actual financial costs over this period have decreased proportionally.

Over the same period of time the number of requests made to provincial duty officers have declined. In 1990, 64% of helicopter requests were approved, compared to 71% in 1991, and 57% in 1992. In addition to this, the number of days when no requests occurred has increased steadily over the past three years from about 80% in 1990 to about 95% in 1992. This would appear to indicate that the alert systems ability to allocate resource levels is continuing to improve as time progresses or that less resources are needed, and that for the most part the provincial duty officer meets the requested needs of the regional fire managers. In addition to these quantitative derivations from the daily planning sheets, candid qualitative information can be found in Appendix I.

4.8 CL-215 waterbomber analysis

The waterbomber support field of the wildfire report was broken down by action status and method for the past three fire seasons. Table 45 shows that CL-215 utilizatiion occurs approximately 16% of the time when all fires are considered. When only actioned fires are considered this figure improves somewhat to approximately 19% of the time.

In 1990 and 1991 the utilization of CL-215 air support resulted in smaller average fire sizes, but in 1992 Cl-215 actioned fires were noticeably larger. This anomaly can be explained by the fact that several large limited action fires received considerable waterbomber support, which resulted in large hectarage figures being incorporated into the CL-215 category.

The relatively low utilization (19%) by the number of fires actioned must

Table 45 : Three year comparison of waterbomber usage by fire status 1990, 1991, 1992

1992	ACTIONED FIRES				NO ACTION FIRES				LIMITED ACTION FIRES				ALL FIRES			
AIR SUPPORT	# fires	% of fires	area burned (ha)	avg size (ha.)	# fires	% of fires	area burned (ha)	avg size (ha.)	# fires	% of fires	area burned (ha)	avg size (ha.)	# fires	% of fires	area burned (ha)	avg size (ha.)
no bombing support	168	66%	45,046	268	29	100%	81,476	2,810	8	53%	141,083	17,635	205	69%	267,605	1,305
CL-215 support	49	19%	14,706	300					2	13%	88,505	44,253	51	17%	103,211	2,024
helibucket support	27	11%	277	10					3	20%	85,998	28,666	30	10%	86,275	2,876
Otter support	10	4%	62	6					2	13%	302	151	12	4%	364	30
total	254	100%	60,091	237	29	100%	81,476	2,810	15	100%	315,888	21,059	298	100%	457,455	1,535

1991	ACTIONED FIRES				NO ACTION FIRES				LIMITED ACTION FIRES				ALL FIRES			
AIR SUPPORT	# fires	% of fires	area burned (ha)	avg size (ha.)	# fires	% of fires	area burned (ha)	avg size (ha.)	# fires	% of fires	area burned (ha)	avg size (ha.)	# fires	% of fires	area burned (ha)	avg size (ha.)
no bombing support	422	72%	16,092	38	66	100%	95,515	1,447	16	73%	17,506	1,094	504	75%	129,112	256
CL-215 support	103	18%	2,754	27					6	27%	3	0.4	109	16%	2,757	25
helibucket support	49	8%	1,637	33									49	7%	1,637	33
Otter support	14	2%	184	13									14	2%	184	13
Grand total	588	100%	20,668	35	66	100%	95,515	1,447	22	100%	17,508	796	676	100%	133,691	198

1990	ACTIONED FIRES				NO ACTION FIRES				ALL FIRES			
AIR SUPPORT	# fires	% of fires	area burned (ha)	avg size (ha.)	# fires	% of fires	area burned (ha)	avg size (ha.)	# fires	% of fires	area burned (ha)	avg size (ha.)
no bombing support	343	66%	7,987	23	52	100%	3,964	76	395	69%	11,950	30
CL-215 support	93	18%	2,035	22					93	16%	2,035	22
helibucket support	70	14%	2,310	33					70	12%	2,310	33
Otter support	9	2%	65	7					9	2%	65	7
Canso	3	1%	5	2					3	1%	5	2
Grand total	518	100%	12,402	24	52	100%	3,964	76	570	100%	16,365	29

also be considered in the knowledge that there are only 5 waterbombers in the province which are generally stationed in three groups of 2, 2, and 1. Since the bombers usually operate as a group only 2-3 base areas can be serviced each day, with these locations generally being Thompson, The Pas, or Gimli. Consequently, once a bomber becomes committed to a fire, it is unavailable to action other fires which may occur while it is committed. This is coupled with the fact that the CL-215s will generally action a fire that is excess of the capability of the initial attack crews. In the end, the raw numbers appear to indicate CL-215 under untilization, but in reality it may point to a need to acquire more CL-215 waterbombers to increase availability, and spread out utilization.

The wildfire report only provides enough CL-215 related information to identify the general trends that have been described. Comprehensive information regarding times, distances, loads dropped, suppressant utilization, and pick-up times can only be found from air attack officers reports and Cl-215 pilot logs. While these sources were not considered in this evaluation, they were perused and found to be in a formatted but non-computerized state. If these reports and logs, could be tied into a comprehensive database which was cross-referenced by fire number, a detailed suppression effectiveness and efficiency analysis could be conducted on CL-215 usage in Manitoba.

4.9 IFMIS fuels vs. wildfire report fuels

The IFMIS fuels database was found to have an accuracy between 25% and 30%. A complete breakdown by region and year is provided in Tables 46 through 48. The accuracy level remains relatively consistent over the three years. The fuels database appears to be more reliable in the northern regions

Table 46: 1990 Fuels comparison IFMIS vs wildfire report

REGION	IFMIS correct	% correct	IFMIS wrong	% wrong	other fuels	ALL FIRES 1990
Northeast	64	40%	95	60%	13	172
Northwest	26	23%	89	77%	3	118
Southeast	5	25%	15	75%	2	22
Southwest	0	0%	1	100%	0	1
Eastern	21	16%	113	84%	6	140
Interlake	4	11%	31	89%	3	38
Western	3	16%	16	84%	0	19
Whiteshell	7	12%	51	88%	2	60
Province	130	24%	411	76%	29	570

Table 47: 1991 Fuels comparison IFMIS vs wildfire report

REGION	IFMIS correct	% correct	IFMIS wrong	% wrong	other fuels	ALL FIRES 1991
Northeast	88	47%	101	53%	7	196
Northwest	37	32%	77	68%	1	115
Southeast	3	19%	13	81%	0	16
Southwest	2	100%	0	0%	0	2
Eastern	12	8%	143	92%	0	155
Interlake	14	18%	66	82%	3	83
Western	4	8%	45	92%	0	49
Whiteshell	10	18%	45	82%	5	60
Province	170	26%	490	74%	16	676

Table 48 : 1992 Fuels comparison IFMIS vs wildfire report

REGION	IFMIS correct	% correct	IFMIS wrong	% wrong	other fuels	ALL FIRES 1992
Northeast	60	46%	71	54%	1	132
Northwest	27	40%	40	60%	1	68
Western	2	10%	18	90%	0	20
Central	7	23%	23	77%	0	30
Eastern	4	9%	41	91%	3	48
Province	100	34%	193	66%	5	298

than in southern areas. This trend can likely be attributed to the fact that northern areas possess more continuous and homogeneous fuel types, and southeastern areas possess homogeneous grass fuel types mixed with complex forest fuel structures in Eastern Manitoba.

It should be noted that the finest possible fuel cell resolution the database was capable of supporting was used. The IFMIS program does allow for one finer rendition of fuel cells precision, but the Manitoba data is not capable of supporting it.

The accuracy of the fuel cell data limits the use and potential of the system for fire planning to general applications. For example, its usage to provide a provincial scale hazard rating map is acceptable due to the neccesary averaging which occurs to synthesize the data cells to a provincial scale. However, the application of this imprecise fuels database for regional or district hazard prediction is not advised due to the misinformation and false sense of accuracy it could create with local fire management staff.

Towards this end of improving the fuels cell database, the National Fire Information System (NFIS) has commenced to create a comprehensive GIS fuels database based on forestry stand data from the Forestry Branch. This information will provide detailed stand breakdowns to a 50 meter resolution which incorporates other landmarks, such as rivers, streams, roads, hydro lines, bridges, structures, etc., onto a comprehensive database. At the present time, the N.F.I.S. GIS database has been completed for the eastern region, but its use is limited as it is not currently linked to the smoke report and fire prediction modules of the system. Work continues in this regard with the goal of expanding to northern regions as funds permit.

4.10 IFMIS fire growth predictions (FBP) comparison

The average IFMIS (FBP) area predictions were cross-referenced by the fire type, and fire rate fields of the wildfire report to produce a very crude analysis of when the models worked best.

Tables in Appendix J show all FBP fuel types cross compared with actual detection, and arrival sizes, and average IFMIS predicted sizes. The data indicates that predictions reflect actual growths in the following instances;

1) slow moving C1 surface fires
2) moderate moving C3 surface fires
3) all D1 surface fires show good predictions
4) slow, moderate, and fast O1 fuel types show reasonable predictions.

In general, the IFMIS detection assessment module appears to over predict the size of the fire at arrival. While many sources of error can be cited, ie. methodology of the comparison, accuracy of daily weather, homogeneity of the fuel type, perceived observations, etc., that the projection is only as good as the information that goes into it. Ongoing comparisons of this nature should occur to further understand fire behaviour prediction systems.

This exercise also revealed a major error in the 1990, 1991, and 1992 wildfire databases. It was found that many fires had been incorrectly entered as being west of the principal meridian which bisects the province. As a result, many fires in eastern Manitoba, which were documented with the section/township/range description, but the wrong meridian (W1 instead of E1) appeared as fires in western and central Manitoba in the Neepawa and Dauphin districts. Since it is known that the Eastern and Whiteshell regions are entirely east of the prime meridian, the correct meridian was changed on the working database. A thorough checking and correcting of meridians in the master wildfire database should be done before any fire cause and locational data is incorporated into the soon to be developed fire prediction module for the NFIS system, or major errors and location referencing problems will occur.

Chapter 5

Summary, Conclusions and Recommendations

5.1 Summary

Natural Resources Fire Program commissioned this study to determine if the current time and size objectives defined by Fire Program policy are appropriate. The need to review and monitor documented response times and fire sizes stems from the Fire Program's own committment to evaluation and review, coupled with the fact that existing time and size objectives defined in policy were arbitrarily adopted from the Alberta Preparedness System after the 1989 fire season.

This study quantified existing wildfire report data to permit a direct comparison to policy objectives, enabling fire managers to assess their own performance, as well as providing data to determine if existing policies and guidelines are appropriate. In order to properly quantify the existing wildfire data, the following criteria were utilized. First, only actioned fires were incorporated into the evaluation; second, only those fires that were actioned on the same day they were detected were reviewed; and third all measurements of program efficiency at meeting objectives were based upon the time period from detection to suppression arrival.

The actioned fires criteria was used because these fires represent situations the department decided merited an initial attack response. The same day criteria was employed to eliminate the error and elongated dispatch to suppression times associated with fires that are detected and assessed late in the day, but not actioned until the following day. Finally, the evaluation of efficiency was based upon detection to suppression times because report time data (i.e. the time Natural Resources was first notified of a fire) collection only began in 1992. Ideally the time from report to suppression arrival is the correct measurement of the department's responsibility and effectiveness in meeting its objectives, however the more stringent time frame from detection to suppression arrival was employed to ensure continuity existed and a proper comparison was made between the three fire seasons.

5.2 Conclusions

Over the past three years the Natural Resources Fire Program has succeeded in suppressing 95% of the forest fires occurring in Manitoba. This evaluation found that the Fire Program has continued to improve its Initial Attack response system since the 1989 fire season, through the utilization of a structured alert level and reporting system that properly documents resource placement. In addition to this, amendments to the wildfire report have been made to facilitate the documentation of alert levels, report times, and initial attack successes.

Time, size, and distance information found in the 1990, 1991, and 1992 wildfire report databases was evaluated to determine if the policy objectives that were arbitrarily established by the 1989 review were being met, and if these objectives remained appropriate to Manitoba's Fire Program. The following conclusions can be made from the information that was reviewed.

1) The Fire Program is partially meeting the initial attack time objectives of its current alert response system. At alert levels 0 and I, the one hour red zone objective is achieved 72-77% of the time. At level II, the 30 minute red zone objective is attained 48% of the time, and at levels III and IV the 15 minute red zone objective is reached 36% and 33% of the time, respectively. Since this analysis compared the time frame from detection to suppression rather than from report to suppression, the efficiency of meeting set objectives appears slightly lower than what it would have been had report time data been available.

2) Initial attacks which utilize truck transportation account for the largest number of fires when compared to other transportation methods. In addition to this, average travel times and distances associated with truck transportation are lower than any other means of transport. This unexpected efficiency is likely due to the fact that truck transportation and road networks are associated with many district offices within the wooded district, making this transport method highly available. Helicopter transport provides the fastest response over any terrain, however ground transportation was found to provide equal response times to a 30 kilometer, 30 minute range where adequate road networks exist, after which point the helicopter provides a faster response.

3) Documented resource and equipment requests generally reflect a satisfaction with the resources that are being provided. Some repeated requests for equipment for short periods of time during high hazards do occur. In most of these instances, additional machinery and resources are provided, when a valid need exists and the equipment is available to be hired.

4) A trend towards longer detection to dispatch times since the 1990 fire season was found. The absence of report time data in 1990 and 1991 made it difficult to pinpoint the exact cause of this trend, however it is likely related to

the method and manner by which fires are detected. On average it was found that it takes approximately 30 minutes from detection to dispatch, and 30 minutes from dispatch to suppression arrival, resulting in a total response time of about one hour.

5) The .5 hectare detection size objective is only achieved 59% of the time when all fire priority zones are considered. Individually, the percentage efficiency at achieving the objective is as follows: red (68%), orange (43%), yellow (43%), green (51%), and white (32%). The relatively high efficiency found in the lower priority green zone is caused by the high priority nature of the remote communities located within the zone. Since life and property values within these communities result in an immediate response, efficiencies are high even though the priority of the surrounding forest is low (green zone). Considering detection methods, the .5 hectare objective is achieved as follows: railway operations detect 75% of the fires before the .5 hectare size is reached, contract aircraft (69%), helicopter patrol (66%), public cooperation (61%), tower (57%), designated air patrol (55%), ground patrol (55%), aircraft cooperation (55%), and the 1-800 line service (25%). The lower than expected efficiency of the 1-800 service can be accounted for by the fact that most 1-800 calls are incorrectly documented as being public cooperation rather than being distinguished as a 1-800 reported fire.

An important aspect of the .5 hectare detection policy is that it does not differentiate between active detection the department conducts, and passive or cooperative detection the public provides. Since the public is not at task to detect fires before they attain .5 hectares in size, and because public cooperation reported fires account for over half of all fires, the .5 hectare detection objective would more properly be applied only to those detection methods the department actively engages in as part of a structured detection program.

6) Response times in the orange priority zone were found to be longer than one would expect given that this zone has the second highest priority. The Fire Program should determine if this is due to logistical placement problems, or due to a change in status of orange zone values.

7) The alert response system does not always reflect the speed and efficiency of the resouces on hand in many remote communities. For example, a red zone area which is regularly serviced by boat transportation should be afforded an initial attack response time objective that is in keeping with the equipment at hand, or more appropriate equipment should be provided.

8) Resource placement and travel distances are more effective in the south than in the north due to the dispersed nature of resources at multiple points on the landscape. The compactness of southern regions as compared to northern areas allows for more efficient attack coverage. Southern regions also have the benefit of a greater mix of resources with good ground and helicopter integration. The north is generally dependent on helicopter transport.

9) A direct correlation between expenditure levels and documented response times can't be made from the information studied. No instances were found where the lack of staff and machinery due to cost saving measures has affected the ability to successfully respond to a fire. To properly determine any direct linkage between expenditure levels and response times an extensive analysis of all costs associated with general operation, wages, helicopter usage, vehicle mileage, infrastructure maintenance, and capital investment would be required. However there is certainly a linkage between the severity of the fire season and the level of dollars spent. As shown by total cost figures (Table 5), and helicopter placement expenditures (Table 44), expenditures have decreased

steadily since 1990. During this same period 1991 experienced the greatest number of high alert days, followed by 1990, then the 1992 fire season (Table 21). The number of fires occurring on high alert days was also highest in 1991, followed by 1990, then 1992 (Table 20). This correlation between alert levels and expenditures indicates that the 1991 fire season was the most efficient of the three seasons reviewed, since higher hazards were addressed with a lower expenditure than the previous fire season.

The longer response times found in the 1992 season are likely the effects of a cool damp summer which may have afforded a higher confidence to field staff that burning conditions were not as severe as what the alert system was indicating. Since the 1992 season had a large number of low alert level days longer response times would be in keeping with the design of the alert response system. The net result of this is longer response time averages for the 1992 fire season.

10) The fuels database that was derived from N.O.A.A. satellite imagery, and that is utilized by the Intelligent Fire Information Management System (IFMIS), and the National Fire Information System (NFIS) (Tables 46, 47,and 48) is inaccurate and requires replacement. The inaccurate nature of this fuels database is likely caused by the large size of the fuel cells and the imprecise nature of the original satellite imagery. The existing fuels data is more accurate in northern areas than in southern locations due to the homogeniety of northern fuel types. Since southern areas generally possess more complex fuel types, the chances of the database having the correct fuel type are lower. Fire managers should be aware of the error associated with the fuels database and verify or input fuel information manually if it is possible. This testing of the database by location was instrumental in discovering key punch errors associated with the

principal meridian on some fire reports which were referenced by the township system.

11) Further utilization and research is required to determine the operational applications for the Fire Behaviour Prediction (FBP) modules of the IFMIS and NFIS fire information programs. Initial comparisons done in this study (Appendix J) indicate that the formulas and calculations associated with fire behaviour and growth prediction produce good results under certain conditions. The importance of inputting precise information is integral to the successful application of these fire growth models. The crudeness of the existing fire behaviour data recorded on the wildfire report may be responsible for more inaccurate predictions than the growth model programs that were utilized.

5.3 Recommendations

The following recommendations are made to the Fire Program as a result of this study:

1) The Fire Program should amend its level III and level IV red and orange zone objectives from 15 minutes to 30 minutes. A 30 minute objective (report to suppression arrival) will provide a more realistic goal for the Fire Program to maintain and to be measured against. Since the original 15 minute objective was arbitrary and was a reflection of what the Alberta alert response system was capable of achieving with its level of resources, it can be argued and proved that a 30 minute objective is in keeping with Manitoba's current preparedness system and the level of resources it has had available in the past three fire seasons. The level of preparedness and efficiency associated with a 30

minute objective is appropriate for Manitoba when one considers these times were concurrent with a 95% initial attack success rate.

A 30 minute attack time objective is not likely to result in longer response times since Manitoba's fire crews have demonstrated that they respond as quickly as possible every time they are called upon to do so. Regardless of what the objective is, fire crews will still have response times of 2, 5, 15, 20, 40, and 100 minutes, but a realistic measure of efficiency is required if meaningful evaluation is desired. Setting the policy objective to 30 minutes does not preclude the utilization of a 15 minute criteria for internal review and discussion. For example, since the last three seasons have shown that 15 minutes is attainable 35% of the time, it is not unreasonable for fire managers to expect this level of 15 minute efficiency to be maintained within a 30 minute time objective. Finally, the ongoing analysis and review of response time distributions at 15 minute intervals should continue to ensure that proper responses and policies are maintained. Future research in this regard should be standardized to measure efficiencies from report to suppression, rather than from detection to suppression.

2) The Fire Program should also review the needs and dynamics associated with alert level IV. Since the data indicates that the system is not following its designed intent at level IV, the Fire Program should determine why this is occurring and what can be done to correct the trend.

3) The efficiency of the fire-tac truck should not be underestimated in areas where good road access exists and where fires are actioned within a 30 kilometer, 30 minute range. Initial attack coverage must focus on utilization of

all transport methods at one's disposal, rather than being predisposed to always requiring a helicopter. This integration of resources will be more applicable to developed regions than to remote areas.

4) The documentation of daily resource levels and placements should continue and be enhanced where it is possible. The need exists to develop an integrated computer database that documents resources by location, day, cost, alert level, and type of fire action. Such a source of information would facilitate future evaluations in an efficient manner and eliminate the need to manually review request sheets. The computerization of daily planning and situation report sheets would be a first step at addressing this concern.

5) The trend toward longer detection to dispatch times should be investigated in future fire seasons. The utilization of the report time parameter should permit analysts to determine if delays are external (detection to report) or internal (report to dispatch). The continued monitoring of all time parameters based on 15 minute frequency distributions will begin the process of standardizing yearly comparisons.

6) The detection program should be reviewed to determine the application of the .5 hectare detection objective. Initial efforts should focus on applying the objective only to departmental detection initiatives, with secondary efforts being directed at determining what level of efficiency has been achieved in the past when a large structured detection program existed. Research is required to determine if structured detection can achieve the .5 objective in addition to determining if a floating detection objective; i.e. .1 hectare at level 4

and 2 hectares at level 0 and 1 would more properly reflect initial attack needs and the abilities of crews to be successful under increasing hazard conditions.

7) Resource placement and positioning to protect the orange zone must be reviewed to develop better response times in this zone. If the issue is the result of a changed priority in the orange zone, the priority map should be amended to reflect this change.

8) The attack times associated with boat transport should be reviewed to determine if this method of transport is in keeping with the resources being protected. Longer boat response times to protect green zone forests may be acceptable, but their application to fires directly in or adjacent to remote communities or high forest priorities, may require further review and discussion.

9) The Fire Program should monitor attack time efficiencies on a regional basis to better understand those factors relating to geographic and logistical differences, and those factors that occur due to planning and procedural differences. Improvements based on procedures and planning differences should be investigated to determine if efficiencies in one area can be transplanted to result in improved results in other locations.

10) The improvements the Fire Program has made with regards to cost itemization and resource use by fire number should continue. As new computerized administrative programs are developed, cost data should be formatted in such a manner to permit its utilization in future cost + loss analysis.

A comprehensive relational database that permits the referencing by fire number that permits all cost information regarding a particular fire to be compared with wildfire report information for the same fire should be pursued.

11) Replacement of the N.O.A.A. satellite fuels database with forestry stand GIS information should continue so that the Intelligent Fire Management Information System (IFMIS) and the National Fire Information System (NFIS) can be utilized to their fullest potential. In addition to this, meridian references in 1990, 1991, and 1992 fire reports should be cross-referenced by region and district number to correct for any data entry errors that have occurred.

12) The utilization and validation of fire behaviour prediction systems should continue with the goal of refining the accuracy of the information that is entered into the models. Ongoing analysis of fire behaviour fields found in the wildfire reports should continue to gain greater knowledge of how documented and predicted behaviour compare.

13) Information regarding waterbomber and helicopter usage at the fire site is currently being documented by air attack officers and should be computerized so that future analysis can be done. The application of this information to future studies will be valuable in determining the efficiencies of specific resource mixtures. A comprehensive method must also be developed to evaluate the efficiencies of helicopter detection patrols (loaded patrols). Such a method would have to account for how fire distances and times are referenced, as well as incorporate the number of uneventful patrols that were flown with no fires detected.

This evaluation of Manitoba's Forest Fire Preparedness System has shown that the structured approach developed after the 1989 fires yields results and sets out an excellent basis for evaluation. The study provides the Fire Program with the basis to set 'made-in Manitoba' policy benchmarks that have been demonstrated to work for Manitoba over the past three fire seasons. Finally, this evaluation has documented the type of research and analysis that can be done to improve forest fire management and planning in Manitoba.

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Appendix A Operational Guideline F030105

Operational Guideline

Manitoba
Natural Resources
Regional Services

INDEX NUMBER	F 0 3 0 1 0 5
REVISION NUMBER	

SUBJECT: PRIORITIES - INITIAL ATTACK RESPONSE SYSTEM	DATE ISSUED 92 04 14 (Y R M O D Y)	DATE REVISED (Y R M O D Y)
	APPROVED	PAGE 1 OF 2
SUB-PROGRAM: Suppression	Director Regional Services	

INTENT

To ensure that all fires occurring in Manitoba's primary protection area receive an appropriate initial attack response based on the risk of fire ignitions, the potential fire behaviour, and the values at risk.

DEFINITION

Response Level 0	-	Stand Down.
Response Level 1	-	60 minute initial attack response time.
Response Level II	-	30 minute initial attack response time.
Response Level III	-	15 minute initial attack response time.
Response Level IV	-	15 minute initial attack response time.

NOTE: In lower priority forested areas, i.e. green and yellow fire priority zones, the Response Level III and IV initial attack response time shall be 30 minutes.

PROCEDURES

NOTE: This guideline is to be used in conjunction with the "Operational Procedures - Initial Attack Response System" paper as revised April 1, 1992.

1. In order to determine Alert Levels and Man-Up requirements, the following list of essential data is required:

   a) Actual weather observations and F.W.I. system indicies for 13:00 hours.

   b) Forecasted F.W.I. system indicies for noon the next day.

   c) Forecasted weather information (including general forecast, 3 to 5 day outlook, 500 mb data).

   d) Lightning Location Maps.

   e) Information on equipment and manpower availability.

   f) Local knowledge and experience.

2. Use forecasted weather information for noon the next day (usually available by 14:30 each day), to determine the "Calculated" Fire Danger/Response Levels from Tables 1 and 2.

3. Complete Daily Planning Sheet (Table 4) to ascertain the Requested Response Levels.

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4. Once the Request Response Level has been ascertained, refer to Appendices B, C, D, and E to determine:

   a) initial attack resource requirements necessary to meet the Requested Response Level. Predesignated bases located across the Province are to be manned so that the initial attack response objective (60, 30, or 15 minutes) can be met.

   b) detection requirements.

5. Prevention requirements and travel restrictions should also be considered as necessary.

6. Complete Initial Attack Response - Resource Requests Sheet (Table 5) and request additional Resources as necessary to meet Total Resource Requirements.

7. Any increase in resources above those available within the Region must be arranged through and agreed to by the Provincial Duty Officer.

8. Whenever it is necessary to allocate fewer resources than those required under the Initial Attack Response System, due consideration will be given to values at risk, past fire history, priorities elsewhere in the Province, and other relevant factors. Additional Resources "Allocated" will be clearly shown and explained in Table 5 by the Provincial Duty Officer.

Appendix B Fire Program Policy PO/15/02, June 8, 1990

Policy Directive

Manitoba
Natural Resources

Subject:	Fire Program Policy	Index Number PO 13.02	Revision Number 00
		Approved	Date Issued June 8, 1990
Division/ Branch	Regional Services	Page 1 of 3	Date of Revision

INTENT: To establish general policy objectives and provide direction regarding the Department of Natural Resources forest fire program.

POLICY: A. Mandate

As the primary forest fire protection agency in the Province, the Department has a mandate under the Fires Prevention Act to directly provide and/or support fire protection within the wooded districts and unorganized territory and to assist in fire control outside of these areas when necessary and/or requested-subject to availability of resources and values at risk.

B. Priorities

i) Life

ii) Significant property values including forestry and other resource values.

In the event of multiple fire starts and/or large fires it may be necessary to assign priorities between property values (e.g. homes, cottages, lodges) and resource values (e.g. valuable timber stands). In such cases, decisions will be required in setting priorities based on overall values at risk. For example, it may be necessary to assign a higher protection priority to valuable current prime forestry cutting areas than remote property values such as cottages, trappers cabins, wilderness lodges, etc.

C. Overall Objectives

The overall objectives of the fire program are

i) to protect life, property and other resources from wildfires.

ii) to provide levels of protection consistent with the values at risk.

iii) to minimize total costs plus losses.

D. Protection Zones

There are 3 fire protection zones within the Province where the department's fire response varies as follows (Refer to Figure 1):

i) Primary Protection Zone - This zone constitutes much of the wooded district and contains most of the Province's commercially valuable timber resources. Within this zone the Department will carry out an immediate initial response on all fires and will conduct an initial attack whenever values warrant and suppression resources are available. Initial attacks that have failed will require an escaped fire analysis with continued action determined based on values at risk, avail-ability of suppression resources and estimated suppression costs.

ii) Observation Zone - Within this zone an initial response is taken only if life is at risk and/or property values warrant a suppression response.

iii) Agricultural Zone - Within this zone fire action is generally the responsibility of another agency (Rural Municipality or Local Government District). However, the Department will assist these agencies when necessary and/or when requested - subject to availability of resources and values at risk.

E. Responsibility for Suppression Costs

Where the Department assists another agency (e.g. Rural Municipality or Local Government District), the costs of any suppression action taken by the Department will be invoiced only when, in the opinion of the Minister, reasonable suppression efforts were not taken by the agency.

F. Fire Priorities Map

Within the primary protection zone, the Department will establish priority levels based on the forestry and other resource values at risk. A map depicting these priorities will be prepared for use in determining priorities when adequate resources are not available to man-up in all areas or in the event of multiple fire starts.

G. Base Level of Suppression Resources and Initial Attack Response System

Each year, the Department shall station sufficient suppression resources throughout the primary protection area to provide and support rapid initial attack. The base level of such resources will be aimed at achieving a 60 minute response from fire report to initial attack. An initial attack response system will be maintained which provides a systematic basis for determining initial attack response requirements as the fire danger conditions change. As the "alert" level increases, the Department's initial attack response time will be reduced from the normal 60 minutes to either 30 minutes or 15 minutes. This more rapid response will require additional initial attack crews, aircraft and equipment which will be hired and charged to the extra-suppression account as man-up costs.

H. Specific Objectives

i) to minimize the number of human-caused fire starts

ii) to detect fires while they are not more than .5 hectares in size

iii) to report fires within 5 minutes of detection

iv) to arrive at fires within 60, 30 or 15 minutes of report as dictated by the alert response system

v) to control fires upon initial attack before they reach 1.2 hectares in size

vi) to minimize the area lost to fires within the primary protection zone - with lowest percentage losses within the higher priority areas.

The success of the Department in meeting the objectives will also be determined by such factors as:

- the base level of suppression resources provided
- severity of fire weather conditions
- availability of resources to man-up as fire danger increases
- multiple fire starts

Appendix C Text of the original circular letter of May 7, 1935 which outlined the 10:00A.M. Policy in the United States

The approved protection policy on the National Forests calls for fast, energetic and thorough suppression of all fires in all locations, during possibly dangerous fire weather.

When immediate control is not thus attained, the policy then calls for prompt calculating of the problems of the existing situation and probabilities of spread, and organizing to control every such fire within the first work period. Failing in this effort the attack each succeeding day will be planned and executed with the aim, without reservation, of obtaining control before ten o'clock of the next morning.

In order to bring out the policy in sharp relief for discussion by the Conference all written interpretative material was stripped from it. However, I believe it is now time for Operation to issue such instructions as may seem necessary to have the policy put into full effect during the coming fire season. These will be sent you within the next few days.

I am confident that the sum total of costs plus losses of all classes will be lower in the long run under this policy than they have been under comparable conditions heretofore. To this end, I am adding the following notes for consideration in placing it into effect:

It may not be clear from the wording of the policy but it is obvious, nevertheless, that the objective sought also projects that policy into pre-suppression, since only by strengthening the pre-suppression forces in some quarters can the action contemplated be realized. This may call for increasing the standard of detection; plugging holes with additional fireman where so-called fireman or smoke chaser travel time is known to be longer than limits of safety; advanced placement of trained fire suppression crews to be held at carefully selected travel time limit centers. After full use of CCC, , improvement and similar available man power, these additional pre-suppression sources likely can be provided in the main only by drawing upon FF. To the extent that carefully thought out plans make this necessary, you are authorized to draw upon funds from that source to enable the building up of the pre-suppession forces to required strength.

Subject to the action required to meet the above quoted policy, expenditures for preparedness and suppression will be held to the absolute minimum, and will vary with the total of the tangible and intangible values endangered; being higher, if necessary, where values are high than in areas where values are low. In lower value country this may call for dropping back to more easily held lines no great distance from the fire front, and from these lines taking definite and prompt action to extinguish the fire. In such country lower expenditures will also be expected for fire breaks and other types of improvements, than would be justified were higher values involved.

No fixed rule can be given to meet every situation; the spirit implied in the policy itself will determine the action to be taken in doubtful situations.

F.A. Silcox
Forester

Appendix D Wildfire Report format

Wildfire Report

Manitoba Natural Resources

IDENTIFICATION

			YY MM DD	Signature	Title
Region:	Region Fire No.: 0020				
District: 03		Fire Boss	92 07 22		NRO II
Fire No.: 001		Officer in Charge	92 07 22		NRO III
		FCO/Superintendent	92 08 11		F.C.C

Location: L.S.	Sect.	Township	Range	
and/or	Latitude 56 - 04		Longitude 95 - 34	
Zone: 4	Area: 1	Action: 1	Reason: 1	
Ownership: 01	Number:		Status: 02	
If Other; write in:				

HISTORY (to be completed by District Office)

RECEIVED JUL 30 1992

Fire Time	YY	MM	DD	HH	MM
Ignition		06	14		
Detected		06	14	11	30
Reported		06	14	11	40
Dispatch		06	14	11	45
Suppression/Arrival		06	14	12	30
Controlled		06	23	08	00
Extinguished		08	07		

Fire Size: (to 1/10 ha)	
Detected	20
Init. Supp.	250
Control	2500
Final Size	2500

Initial Attack	Successful?	Yes X	No [redacted]
Type 3	Base 113	[redacted]	40
Dist. from fire (km)	64		2
Pumping Distance (ft.)			10
Air Attack	Yes X	No	
Bombing Support Type	01	Type	02
Distance Base from Fire (km)			150
Fuel Type			
Pt. of origin (Surface)	1	Rate of Spread	5
FBPS Fuel Type	C1	Fire Type	3

Standard Cause:			Detection:	
General Activity	05	Kn/Sus 1	Method	4
Specific Activity		Kn/Sus	Reported by	
Cause		Kn/Sus		
Fire Investigation Conducted		Yes X	No	
Major Factor Influencing Fire		01		
If other write them in remarks below				

(Type) - Hetitue point Lake, 7 crews EFF's, CL 215, B-206, Islander hauling equipment from Gillam to Ilford.
- Also reported through TIP LINE

TO BE COMPLETED BY REGION Gillam

Fire Weather: Nearest Station C42 — Distance From Fire (km) 064

Index Readings:	FFMC	DMC	DC	ISI	BUI	FWI
Ignition	87.7	27.4	148.5	4.8	37.5	11.0
Detected	↓	↓	↓	↓	↓	↓
Suppression/Arrival	↓	↓	↓	↓	↓	↓
Controlled	86.0	51.0	203.0	7.0	62.6	19.3

Alert Level at Nearest Weather Station	
Actual at Detection	I ~~IV~~
Adjusted at Detection	I ~~IV~~
Actual at Suppression	I ~~IV~~
Adjusted at Suppression	I ~~IV~~

Suppression Costs (thousands) $

Costs to be Invoiced Yes ✓ No ___

Invoiced to C. N. Railway

ADDITIONAL REMARKS

- Fire was 200 yds off Ilfords East fireguard.
- Fire started as a result of Faulty journal on the train
- Fire case book done and charge back report
- June 17th fire jumped to a ridge, was controlled by the next evening.
- 1 hr to do fire report

FIRE PROGRAM AUG 19 92 ENTERED BY

Appendix E Briefing Agenda, Provincial Operating Plan, Daily Planning and Request Sheets

FIRE PROGRAM BRIEFING AGENDA & PLANNING SHEET

DATE: SEPTEMBER 08, 1992 TIME: 15:30

1. WEATHER BRIEFING, DISCUSSION AND SUMMARY NOTES:

DAY 1 - NORTH - WED - MOSTLY CLOUDY WITH SHWRS, HI 7-11, WIND NW 20

SOUTH - WED - MOSTLY CLOUDY SCT SHWRS, HI 16-20, WIND NW 20

DAY 2 - NORTH - THUR - MOSTLY SUNNY, POP 30%, HI 13

SOUTH - THUR - MAINLY SUNNY, SUNNY, HI 17

DAY 3 - NORTH - FRI - MOSTLY CLOUDY WITH SHWRS, POP 60%, HI 15

SOUTH - FRI - MOSTLY CLOUDY, POP 40%, HI 21

2. CURRENT FIRE SITUATION:

A. PRESENTATION AND DISCUSSION OF PROVINCIAL SUMMARY:

NEW STARTS 3

O/C ____ B/H ____ N/A 3 B/W 4 U/C ____ TOTAL 290 HA 346,491

B. NEW STARTS/AREAS OF CONCERN:

NE 3 FIRES RECORDED FROM OLD LIGHTNING, THESE WERE KNOWN LOW PRIORITY FIRES

NW ____

WE ____

CE ____

EA ____

3. ADDITIONAL RESOURCE REQUIREMENTS TO MEET ALERT LEVELS:

NE ______________________________

NW ______________________________

WE ______________________________

CE ______________________________

EA ______________________________

5. RESOURCES REQUIRED FROM OUTSIDE THE PROVINCE:

CREWS NIL

EQUIPMENT NIL

AIRCRAFT NIL

6. RESOURCES AVAILABLE FOR OUT-OF-PROVINCE USE:

CREWS NONE

EQUIPMENT NONE

AIRCRAFT 1 CL 215 GROUP

7. OTHER ITEMS: ______________________________

MANITOBA NATURAL RESOURCES - FIRE PROGRAM
PROVINCIAL OPERATING PLAN

DATE: 92-09-04 **VALID FOR:** 92 09 05

REGION	NE	NW	WE	CE	EA
FORECASTED ALERT LEVEL	O/I	O/I	O	0	0
AIRCRAFT DISPOSITION					
BOMBERS OTTERS	BD1 (JAX)				250 BD2 251 252 253 254 ODY
CONTRACT HELICOPTERS	VEG(204) EKM(206)				MHA(205) REPLACING MHC CONTRACT #4
CASUAL HELICOPTERS					

I. A. CREWS

REGION:	NE	NW	WE	CE	EA
COMMITTED	0	0	0	0	0
AVAILABLE	2	3	2	2	2.5

OVERHEAD TEAMS:

ALERTED?	YES	NO	TEAM#	STATUS:
		X		

REMARKS OR POTENTIAL PROBLEM AREAS AND NEEDS:

HEADQUARTERS OFFICE WILL BE CLOSED THIS WEEKEND.
THE DUTY OFFICER CAN BE REACHED AT: 945-5252 OR 941-0568.

APPROVED: DICK BON

TABLE 4. INITIAL ATTACK RESPONSE SYSTEM – DAILY PLANNING SHEET

REGION: NORTHEAST

Date Completed: Sept 4/92 **Date Valid For:** Sept. 5/92

Weather Stations:	Wab	Puk	God's	Oxford	Cross	Leaf	Lynn	Gillam	Norway	Island	Thompson
"Calculated" Fire Danger/Response Level	I	I	O	O	O		O	O	O	O	I
Response Level Adjustment Factors											
Potential for Ignition											
–Man–Caused – FFMC Danger Class	low	low	nil	nil	low		nil	low	low	low	low
– Forest Use (long weekend, stubble burning, fishing season, etc.)											
–Lightning – DMC Danger Class	nil	mod	nil	nil	nil		nil	nil	nil	nil	low
– lightning or dry lightning occurred or predicted											
–Other –Historical Occurrences											
–Arson, Railway, or Industrial Activities											
Potential Fire Behaviour											
–Rate of Spread – ISI Danger Class	low	low	nil	nil	nil	DATA	nil	nil	nil	nil	low
–Fuel Availability – BUI Danger Class	low	mod	nil	nil	nil		nil	nil	nil	nil	low
–Other (e.g., crowning potential, unique fuel type – slash, grass etc., green–up)											
Potential Suppression Difficulty											
–Suppression Difficulty – FWI Danger Class	low	mod	nil	nil	low	NO	nil	low	low	nil	low
–Mop–up Difficulty – DC Danger Class	mod	high	low	low	low		mod	mod	low	low	high

Weather Forecast Comments:
–24–72 hour Forecast, Frontal Passages
500 mb Breakdown, etc.

Waterbomber Availability or Quick Strike Comments:

Values at Risk Comments:

	Wab	Puk	God's	Oxford	Cross	Leaf	Lynn	Gillam	Norway	Island	Thompson
REQUESTED RESPONSE LEVEL	I	I	O	O	O		O	O	O	O	I

TABLE 5. INITIAL ATTACK RESPONSE - RESOURCE REQUESTS

REGION: NORTHEAST

DATE VALID FOR: Sept 08/92.

A) TOTAL RESOURCE REQUIREMENTS (Based on Requested Response Level):

ATTACK BASE	CALC. DANGER LEVEL	REQUESTED RESPONSE LEVEL	ATTACK TIME	I.A. CREWS		AIRCRAFT*			HEAVY EQUIP		DETECTION		
				COMM.	AVAIL	LR	MR	WB	DOZ	SKID	FW	T	LP
WABOWDEN	I	I	60										
PUKATAWAGAN	I	I											
GODS NARROWS	O	O											
OXFORD HOUSE	O	O											
CROSS LAKE	O	O											
LEAF RAPIDS	NO DATA												
LYNN LAKE	O	O											
GILLAM	O	O											
NORWAY HOUSE	O	O			1								
ISLAND LAKE	O	O											
THOMPSON	I	I					BD I	JAX					
PAINT LAKE	I	I			1	EQU	VEG						
NELSON HOUSE	I	I											
MOLSON LAKE	O	O											
BLUEBERRY H.	I	I											
HILL LAKE	I	I											
ILFORD/KELSY	O	O	60		2								

* Aircraft not in place should be shown in brackets

FIRE PROGRAM
SEP 0 8 92
ENTERED BY:

B) ADDITIONAL RESOURCES "REQUIRED" TO MEET REQUESTED RESPONSE LEVELS:

1) Helicopters ______

2) Waterbombers ______

3) Crews ______

4) Other ______

REGIONAL DUTY OFFICER: ______

C) ADDITIONAL RESOURCES "ALLOCATED": ______

D) COMMENTS (H.O.'s Reasons for Differences Between "Required and Allocated Resources):

______

PROVINCIAL DUTY OFFICER: ______

Appendix F Glossary of selected Canadian forest fire terms

GLOSSARY OF SELECTED CANADIAN FOREST FIRE TERMS

Airtanker - A fixed-wing aircraft fitted with tanks and equipment for dropping suppressants or retardants on fires. Synonyms - Fire Bomber and Water Bomber.

Anchor Point - An advantageous location, usually a barrier to fire spread, from which to start or finish construction of a control line.

Backfire - A fire spreading, or set to spread, into or against the wind

Campaign Fire - A fire of such size, complexity and/or priority that its extinction requires a large organization, high resource commitment, significant expenditure, and prolonged suppression activity. Synonym - Project Fire.

Canadian Forest Fire Weather Index (FWI) System - A subsystem of the Canadian Forest Fire Danger Rating System; referred to previously by a variety of names (e.g., Canadian Forest Fire Weather Index, Canadian Fire Weather Index, Canadian Forest Fire Weather Index Tables). The six components of the FWI System provide numerical ratings of relative fire potential in a standard fuel type (i.e., a mature pine stand) on level terrain, based solely on consecutive observations of four fire weather elements measured daily at noon (1200 hours local standard time or 1300 hours daylight saving time) at a suitable fire weather station; the elements are dry-bulb temperature, relative humidity, wind speed, and precipitation. The system provides a uniform method of rating fire danger across Canada.

The FWI System consists of six components. The first three are fuel moisture codes that follow daily changes in the moisture contents of three classes of forest fuel: higher values represent lower moisture contents and hence greater flammability. The final three components are fire behaviour indexes representing rate of spread, amount of available fuel, and fire intensity; their values increase as fire weather severity worsens.

The six standard codes and indexes of the FWI System are:

Fine Fuel Moisture Code (FFMC) - A numerical rating of the moisture content of litter and other cured fine fuels. This code indicates the relative ease of ignition and flammability of fine fuel.

Duff Moisture Code (DMC) - A numerical rating of the average moisture content of loosely compacted organic layers of moderate depth. This code indicates fuel consumption in moderate duff layers and medium-sized woody material.

Drought Code (DC) - A numerical rating of the average moisture content of deep, compact, organic layers. This code indicates seasonal drought effects on forest fuels, and the amount of smouldering in deep duff layers and large logs.

Initial Spread Index (ISI) - A numerical rating of the expected rate of fire spread. It combines the effects of wind and FFMC on rate of spread but excludes the influence of variable quantities of fuel.

Buildup Index (BUI) - A numerical rating of the total amount of fuel available for combustion that combines DMC and DC. (Referred to as the Adjusted Duff Moisture Code or ADMC between 1969 and 1975).

Fire Weather Index (FWI) - A numerical rating of fire intensity that combines ISI and BUI. It is suitable as a general index of fire danger throughout the forested areas of Canada.

Control Line - A comprehensive term for all constructed or natural fire barriers and treated fire perimeter used to control a fire. see Fireguard and Fireline.

Day Basing - A procedure whereby initial attack resources are positioned away from their regular administrative or operational base for a burning period, in anticipation and readiness for fires that may start in a given area. A procedure used primarily in areas where there is a high probability of lightning and very high fire danger. (Term used primarily in Alberta.)

Direct Attack - see **Fire Suppression, Direct.**

Drought Code - see **Canadian Forest Fire Weather Index System.**

Duff - The layer of partially and fully decomposed organic materials lying below the litter and immediately above the mineral soil. It corresponds to the fermentation (F) and humus (H) layers of the forest floor. When moss is present, the top of the duff is just below the green portion of the moss.

Duff Moisture Code - see **Canadian Forest Fire Weather Index**

Elapsed Time - The difference in time between the beginning of any action and its actual accomplishment; in fire fighting operations it is customarily divided into:

Discovery Time - The period from start of a fire (estimated or known) until the time of discovery.

Report Time - The period from discovery of a fire until the first person charged with initiating suppression action is notified of its existence and location.

Get-Away Time - The period from receipt of report of a fire by the first person responsible for suppression until departure of the initial attack force. Synonym -**Response Time**.

Travel Time - The period between departure of the initial attack force for a fire and its arrival at the fire.

Attack Time - The period from receipt of first report of a fire to start of actual fire fighting; includes both **get-away** and **travel time**.

Control Time - The period from initial attack until the fire is controlled.

Mop-up Time - The period from achievement of control until enough work has been done to ensure the fire can not rekindle.

Extra Fire Fighters (EFF) - Personnel other than regular employees or seasonally employed crews, hired on a casual basis to work on fires or provide man-up for short-term preparedness.

Fine Fuel Moisture Code - see **Canadian Forest Fire Weather Index System.**

Fine Fuels - Fuels that ignite readily and are consumed rapidly by fire (e.g., cured grass, fallen leaves, needles, small twigs). Dead fine fuels also dry very quickly. Synonym - Flash Fuels.

Fire Danger Rating - The process of systematically evaluating and integrating the individual and combined factors influencing fire danger represented in the form of fire danger indexes.

Fire Front - The strip of primarily flaming combustion along the fire perimeter; a particularly active fire edge. Fine fuels typically produce a narrow fire front, whereas dry heavy fuels produce a wider zone or band of flames. Synonym - Flaming Front.

Fireguard - A strategically planned barrier, either manually or mechanically constructed, intended to stop or retard the rate of spread of a fire, and from which suppression action is carried out to control a fire. The constructed portion of a control line.

Fireline -

(1) That portion of the fire upon which resources are deployed and are actively engaged in suppression action. In a general sense, the working area around a fire.

(2) Any cleared strip used to control a fire. Loosely synonymous with fireguard.

Fire Perimeter - The entire outer edge or boundary of a fire. Recommended SI units are metres (m) or kilometres (km) (1000 m is equal to 1.0 km).

Fire Risk - The probability or chance of fire starting determined by the presence and activities of causative agents (i.e., potential number of ignition sources).

Fire Suppression - All activities concerned with controlling and extinguishing a fire following its detection. Synonym - Fire Control.

Methods of suppression are:

Direct Attack - A method whereby the fire is attacked immediately adjacent to the burning fuel.

Parallel Attack - A method whereby a fireguard is constructed as close to the fire as heat and flame permit, and burning out the fuel between the fire and the fireguard.

Indirect Attack - A method whereby the control line is strategically located to take advantage of favourable terrain and natural breaks in advance of the fire perimeter and the intervening strip is usually burned out or backfired.

Hot Spotting - A method to check the spread and intensity of a fire at those points that exhibit the most rapid spread or that otherwise pose some special threat to control of the situation. This is in contrast to systematically working all parts of the fire at the same time, or progressively, in a step-by-step manner.

Cold Trailing - A method of determining whether or not a fire is still burning, involving careful inspection and feeling with the hand, or by use of a hand-held infrared scanner, to detect any heat source.

Mop-up - The act of extinguishing a fire after it has been brought under control.

Fire Weather Forecast - A prediction of the future state of the atmosphere prepared specifically to meet the needs of fire management in fire suppression and prescribed burning operations. Two types of forecasts are most common: The zone or area weather forecast is issued on a regular basis during the fire season for a particular geographical region and/or one or more fire weather stations. These regions are delineated on the basis of fire climate and/or administrative considerations. A spot weather forecast is issued to fit the time, topography, and weather of a specific campaign fire location or prescribed fire site. These forecasts are issued on request and are more detailed, timely, and specific than zone or area weather forecasts.

Fire Weather Index - see **Canadian Forest Fire Weather Index System.**

Forest Floor - The organic surface component of the soil supporting forest vegetation; the combined duff (if present) and litter layers.

Get-Away Time - see **Elapsed Time**.

Helitack - **Initial attack** on wildfires involving the use of helicopters and trained crews, deployed as a complete unit.

Helitack Crew - An **initial attack crew** specially trained in the tactical and logistical use of helicopters for fire suppression.

I.F.M.I.S. - Intelligent Fire Management System, decision support software package developed by Forestry Canada

Indirect Attack - see **Fire Suppression, Indirect.**

Initial Action - The steps taken after the report of a fire and before actual fire fighting begins on it. Note **Initial Attack.**

Initial Attack - The action taken to halt the spread or potential spread of a fire by the first fire fighting force to arrive at the fire. see **Initial Action.**

Initial Attack Base - Any place where **initial attack** capability has been positioned in readiness for probable fire action. The forces must have air and/or ground transport capability on site.

Initial Attack Crew - A crew specifically hired, trained, equipped, and deployed to conduct **initial attack** on wildfires. Also see **Helitack Crew**.

Initial Attack Resources - Fire fighting resources funded and organized specifically for the prime objective of implementing **initial attack** on wildfires (e.g., airtankers, **initial attack crews, helitack crews**).

Initial Spread Index - see **Canadian Forest Fire Weather Index System**.

Lightning Locator System - A network of electronic field sensors linked to a central computer to detect, triangulate, plot the location, and record cloud-to-ground lightning flashes in real time over a large predetermined area.

Limited Action Fire - A fire that is receiving little or no suppression action, especially beyond **initial attack**, because of resource management priorities, fire load or other agency constraints. A fire on which any action taken is less than the agency's normal standard for full suppression. May involve one or more of the following conditions: a decision to let the fire burn freely, reconnaissance and mapping only, resource staging to await more favourable control conditions, site-specific action to protect a local value, **mop-up** of fire perimeter once weather conditions facilitate easy control.

Limited Action Zone - Any predetermined area within an agency's jurisdiction where fires will be allowed to burn without full suppression effort to control. Fires may receive **initial attack** in some situations but follow up after escape is always limited. Such a zone is generally established formally to recognize low values-at-risk or other agency constraints.

Loaded Patrol - An active helicopter detection method that utilizes fully equipped (loaded) fire crews flying detection routes in anticipation of finding a fire and actioning it immediately upon discovery.

Man-down - see **Manning Action**.

Manning Action - The daily or short-term adjustments in the strength and positioning of fire suppression resources required for **initial attack** to meet a predetermined level of preparedness based on the likelihood of fire occurrence and probable fire behaviour as determined by the forecasted fire danger. This may involve increasing (i.e., **man-up**) or decreasing (i.e. **man-down**) the number and types of suppression crews and equipment.

Man-up - see **Manning Action.**

Mineral Soil - That portion of the soil stratum immediately below the litter and duff. Mineral soil contains very little combustible material except on highly productive sites where an uppersoil horizon may be enriched with organic matter.

Parallel Attack - see **Fire Suppression,Parallel.**

Preparedness - Condition or degree of being able and ready to cope with an anticipated fire situation.

Project Fire - see **Campaign Fire.**

Response Time - see **Get-Away Time** under **Elapsed Time.**

Travel Time - see **Elapsed Time.**

Values-at-Risk - The specific or collective set of natural resources and man-made improvements/developments that have measurable or intrinsic worth and that could or may be destroyed or otherwise altered by fire in any given area.

Water Bomber - see **Airtanker.**

Appendix G Response Time Distributions By Alert Level and Forest Priority Zone

Table G1: RED ZONE 1990 detection to suppression response time distribution by alert level with corresponding sizes and distances

ALERT	0					1					2					3					ALL LEVELS				
det/supp time (h:mm)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)
0:15	13	17.8%	0.4	0.8	12.0	20	24.7%	0.5	0.6	12.0	16	14.4%	0.5	0.6	26.1	24	30.8%	0.3	0.4	18.5	73	21.3%	0.4	0.6	17.2
0:30	14	37.0%	5.9	10.6	18.7	19	48.1%	0.6	0.7	25.6	36	46.8%	0.5	0.5	26.8	25	62.8%	0.6	1.0	22.8	94	48.7%	1.3	2.2	24.3
0:45	17	60.3%	3.1	3.5	25.2	15	66.7%	0.4	1.1	40.5	28	72.1%	0.8	1.0	42.0	13	79.5%	0.6	1.0	35.9	73	70.0%	1.2	1.6	36.7
1:00	10	74.0%	0.8	0.9	29.2	9	77.8%	0.8	1.0	26.3	12	82.9%	0.6	0.6	51.8	5	85.9%	0.4	0.5	35.6	36	80.5%	0.7	0.8	36.9
1:15	4	79.5%	7.0	10.1	10.0	5	84.0%	1.1	2.8	60.8	6	88.3%	0.5	0.5	64.3	4	91.0%	1.9	1.9	62.0	19	86.0%	2.3	3.4	51.5
1:30	6	87.7%	141.3	146.2	26.7	4	88.9%	1.4	1.5	55.8	1	89.2%	0.7	0.7	12.0	1	92.3%	0.1	0.2	50.0	12	89.5%	71.2	73.7	37.1
1:45	2	90.4%	0.3	0.3	21.5	2	91.4%	0.8	0.9	55.5	1	90.1%	0.1	0.1	220.0	2	94.9%	2.1	9.1	28.0	7	91.5%	0.9	2.9	61.4
2:00	2	93.2%	3.0	25.5	71.0	2	93.8%	0.1	0.1	15.5	2	91.9%	1.8	2.3	20.0						6	93.3%	1.6	9.3	35.5
2:15	2	95.9%	0.1	0.1	10.0						1	92.8%	0.6	0.7	65.0	1	96.2%	2.0	2.0	30.0	4	94.5%	0.7	0.7	28.8
2:30						1	95.1%	1.0	130.0	35.0											1	94.8%	1.0	130.0	35.0
2:45											2	94.6%	0.7	1.4	65.0						2	95.3%	0.7	1.4	65.0
over 3:00	3	100.0%	18.4	28.4	24.3	4	100.0%	1.4	3.1	45.5	6	100.0%	0.9	3.9	33.5	3	100.0%	100.1	383.4	31.3	16	100.0%	22.9	79.4	34.4
totals	**73**		**14.9**	**17.5**	**22.1**	**81**		**0.7**	**2.6**	**30.3**	**111**		**0.6**	**0.9**	**38.1**	**78**		**4.5**	**15.7**	**27.4**	**343**		**4.5**	**8.2**	**30.4**

Table G2: ORANGE ZONE 1990 detection to suppression response time distribution by alert level with corresponding sizes and distances

ALERT	0					1					2					3					ALL LEVELS				
detsupp time (h:mm)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)
0:15											1	14.3%	3.0	3.0	12.0						1	7.7%	3.0	3.0	12.0
0:30																									
0:45						1	33.3%	0.5	1.0	25.0	1	28.6%	0.1	0.1	12.0						2	23.1%	0.3	0.6	18.5
1:00	2	66.7%	4.7	4.7	18.0	1	66.7%	0.1	0.1	55.0	3	71.4%	6.0	3.5	59.0						6	69.2%	4.6	3.3	44.7
1:15											1	85.7%	1.0	5.0	50.0						1	76.9%	1.0	5.0	50.0
1:30											1	100.0%	0.5	0.0	40.0						1	84.6%	0.5	0.0	40.0
1:45																									
2:00																									
2:15																									
2:30																									
2:45																									
over 3:00	1	100.0%	250.0	260.0	25.0	1	100.0%	5.0	5.6	55.0											2	100.0%	127.5	132.8	40.0
totals	**3**		**86.4**	**89.8**	**20.3**	**3**		**1.9**	**2.2**	**45.0**	**7**		**3.2**	**2.7**	**41.6**						**13**		**22.1**	**22.7**	**37.5**

Table G3: YELLOW ZONE 1990 detection to suppression response time distribution by alert level with corresponding sizes and distances

ALERT	0					1					2					3					ALL LEVELS				
det/supp time (h:mm)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)
0:15	2	28.6%	0.5	0.8	19.5						1	6.7%	0.5	0.5	46.0	1	100.0%	0.1	0.1	65.0	4	15.4%	0.4	0.5	37.5
0:30	4	85.7%	1.3	1.4	18.0	1	33.3%	0.4	0.4	50.0	3	26.7%	0.7	0.8	48.3						8	46.2%	0.9	1.0	33.4
0:45						2	100.0%	2.1	2.6	67.5	3	46.7%	0.1	0.2	63.0						5	65.4%	0.9	1.1	64.8
1:00	1	100.0%	0.8	0.8	15.0						2	60.0%	3.2	3.3	60.5						3	76.9%	2.4	2.4	45.3
1:15											1	66.7%	0.6	0.6	144.0						1	80.8%	0.6	0.6	144.0
1:30											2	80.0%	3.6	3.6	50.0						2	88.5%	3.6	3.6	50.0
1:45																									
2:00											1	86.7%	2.5	3.0	50.0						1	92.3%	2.5	3.0	50.0
2:15																									
2:30											1	93.3%	8.0	35.0	50.0						1	96.2%	8.0	35.0	50.0
2:45											1	100.0%	8.0	8.0	80.0						1	100.0%	8.0	8.0	80.0
over 3:00																									
totals	**7**		**1.0**	**1.1**	**18.0**	**3**		**1.5**	**1.9**	**61.7**	**15**		**2.3**	**4.2**	**56.9**	**1**		**0.1**	**0.1**	**65.0**	**26**		**1.8**	**3.0**	**47.3**

Table G4: GREEN ZONE 1990 detection to suppression response time distribution by alert level with corresponding sizes and distances

ALERT	0					1					2					3					ALL LEVELS				
det/supp time (h:mm)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)
0:15						3	15.0%	0.3	0.3	11.7	6	17.6%	0.6	0.9	29.7	2	16.7%	0.3	0.4	43.5	11	15.3%	0.5	0.6	27.3
0:30	3	50.0%	0.4	1.1	10.3	4	35.0%	0.6	0.7	1.8	11	50.0%	1.7	3.2	12.3	2	33.3%	0.2	0.8	34.0	20	43.1%	1.2	2.1	12.1
0:45	1	66.7%	20.0	20.0	25.0	4	55.0%	0.8	1.8	6.0	5	64.7%	2.3	3.3	22.6						10	56.9%	3.5	4.4	16.2
1:00	1	83.3%	4.0	10.0	20.0	2	65.0%	1.3	1.3	27.5	2	70.6%	0.5	0.5	20.0	4	66.7%	0.4	0.7	18.3	9	69.4%	1.0	1.8	20.9
1:15						2	75.0%	4.3	5.3	12.5	2	76.5%	1.6	1.8	15.0						4	75.0%	2.9	3.5	13.8
1:30						1	80.0%	8.1	8.1	112.0	2	82.4%	0.6	0.7	31.0	2	83.3%	0.3	0.3	24.0	5	81.9%	2.0	2.0	44.4
1:45											1	85.3%	1.0	1.0	130.0						1	83.3%	1.0	1.0	130.0
2:00						1	85.0%	1.0	1.0	55.0	2	91.2%	20.1	50.8	65.0						3	87.5%	13.7	34.2	61.7
2:15																									
2:30	1	100.0%	0.4	6.0	115.0						2	97.1%	3.1	5.6	31.5						3	91.7%	2.2	5.7	59.3
2:45																									
over 3:00						3	100.0%	1.0	1.2	49.3	1	100.0%	1.0	1.0	130.0	2	100.0%	1.5	2.5	41.5	6	100.0%	1.2	1.6	60.2
totals	**6**		**4.3**	**6.5**	**31.8**	**20**		**1.5**	**1.8**	**23.1**	**34**		**2.6**	**5.2**	**29.7**	**12**		**0.5**	**0.9**	**29.9**	**72**		**2.1**	**3.7**	**28.1**

Table G5: WHITE ZONE 1990 detection to suppression response time distribution by alert level with corresponding sizes and distances

ALERT	0					1					2					3					ALL LEVELS				
detsupp time (h:mm)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)
0:15																									
0:30											3	60.0%	0.3	3.7	21.7						3	21.4%	0.3	3.7	21.7
0:45	3	42.9%	14.0	48.3	36.7																3	42.9%	14.0	48.3	36.7
1:00	1	57.1%	5.0	8.0	50.0																1	50.0%	5.0	8.0	50.0
1:15	1	71.4%	100.0	100.0	0.0																1	57.1%	100.0	100.0	0.0
1:30	1	85.7%	0.8	2.0	120.0																1	64.3%	0.8	2.0	120.0
1:45						1	50.0%	4.0	10.0	40.0											1	71.4%	4.0	10.0	40.0
2:00	1	100.0%	200.0	250.0	0.0						1	80.0%	1.6	2.0	4.0						2	85.7%	100.8	126.0	2.0
2:15																									
2:30						1	100.0%	4.0	30.0	6.0											1	92.9%	4.0	30.0	6.0
2:45																									
over 3:00											1	100.0%	0.2	0.2	110.0						1	100.0%	0.2	0.2	110.0
totals	**7**		**49.7**	**72.1**	**40.0**	**2**		**4.0**	**20.0**	**23.0**	**5**		**0.6**	**2.7**	**35.8**						**14**		**25.6**	**39.9**	**36.1**

Table G6: RED ZONE 1991 detection to suppression response time distribution by alert level with corresponding sizes and distances

ALERT	0					1					2				
det/supp time (h:mm)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)
0:15	17	18.9%	3.1	4.1	8.2	18	32.1%	0.6	0.7	23.1	12	16.7%	0.2	0.3	24.9
0:30	26	47.8%	5.1	10.5	16.5	8	46.4%	0.4	0.6	15.3	26	52.8%	0.4	0.5	30.7
0:45	14	63.3%	5.1	6.6	17.4	7	58.9%	0.5	0.6	37.7	15	73.6%	0.5	0.9	57.1
1:00	10	74.4%	66.8	78.2	34.3	6	69.6%	2.2	2.7	53.3	8	84.7%	0.3	0.3	41.4
1:15	4	78.9%	2.1	6.2	73.3	3	75.0%	0.2	0.3	65.3	2	87.5%	2.3	2.3	85.0
1:30	4	83.3%	78.0	80.1	44.5	5	83.9%	5.7	6.7	61.8	1	88.9%	0.2	0.2	55.0
1:45															
2:00	3	86.7%	1.7	5.3	33.3	2	87.5%	1.8	1.9	33.0	4	94.4%	9.1	14.9	58.3
2:15	2	88.9%	0.6	2.6	33.5										
2:30	3	92.2%	3.2	3.2	34.3	2	91.1%	0.2	0.2	58.5					
2:45	1	93.3%	0.1	0.1	57.0						1	95.8%	0.2	0.3	60.0
over 3:00	6	100.0%	8.9	11.4	22.7	5	100.0%	3.7	4.0	33.0	3	100.0%	0.2	0.2	49.3
totals	90		14.6	18.5	23.2	56		1.5	1.7	36.3	72		0.9	1.4	41.0

ALERT	3					4					ALL LEVELS				
det/supp time (h:mm)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)
0:15	26	41.3%	0.4	0.5	22.1	13	32.5%	2.7	2.7	21.1	86	26.8%	1.3	1.5	19.8
0:30	13	61.9%	0.9	1.1	25.9	11	60.0%	0.2	0.2	33.2	84	53.0%	1.9	3.7	24.4
0:45	13	82.5%	0.3	0.4	33.9	5	72.5%	0.7	0.7	29.0	54	69.8%	1.7	2.2	36.1
1:00	5	90.5%	0.2	0.2	41.0	3	80.0%	1.4	2.0	70.3	32	79.8%	21.5	25.3	44.1
1:15	2	93.7%	0.1	0.1	14.0	1	82.5%	4.0	4.0	150.0	12	83.5%	1.5	2.9	69.8
1:30	2	96.8%	0.1	0.1	55.0	1	85.0%	0.1	0.1	22.0	13	87.5%	26.2	27.2	51.8
1:45						1	87.5%	0.4	0.4	40.0	1	87.9%	0.4	0.4	40.0
2:00	1	98.4%	1.0	1.0	100.0	2	92.5%	2.2	2.2	47.5	12	91.6%	4.2	7.1	49.5
2:15											2	92.2%	0.6	2.6	33.5
2:30						2	97.5%	1.2	1.2	77.5	7	94.4%	1.7	1.8	53.6
2:45											2	95.0%	0.2	0.2	58.5
over 3:00	1	100.0%	0.1	0.1	1.0	1	100.0%	0.1	0.1	46.0	16	100.0%	4.6	5.6	31.0
totals	63		0.4	0.6	28.5	40		1.4	1.4	37.6	321		4.8	6.1	32.1

Table G7: ORANGE ZONE 1991 detection to suppression response time distribution by alert level with corresponding sizes and distances

ALERT	0					1				
det/supp time (h:mm)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)
0:15										
0:30	3	25.0%	1.1	1.1	9.3	2	18.2%	0.4	2.6	94.0
0:45	2	41.7%	1.5	5.5	35.0	4	54.5%	55.5	130.7	40.0
1:00	3	66.7%	33.4	35.1	24.3					
1:15	1	75.0%	0.5	0.5	75.0	2	72.7%	0.5	0.5	70.5
1:30										
1:45										
2:00										
2:15	1	83.3%	1.0	100.0	40.0					
2:30	1	91.7%	20.0	20.0	0.0	1	81.8%	80.0	80.0	30.0
2:45										
over 3:00	1	100.0%	80.0	90.0	50.0	2	100.0%	125.3	150.3	42.5
totals	**12**		**17.3**	**27.5**	**28.0**	**11**		**50.4**	**82.7**	**54.9**

ALERT	2					3				
det/supp time (h:mm)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)
0:15						1	20.0%	0.3	0.5	40.0
0:30	1	33.3%	0.1	0.1	6.0	1	40.0%	2.0	567.0	51.0
0:45										
1:00	1	66.7%	0.5	1.0	50.0	2	80.0%	0.3	0.6	47.5
1:15	1	100.0%	5.0	8.0	60.0	1	100.0%	0.8	1.0	55.0
1:30										
1:45										
2:00										
2:15										
2:30										
2:45										
over 3:00										
totals	**3**		**1.9**	**3.0**	**38.7**	**5**		**0.7**	**113.9**	**48.2**

ALERT	4					ALL LEVELS				
det/supp time (h:mm)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)
0:15						1	3.1%	0.3	0.5	40.0
0:30	1	100.0%	0.2	0.2	35.0	8	28.1%	0.8	72.0	38.5
0:45						6	46.9%	37.5	88.9	38.3
1:00						6	65.6%	16.9	17.9	36.3
1:15						5	81.3%	1.4	2.1	66.2
1:30										
1:45										
2:00										
2:15						1	84.4%	1.0	100.0	40.0
2:30						2	90.6%	50.0	50.0	15.0
2:45										
over 3:00						3	100.0%	110.2	130.2	45.0
totals	**1**		**0.2**	**0.2**	**35.0**	**32**		**24.1**	**56.8**	**41.6**

Table G8: YELLOW ZONE 1991 detection to suppression response time distribution by alert level with corresponding sizes and distances

ALERT	0					1					2					3					4					ALL LEVELS				
det/supp time (h:mm)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)
0:15											2	13.3%	0.1	0.2	32.0	1	16.7%	2.0	2.0	40.0	1	50.0%	0.2	2.5	20.0	4	9.5%	0.6	1.2	31.0
0:30	1	25.0%	0.5	0.5	8.0	2	13.3%	12.2	12.7	14.0	5	46.7%	0.5	0.6	58.4	2	50.0%	2.1	8.5	20.0						10	33.3%	3.1	4.6	36.8
0:45						3	33.3%	0.6	0.7	10.3	3	66.7%	2.0	4.0	54.7	1	66.7%	20.0	20.0	15.0	1	100.0%	5.0	15.0	210.0	8	52.4%	4.1	6.2	52.5
1:00	1	50.0%	0.1	0.1	4.0	5	66.7%	37.9	41.1	48.4	3	86.7%	2.4	4.2	37.3	2	100.0%	4.3	5.3	13.5						11	78.6%	18.6	20.8	35.0
1:15						1	73.3%	3.0	10.0	122.0	1	93.3%	0.7	0.7	45.0											2	83.3%	1.9	5.4	83.5
1:30						1	80.0%	2.0	5.0	4.0	1	100.0%	1.0	1.0	10.0											2	88.1%	1.5	3.0	7.0
1:45						1	86.7%	1.0	0.0	2.5																1	90.5%	1.0	0.0	2.5
2:00																														
2:15	1	75.0%	0.8	1.0	12.0																					1	92.9%	0.8	1.0	12.0
2:30						1	93.3%	0.1	0.2	54.0																1	95.2%	0.1	0.2	54.0
2:45																														
over 3:00	1	100.0%	2.0	2.2	32.0	1	100.0%	1.0	2.0	128.0																2	100.0%	1.5	2.1	80.0
totals	4		0.9	1.0	14.0	15		14.9	16.9	44.6	15		1.2	2.0	45.8	6		5.8	8.3	20.3	2		2.6	8.8	115.0	42		6.8	8.4	42.0

Table G9: GREEN ZONE 1991 detection to suppression response time distribution by alert level with corresponding sizes and distances

ALERT	0					1				
det/supp time (h:mm)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)
0:15	2	12.5%	2.6	2.6	6.5	4	11.4%	6.8	7.6	32.8
0:30	3	31.3%	4.9	5.4	8.0	6	28.6%	3.5	5.0	9.7
0:45	3	50.0%	20.2	23.6	10.7	10	57.1%	0.4	0.6	21.9
1:00	2	62.5%	0.6	0.9	66.5	4	68.6%	0.4	0.8	12.0
1:15	1	68.8%	0.1	0.1	3.0	6	85.7%	0.7	0.7	16.8
1:30	1	75.0%	0.1	0.1	35.0	2	91.4%	0.2	0.2	58.0
1:45	1	81.3%	0.1	0.1	109.0	1	94.3%	150.0	160.0	3.0
2:00										
2:15	1	87.5%	0.1	0.1	3.0	1	97.1%	0.1	0.1	3.0
2:30										
2:45						1	100.0%	0.1	0.1	13.0
over 3:00	2	100.0%	17.7	29.2	38.0					
totals	**16**		**7.3**	**9.5**	**26.8**	**35**		**5.9**	**6.7**	**19.8**

ALERT	2					3				
det/supp time (h:mm)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)
0:15	2	6.5%	0.7	0.7	21.0	2	40.0%	0.1	0.1	3.5
0:30	7	29.0%	0.4	0.7	18.7	1	60.0%	2.0	2.1	115.0
0:45	6	48.4%	2.5	3.2	41.5					
1:00	1	51.6%	1.0	2.5	75.0	1	80.0%	0.2	0.2	132.0
1:15	3	61.3%	0.6	0.7	11.3					
1:30	4	74.2%	0.8	1.2	50.3					
1:45	1	77.4%	4.0	6.0	110.0					
2:00	2	83.9%	2.6	7.6	11.5	1	100.0%	2.0	3.0	50.0
2:15										
2:30	2	90.3%	2.6	3.3	69.0					
2:45	1	93.5%	1.3	1.5	120.0					
over 3:00	2	100.0%	0.1	0.2	72.5					
totals	**31**		**1.3**	**2.1**	**40.9**	**5**		**0.9**	**1.1**	**60.8**

ALERT	4					ALL LEVELS				
det/supp time (h:mm)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)
0:15						10	10.4%	3.4	3.7	19.3
0:30	2	22.2%	0.1	0.1	15.0	19	30.2%	2.1	2.8	18.8
0:45	2	44.4%	0.3	0.3	33.5	21	52.1%	3.8	4.6	27.0
1:00	2	66.7%	0.1	0.2	9.5	10	62.5%	0.4	0.8	40.7
1:15	1	77.8%	0.5	140.0	15.0	11	74.0%	0.6	13.3	13.9
1:30	1	88.9%	0.5	1.5	2.0	8	82.3%	0.5	0.8	44.3
1:45	1	100.0%	5.0	6.0	34.0	4	86.5%	39.8	43.0	64.0
2:00						3	89.6%	2.4	6.0	24.3
2:15						2	91.7%	0.1	0.1	3.0
2:30						2	93.8%	2.6	3.3	69.0
2:45						2	95.8%	0.7	0.8	66.5
over 3:00						4	100.0%	8.9	14.7	55.3
totals	**9**		**0.8**	**16.5**	**18.6**	**96**		**3.9**	**6.3**	**29.8**

Table G10: WHITE ZONE 1991 detection to suppression response time distribution by alert level with corresponding sizes and distances

ALERT	0					1					2					3					4					ALL LEVELS				
det/supp time (h:mm)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)
0:15	2	50.0%	0.1	0.1	0.0																					2	16.7%	0.1	0.1	0.0
0:30	1	75.0%	5.0	6.0	12.0	1	50.0%	0.1	0.1	1.0																2	33.3%	2.6	3.1	6.5
0:45											2	40.0%	1.2	1.4	23.5	1	100.0%	1.5	5.0	5.0						3	58.3%	1.3	2.6	17.3
1:00						1	100.0%	0.1	0.1	120.0	1	60.0%	0.1	0.1	3.0											2	75.0%	0.1	0.1	61.5
1:15																														
1:30																														
1:45																														
2:00	1	100.0%	1000.0	1000.0	20.0																					1	83.3%	1000.0	1000.0	20.0
2:15											1	80.0%	0.6	3.0	32.0											1	91.7%	0.6	3.0	32.0
2:30																														
2:45																														
over 3:00											1	100.0%	4.0	12.0	173.0											1	100.0%	4.0	12.0	173.0
totals	4		251.3	251.6	8.0	2		0.1	0.1	60.5	5		1.4	3.6	51.0	1		1.5	5.0	5.0						12		84.5	85.8	34.4

Table G11: RED ZONE 1992 detection to suppression response time distribution by alert level with corresponding sizes and distances

ALERT	0					1					2				
det/supp time (h:mm)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)
0:15	3	12.0%	70.7	70.7	21.0	8	13.8%	0.2	0.2	13.4	3	9.7%	0.3	0.4	10.0
0:30	5	32.0%	1.1	1.7	19.6	20	48.3%	1.2	1.2	24.7	10	41.9%	0.6	1.0	55.2
0:45	4	48.0%	0.7	0.9	21.0	14	72.4%	0.6	0.8	37.3	5	58.1%	1.2	2.7	40.0
1:00	2	56.0%	0.4	0.4	9.0	5	81.0%	0.3	0.5	40.2	3	67.7%	2.5	3.7	15.7
1:15	3	68.0%	0.1	0.1	25.7	2	84.5%	0.8	0.8	28.0	4	80.6%	0.8	8.0	65.0
1:30	3	80.0%	0.5	0.6	18.7	2	87.9%	0.6	1.1	33.5	2	87.1%	0.6	0.7	45.5
1:45						3	93.1%	1.1	3.6	65.0	3	96.8%	1.8	9.8	96.7
2:00	2	88.0%	1.8	2.8	12.5	2	96.6%	0.6	1.0	70.5					
2:15	1	92.0%	7.0	7.0	190.0										
2:30	1	96.0%	33.0	40.0	65.0	2	100.0%	0.1	0.2	44.0	1	100.0%	0.1	0.2	72.0
2:45															
over 3:00	1	100.0%	0.1	0.1	40.0										
totals	**25**		**10.7**	**11.2**	**28.6**	**58**		**0.7**	**1.0**	**32.3**	**31**		**1.0**	**3.2**	**49.7**

ALERT	3					4					ALL LEVELS				
det/supp time (h:mm)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)
0:15											14	11.7%	15.3	15.3	14.3
0:30						2	50.0%	1.0	2.0	75.0	37	42.5%	1.0	1.3	35.0
0:45	1	50.0%	1.0	1.0	90.0						24	62.5%	0.7	1.2	37.3
1:00											10	70.8%	1.0	1.4	26.6
1:15											9	78.3%	0.6	3.7	43.7
1:30											7	84.2%	0.5	0.7	30.6
1:45											6	89.2%	1.5	6.7	80.8
2:00						1	75.0%	1.0	2.0	90.0	5	93.3%	1.1	1.9	51.2
2:15											1	94.2%	7.0	7.0	190.0
2:30	1	100.0%	0.1	0.1	2.0						5	98.3%	6.7	8.1	45.4
2:45															
over 3:00						1	100.0%	1.0	6.0	80.0	2	100.0%	0.6	3.1	60.0
totals	**2**		**0.6**	**0.6**	**46.0**	**4**		**1.0**	**3.0**	**80.0**	**120**		**2.9**	**3.7**	**37.8**

Table G12: ORANGE ZONE 1992 detection to suppression response time distribution by alert level with corresponding sizes and distances

ALERT	0					1					2				
det/supp time (h:mm)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)
0:15											1	12.5%	0.1	0.1	25
0:30	1	16.7%	0.2	0.2	3	1	33.3%	0.1	0.1	15	3	50.0%	4.0	5.4	35
0:45						1	66.7%	25	32	10	1	62.5%	0.2	0.2	25
1:00	2	50.0%	0.6	0.6	50	1	100.0%	9.0	10.0	85					
1:15															
1:30	1	66.7%	0.2	0.2	10										
1:45											1	75.0%	0.9	1	80
2:00															
2:15	1	83.3%	0.5	0.5	80						1	87.5%	0.8	3.2	50
2:30															
2:45											1	100.0%	16	16	30
over 3:00	1	100.0%	20	55	35										
totals	6		3.7	9.5	38	3		11.4	14.0	36.7	8		3.8	4.6	39.4

ALERT	3					4				
det/supp time (h:mm)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)
0:15										
0:30										
0:45										
1:00										
1:15										
1:30										
1:45										
2:00										
2:15										
2:30										
2:45										
over 3:00										
totals										

ALERT	ALL LEVELS				
det/supp time (h:mm)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)
0:15	1	5.9%	0.1	0.1	25
0:30	5	35.3%	2.5	3.3	24.6
0:45	2	47.1%	12.6	16.1	17.5
1:00	3	64.7%	3.4	3.7	61.7
1:15					
1:30	1	70.6%	0.2	0.2	10
1:45	1	76.5%	0.9	1	80
2:00					
2:15	2	88.2%	0.7	1.9	65
2:30					
2:45	1	94.1%	16	16	30
over 3:00	1	100.0%	20	55	35
totals	17		5.1	8.0	38.4

Table G13: YELLOW ZONE 1992 detection to suppression response time distribution by alert level with corresponding sizes and distances

ALERT	0					1					2					3					4					ALL LEVELS				
det/supp time (h:mm)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)
0:15											2	16.7%	10.2	12.7	172.5	1	14.3%	0.1	0.2	15.0	1	50.0%	0.1	0.1	2.0	4	12.9%	5.2	6.4	90.5
0:30						2	25.0%	10.2	12.7	5.5	5	58.3%	9.0	12.7	21.8	1	28.6%	0.1	0.1	40.0						8	38.7%	8.2	11.1	20.0
0:45						1	37.5%	1.0	7.0	1.0						3	71.4%	0.1	0.2	63.3						4	51.6%	0.3	1.9	47.8
1:00						1	50.0%	0.5	0.5	4.0	1	66.7%	0.8	1.3	21.0	1	85.7%	0.4	0.4	70.0						3	61.3%	0.6	0.7	31.7
1:15						2	75.0%	0.4	0.4	7.5	1	75.0%	0.4	4.0	50.0											3	71.0%	0.4	1.6	21.7
1:30	1	50.0%	10.0	25.0	60.0	1	87.5%	1.0	4.0	3.0						1	100.0%	0.1	0.1	80.0						3	80.6%	3.7	9.7	47.7
1:45	1	100.0%	5.0	5.0	7.0																1	100.0%	1.0	5.0	75.0	2	87.1%	3.0	5.0	41.0
2:00																														
2:15											1	83.3%	8.0	50.0	40.0											1	90.3%	8.0	50.0	40.0
2:30																														
2:45											1	91.7%	8.0	15.0	37.0											1	93.5%	8.0	15.0	37.0
over 3:00						1	100.0%	0.8	0.9	166.0	1	100.0%	0.1	0.1	0.0											2	100.0%	0.5	0.5	83.0
totals	**2**		**7.5**	**15.0**	**33.5**	**8**		**3.1**	**4.8**	**25.0**	**12**		**6.9**	**13.3**	**50.2**	**7**		**0.1**	**0.2**	**56.4**	**2**		**0.6**	**2.6**	**38.5**	**31**		**4.0**	**7.6**	**43.3**

Table G14: GREEN ZONE 1992 detection to suppression response time distribution by alert level with corresponding sizes and distances

ALERT	0					1					2					3					4					ALL LEVELS				
det/supp time (h:mm)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)
0:15	1	12.5%	0.1	0.1	1.0	1	3.3%	0.4	0.4	3.0						2	28.6%	0.1	0.1	1.0						4	7.0%	0.2	0.2	1.5
0:30	3	50.0%	7.1	11.1	10.3	4	16.7%	0.2	0.2	3.3	7	63.6%	6.0	9.2	7.7	1	42.9%	1.0	1.2	50.0						15	33.3%	4.3	6.7	9.9
0:45	1	62.5%	0.1	0.1	2.0	6	36.7%	3.3	3.9	22.5	1	72.7%	0.1	1.0	5.0						1	100.0%	3.0	10.0	110.0	9	49.1%	2.6	3.8	28.0
1:00						8	63.3%	1.8	5.0	22.3						1	57.1%	0.1	2.0	2.0						9	64.9%	1.6	4.6	20.0
1:15	1	75.0%	2.0	2.0	5.0						1	81.8%	40.0	50.0	27.0	2	85.7%	0.8	1.0	66.5						4	71.9%	10.9	13.5	41.3
1:30	1	87.5%	0.5	0.5	10.0	2	70.0%	0.4	5.7	88.5	1	90.9%	0.2	0.8	40.0											4	78.9%	0.4	3.2	56.8
1:45						4	83.3%	3.2	4.0	54.5																4	86.0%	3.2	4.0	54.5
2:00																														
2:15						1	86.7%	1.8	2.0	14.0																1	87.7%	1.8	2.0	14.0
2:30						2	93.3%	2.5	2.5	90.0																2	91.2%	2.5	2.5	90.0
2:45											1	100.0%	0.4	6.0	50.0											1	93.0%	0.4	6.0	50.0
over 3:00	1	100.0%	1.0	2.0	1.0	2	100.0%	1.8	2.9	97.5						1	100.0%	2.0	3.0	60.0						4	100.0%	1.6	2.7	64.0
totals	**8**		**3.1**	**4.8**	**6.3**	**30**		**2.0**	**3.5**	**37.1**	**11**		**7.5**	**11.1**	**16.0**	**7**		**0.7**	**1.2**	**35.3**	**1**		**3.0**	**10.0**	**110.0**	**57**		**3.1**	**5.0**	**29.8**

Table G15: WHITE ZONE 1992 detection to suppression response time distribution by alert level with corresponding sizes and distances

ALERT	0					1					2				
det/supp time (h:mm)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)
0:15															
0:30															
0:45											1	100.0%	2.0	2.0	7.0
1:00	1	50.0%	0.1	0.1	80.0										
1:15															
1:30															
1:45	1	100.0%	0.5	4.0	12.0										
2:00															
2:15															
2:30															
2:45															
over 3:00															
totals	2		0.3	2.1	46.0						1		2.0	2.0	7.0

ALERT	3					4					ALL LEVELS				
det/supp time (h:mm)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)	# fires	% cumulative	avg detection size (ha.)	avg initial size (ha.)	avg distance (km.)
0:15						0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!					
0:30						0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!					
0:45											1	25.0%	2.0	2.0	7.0
1:00											1	50.0%	0.1	0.1	80.0
1:15															
1:30	1	100.0%	0.5	0.5	20.0						1	75.0%	0.5	0.5	20.0
1:45											1	100.0%	0.5	4.0	12.0
2:00															
2:15															
2:30															
2:45															
over 3:00															
totals	1		0.5	0.5	20.0						4		0.8	1.7	29.8

Appendix H Detection Size Frequency Distributions by Priority Zone and Method of Detection

Table H1 : 1990 frequency distribution of detection sizes by priority zone

	none		RED		ORANGE		YELLOW		GREEN		WHITE		ALL ZONES	
detection size (ha)	# fires	% cumulative	# fires	% cumulative	# fires	% cumulative	# fires	% cumulative	# fires	% cumulative	# fires	% cumulative	# fires	% cumulative
0	0	0%	1	0%	0	0%	0	0%	0	0%	0	0%	1	0%
0.1	0	0%	168	44%	3	20%	5	17%	19	18%	3	8%	198	35%
0.2	0	0%	29	52%	0	20%	4	30%	7	25%	2	13%	42	42%
0.3	0	0%	14	56%	1	27%	0	30%	2	26%	0	13%	17	45%
0.4	0	0%	12	59%	0	27%	1	33%	9	35%	1	16%	23	49%
0.5	0	0%	41	70%	2	40%	3	43%	8	42%	6	32%	60	60%
0.6	0	0%	4	71%	0	40%	0	43%	2	44%	0	32%	6	61%
0.7	0	0%	3	72%	0	40%	0	43%	1	45%	0	32%	4	62%
0.8	0	0%	9	74%	0	40%	3	53%	2	47%	1	34%	15	64%
1	0	0%	34	83%	1	47%	2	60%	10	57%	1	37%	48	73%
1.1	0	0%	1	83%	0	47%	0	60%	0	57%	0	37%	1	73%
1.2	0	0%	2	84%	0	47%	0	60%	3	59%	0	37%	5	74%
1.5	0	0%	7	86%	0	47%	1	63%	0	59%	0	37%	8	75%
1.6	0	0%	0	86%	0	47%	0	63%	0	59%	1	39%	1	75%
1.8	0	0%	1	86%	0	47%	0	63%	0	59%	0	39%	1	75%
2	0	0%	16	90%	1	53%	1	67%	11	70%	3	47%	32	81%
2.4	0	0%	0	90%	0	53%	0	67%	1	71%	0	47%	1	81%
2.5	0	0%	5	91%	0	53%	1	70%	0	71%	1	50%	7	82%
3	0	0%	5	93%	1	60%	1	73%	2	73%	1	53%	10	84%
3.2	0	0%	0	93%	0	60%	1	77%	0	73%	0	53%	1	84%
3.5	0	0%	1	93%	0	60%	0	77%	0	73%	0	53%	1	85%
4	1	100%	2	93%	0	60%	2	83%	3	75%	2	58%	10	86%
5	0	100%	11	96%	1	67%	0	83%	9	84%	1	61%	22	90%
5.9	0	100%	0	96%	0	67%	1	87%	0	84%	0	61%	1	90%
6	0	100%	0	96%	0	67%	0	87%	1	85%	0	61%	1	91%
8	0	100%	0	96%	2	80%	2	93%	1	86%	0	61%	5	91%
8.1	0	100%	0	96%	0	80%	0	93%	1	87%	0	61%	1	92%
9	0	100%	1	97%	1	87%	0	93%	0	87%	0	61%	2	92%
10	0	100%	2	97%	0	87%	2	100%	3	90%	0	61%	7	93%
11	0	100%	0	97%	0	87%	0	100%	1	91%	0	61%	1	93%
12	0	100%	1	97%	0	87%	0	100%	1	92%	0	61%	2	94%
14	0	100%	1	98%	0	87%	0	100%	0	92%	0	61%	1	94%
14.5	0	100%	0	98%	0	87%	0	100%	0	92%	1	63%	1	94%
16	0	100%	0	98%	0	87%	0	100%	0	92%	2	68%	2	94%
17	0	100%	1	98%	0	87%	0	100%	0	92%	0	68%	1	95%
20	0	100%	0	98%	1	93%	0	100%	2	93%	4	79%	7	96%
25	0	100%	1	98%	0	93%	0	100%	0	93%	0	79%	1	96%
30	0	100%	1	98%	0	93%	0	100%	0	93%	0	79%	1	96%
32.7	0	100%	0	98%	0	93%	0	100%	0	93%	1	82%	1	96%
40	0	100%	1	99%	0	93%	0	100%	1	94%	1	84%	3	97%
41	0	100%	0	99%	0	93%	0	100%	0	94%	2	89%	2	97%
45	0	100%	1	99%	0	93%	0	100%	0	94%	0	89%	1	97%
50	0	100%	1	99%	0	93%	0	100%	1	95%	0	89%	2	98%
51	0	100%	0	99%	0	93%	0	100%	1	96%	0	89%	1	98%
60	0	100%	0	99%	0	93%	0	100%	0	96%	1	92%	1	98%
70	0	100%	1	99%	0	93%	0	100%	1	97%	0	92%	2	98%
90	0	100%	0	99%	0	93%	0	100%	0	97%	1	95%	1	99%
100	0	100%	0	99%	0	93%	0	100%	0	97%	1	97%	1	99%
200	0	100%	0	99%	0	93%	0	100%	1	98%	1	100%	2	99%
250	0	100%	0	99%	1	100%	0	100%	0	98%	0	100%	1	99%
300	0	100%	1	100%	0	100%	0	100%	0	98%	0	100%	1	99%
400	0	100%	0	100%	0	100%	0	100%	1	99%	0	100%	1	100%
450	0	100%	0	100%	0	100%	0	100%	1	100%	0	100%	1	100%
800	0	100%	1	100%	0	100%	0	100%	0	100%	0	100%	1	100%
TOTAL	1		380		15		30		106		38		570	

Table H2 : 1990 frequency distribution of detection sizes by detection method

	tower		designated air patrol		ground patrol		public cooperation		aircraft cooperation		railway		contract aircraft		all detection methods	
det size (ha)	# fires	% cumlt	# fires	% cumlt	# fires	% cumlt	# fires	% cumlt	# fires	% cumlt	# fires	% cumlt	# fires	% cumlt	# fires	% cumlt
0	0	0%	0	0%	0	0%	1	1%	0	0%	0	0%	0	0%	1	0%
0.1	10	36%	53	28%	19	40%	75	40%	26	33%	3	60%	12	38%	198	35%
0.2	4	50%	16	37%	4	48%	11	46%	6	40%	0	60%	1	41%	42	42%
0.3	0	50%	4	39%	2	52%	6	49%	3	44%	1	80%	1	44%	17	45%
0.4	0	50%	9	44%	2	56%	8	53%	4	49%	0	80%	0	44%	23	49%
0.5	5	68%	20	55%	5	67%	19	63%	7	58%	0	80%	4	56%	60	60%
0.6	0	68%	2	56%	0	67%	3	64%	0	58%	0	80%	1	59%	6	61%
0.7	0	68%	1	56%	1	69%	1	65%	0	58%	0	80%	1	63%	4	62%
0.8	0	68%	5	59%	0	69%	8	69%	2	60%	0	80%	0	63%	15	64%
1	4	82%	18	69%	2	73%	16	77%	5	66%	1	100%	2	69%	48	73%
1.1	0	82%	1	69%	0	73%	0	77%	0	66%	0	100%	0	69%	1	73%
1.2	1	86%	4	72%	0	73%	0	77%	0	66%	0	100%	0	69%	5	74%
1.5	1	89%	0	72%	0	73%	6	81%	1	68%	0	100%	0	69%	8	75%
1.6	0	89%	0	72%	0	73%	1	81%	0	68%	0	100%	0	69%	1	75%
1.8	0	89%	1	72%	0	73%	0	81%	0	68%	0	100%	0	69%	1	75%
2	0	89%	10	77%	2	77%	12	87%	5	74%	0	100%	3	78%	32	81%
2.4	0	89%	0	77%	0	77%	0	87%	1	75%	0	100%	0	78%	1	81%
2.5	0	89%	1	78%	2	81%	2	88%	1	76%	0	100%	1	81%	7	82%
3	1	93%	2	79%	1	83%	3	90%	3	80%	0	100%	0	81%	10	84%
3.2	0	93%	1	80%	0	83%	0	90%	0	80%	0	100%	0	81%	1	84%
3.5	0	93%	0	80%	0	83%	0	90%	0	80%	0	100%	1	84%	1	85%
4	0	93%	8	84%	0	83%	0	90%	1	81%	0	100%	1	88%	10	86%
5	0	93%	12	90%	1	85%	2	91%	6	89%	0	100%	1	91%	22	90%
5.9	0	93%	0	90%	0	85%	0	91%	1	90%	0	100%	0	91%	1	90%
6	0	93%	1	91%	0	85%	0	91%	0	90%	0	100%	0	91%	1	91%
8	0	93%	2	92%	0	85%	1	92%	1	91%	0	100%	1	94%	5	91%
8.1	0	93%	0	92%	0	85%	1	92%	0	91%	0	100%	0	94%	1	92%
9	0	93%	0	92%	1	88%	1	93%	0	91%	0	100%	0	94%	2	92%
10	1	96%	3	94%	0	88%	1	93%	2	94%	0	100%	0	94%	7	93%
11	0	96%	0	94%	0	88%	0	93%	1	95%	0	100%	0	94%	1	93%
12	0	96%	0	94%	1	90%	0	93%	1	96%	0	100%	0	94%	2	94%
14	0	96%	1	94%	0	90%	0	93%	0	96%	0	100%	0	94%	1	94%
14.5	1	100%	0	94%	0	90%	0	93%	0	96%	0	100%	0	94%	1	94%
16	0	100%	1	95%	0	90%	0	93%	0	96%	0	100%	1	97%	2	94%
17	0	100%	0	95%	0	90%	1	94%	0	96%	0	100%	0	97%	1	95%
20	0	100%	3	96%	1	92%	3	95%	0	96%	0	100%	0	97%	7	96%
25	0	100%	0	96%	1	94%	0	95%	0	96%	0	100%	0	97%	1	96%
30	0	100%	0	96%	0	94%	1	96%	0	96%	0	100%	0	97%	1	96%
32.7	0	100%	1	97%	0	94%	0	96%	0	96%	0	100%	0	97%	1	96%
40	0	100%	0	97%	1	96%	1	96%	1	98%	0	100%	0	97%	3	97%
41	0	100%	2	98%	0	96%	0	96%	0	98%	0	100%	0	97%	2	97%
45	0	100%	0	98%	0	96%	1	97%	0	98%	0	100%	0	97%	1	97%
50	0	100%	1	98%	1	98%	0	97%	0	98%	0	100%	0	97%	2	98%
51	0	100%	0	98%	0	98%	0	97%	1	99%	0	100%	0	97%	1	98%
60	0	100%	0	98%	0	98%	1	97%	0	99%	0	100%	0	97%	1	98%
70	0	100%	1	99%	0	98%	1	98%	0	99%	0	100%	0	97%	2	98%
80	0	100%	0	99%	0	98%	1	98%	0	99%	0	100%	0	97%	1	99%
100	0	100%	0	99%	0	98%	1	99%	0	99%	0	100%	0	97%	1	99%
200	0	100%	1	99%	0	98%	0	99%	0	99%	0	100%	1	100%	2	99%
250	0	100%	0	99%	0	98%	1	99%	0	99%	0	100%	0	100%	1	99%
300	0	100%	0	99%	1	100%	0	99%	0	99%	0	100%	0	100%	1	99%
400	0	100%	1	100%	0	100%	0	99%	0	99%	0	100%	0	100%	1	100%
450	0	100%	0	100%	0	100%	0	99%	1	100%	0	100%	0	100%	1	100%
600	0	100%	0	100%	0	100%	1	100%	0	100%	0	100%	0	100%	1	100%
TOTAL	28		186		48		191		80		5		32		570	

Table H3 : 1991 frequency distribution of detection sizes by priority zone

	RED		ORANGE		YELLOW		GREEN		WHITE		ALL ZONES	
det size (ha)	# fires	% cumulative	# fires	% cumulative	# fires	% cumulative	# fires	% cumulative	# fires	% cumulative	# fires	% cumulative
0	0	0%	0	0%	1	2%	0	0%	0	0%	1	0%
0.1	166	44%	7	16%	11	23%	51	31%	7	19%	242	36%
0.2	27	51%	4	25%	6	34%	9	37%	1	22%	47	43%
0.3	16	55%	2	30%	0	34%	5	40%	2	27%	25	47%
0.4	16	59%	1	32%	0	34%	7	44%	1	30%	25	50%
0.5	34	68%	5	43%	3	40%	20	57%	2	35%	64	60%
0.6	0	68%	0	43%	0	40%	1	57%	1	38%	2	60%
0.7	0	68%	0	43%	1	42%	1	58%	0	38%	2	60%
0.8	5	69%	2	48%	2	45%	0	58%	0	38%	9	62%
0.9	1	70%	0	48%	0	45%	0	58%	0	38%	1	62%
1	28	77%	3	55%	10	64%	15	67%	3	46%	59	71%
1.1	2	78%	0	55%	0	64%	0	67%	0	46%	2	71%
1.2	2	78%	1	57%	0	64%	1	68%	1	49%	5	72%
1.3	0	78%	0	57%	0	64%	1	69%	0	49%	1	72%
1.4	1	78%	0	57%	0	64%	0	69%	0	49%	1	72%
1.5	5	80%	0	57%	0	64%	2	70%	1	51%	8	73%
2	8	82%	4	66%	4	72%	14	78%	3	59%	33	78%
2.2	1	82%	0	66%	0	72%	0	78%	0	59%	1	78%
2.5	2	83%	0	66%	1	74%	0	78%	0	59%	3	79%
3	4	84%	0	66%	2	77%	6	82%	0	59%	12	80%
3.2	1	84%	0	66%	0	77%	0	82%	0	59%	1	80%
3.5	2	84%	0	66%	0	77%	0	82%	0	59%	2	81%
4	3	85%	0	66%	3	83%	1	83%	2	65%	9	82%
4.2	0	85%	0	66%	1	85%	0	83%	0	65%	1	82%
4.5	2	86%	0	66%	0	85%	0	83%	0	65%	2	83%
5	5	87%	1	68%	2	89%	5	86%	1	68%	14	85%
6	4	88%	0	68%	1	91%	0	86%	0	68%	5	85%
7	1	88%	0	68%	0	91%	0	86%	0	68%	1	86%
8	2	89%	0	68%	1	92%	0	86%	1	70%	4	86%
10	10	92%	0	68%	0	92%	3	88%	0	70%	13	88%
12	2	92%	0	68%	0	92%	1	88%	0	70%	3	88%
12.2	0	92%	0	68%	0	92%	1	89%	0	70%	1	89%
14	0	92%	0	68%	0	92%	1	90%	0	70%	1	89%
15	4	93%	0	68%	0	92%	0	90%	0	70%	4	89%
16	1	93%	0	68%	0	92%	1	90%	0	70%	2	90%
17	1	94%	0	68%	0	92%	0	90%	0	70%	1	90%
20	8	96%	2	73%	1	94%	0	90%	2	76%	13	92%
24.3	0	96%	0	73%	1	96%	0	90%	0	76%	1	92%
25	1	96%	0	73%	0	96%	3	92%	0	76%	4	92%
29	1	96%	0	73%	0	96%	0	92%	0	76%	1	93%
30	1	97%	1	75%	0	96%	0	92%	1	78%	3	93%
35	1	97%	0	75%	0	96%	1	93%	0	78%	2	93%
40	3	98%	0	75%	0	96%	0	93%	0	78%	3	94%
50	1	98%	3	82%	1	98%	1	93%	0	78%	6	95%
60	1	98%	0	82%	0	98%	1	94%	0	78%	2	95%
70	0	98%	1	84%	0	98%	0	94%	0	78%	1	95%
75	0	98%	0	84%	0	98%	1	94%	0	78%	1	95%
80	1	98%	2	89%	0	98%	0	94%	0	78%	3	96%
90	1	99%	0	89%	0	98%	0	94%	0	78%	1	96%
99.8	1	99%	0	89%	0	98%	0	94%	0	78%	1	96%
100	0	99%	0	89%	0	98%	1	95%	3	86%	4	97%
120	0	99%	1	91%	0	98%	0	95%	0	86%	1	97%
125	0	99%	1	93%	0	98%	0	95%	0	86%	1	97%
145	1	99%	0	93%	0	98%	0	95%	0	86%	1	97%
150	0	99%	0	93%	0	98%	1	96%	0	86%	1	97%
160.1	0	99%	0	93%	1	100%	0	96%	0	86%	1	97%
190	0	99%	0	93%	0	100%	0	96%	1	89%	1	97%
200	0	99%	1	95%	0	100%	0	96%	0	89%	1	98%
250	0	99%	1	98%	0	100%	0	96%	1	92%	2	98%
300	0	99%	1	100%	0	100%	0	96%	0	92%	1	98%
310	1	99%	0	100%	0	100%	0	96%	0	92%	1	98%
318	0	99%	0	100%	0	100%	1	96%	0	92%	1	98%
350	0	99%	0	100%	0	100%	1	97%	0	92%	1	99%
400	0	99%	0	100%	0	100%	1	98%	0	92%	1	99%
450	0	99%	0	100%	0	100%	0	98%	1	95%	1	99%
500	1	100%	0	100%	0	100%	0	98%	0	95%	1	99%
600	1	100%	0	100%	0	100%	1	98%	0	95%	2	99%
700	0	100%	0	100%	0	100%	1	99%	0	95%	1	99%
1000	0	100%	0	100%	0	100%	0	99%	1	97%	1	100%
1500	0	100%	0	100%	0	100%	1	99%	1	100%	2	100%
9000	0	100%	0	100%	0	100%	1	100%	0	100%	1	100%
TOTAL	380		44		53		162		37		678	

Table H4 : 1991 frequency distribution of detection sizes by detection method

	tower		designated air patrol		ground patrol		public cooperation		aircraft cooperation		railway		contract aircraft		loaded helicopter patrol		1-800 line		all detection methods	
det size (ha)	# fires	% cumlt	# fires	% cumlt	# fires	% cumlt	# fires	% cumlt	# fires	% cumlt	# fires	% cumlt	# fires	% cumlt	# fires	% cumlt	# fires	% cumlt	# fires	% cumlt
0	0	0%	0	0%	0	0%	1	0%	0	0%	0	0%	0	0%	0	0%	0	0%	1	0%
0.1	8	19%	29	26%	17	28%	95	41%	23	31%	3	43%	31	53%	36	41%	0	0%	242	36%
0.2	5	31%	12	37%	3	33%	11	46%	4	36%	0	43%	6	63%	6	48%	0	0%	47	43%
0.3	2	36%	8	44%	1	34%	8	49%	2	39%	0	43%	1	64%	3	52%	0	0%	25	47%
0.4	3	43%	7	50%	0	34%	6	52%	4	45%	0	43%	1	66%	4	56%	0	0%	25	50%
0.5	5	55%	11	60%	4	41%	23	62%	8	55%	2	71%	3	71%	8	66%	0	0%	64	60%
0.6	0	55%	0	60%	0	41%	2	63%	0	55%	0	71%	0	71%	0	66%	0	0%	2	60%
0.7	0	55%	0	60%	0	41%	1	63%	0	55%	0	71%	1	73%	0	66%	0	0%	2	60%
0.8	0	55%	1	61%	2	44%	2	64%	1	57%	0	71%	2	76%	1	67%	0	0%	9	62%
0.9	0	55%	1	62%	0	44%	0	64%	0	57%	0	71%	0	76%	0	67%	0	0%	1	62%
1	4	64%	10	71%	9	59%	13	70%	11	72%	0	71%	4	83%	8	76%	0	0%	59	71%
1.1	1	67%	0	71%	0	59%	0	70%	0	72%	1	86%	0	83%	0	76%	0	0%	2	71%
1.2	0	67%	1	71%	0	59%	1	70%	3	76%	0	86%	0	83%	0	76%	0	0%	5	72%
1.3	0	67%	0	71%	0	59%	0	70%	0	76%	0	86%	0	83%	1	77%	0	0%	1	72%
1.4	0	67%	1	72%	0	59%	0	70%	0	76%	0	86%	0	83%	0	77%	0	0%	1	72%
1.5	0	67%	1	73%	0	59%	3	71%	2	78%	0	86%	2	86%	0	77%	0	0%	8	73%
2	3	74%	5	78%	2	62%	8	75%	6	86%	0	86%	1	88%	8	86%	0	0%	33	78%
2.2	0	74%	1	79%	0	62%	0	75%	0	86%	0	86%	0	88%	0	86%	0	0%	1	78%
2.5	0	74%	1	79%	0	62%	2	76%	0	86%	0	86%	0	88%	0	86%	0	0%	3	79%
3	1	76%	3	82%	0	62%	5	78%	2	89%	0	86%	0	88%	1	87%	0	0%	12	80%
3.2	0	76%	1	83%	0	62%	0	78%	0	89%	0	86%	0	88%	0	87%	0	0%	1	80%
3.5	0	76%	0	83%	0	62%	2	79%	0	89%	0	86%	0	88%	0	87%	0	0%	2	81%
4	1	79%	3	86%	0	62%	1	79%	2	92%	0	86%	0	88%	2	90%	0	0%	9	82%
4.2	0	79%	0	86%	0	62%	0	79%	1	93%	0	86%	0	88%	0	90%	0	0%	1	82%
4.5	0	79%	0	86%	0	62%	1	79%	0	93%	0	86%	0	88%	1	91%	0	0%	2	83%
5	2	83%	2	88%	0	62%	7	82%	0	93%	1	100%	2	92%	0	91%	0	0%	14	85%
6	1	86%	0	88%	2	66%	1	83%	1	95%	0	100%	0	92%	0	91%	0	0%	5	85%
7	0	86%	0	88%	1	67%	0	83%	0	95%	0	100%	0	92%	0	91%	0	0%	1	86%
8	0	86%	2	89%	1	69%	1	83%	0	95%	0	100%	0	92%	0	91%	0	0%	4	86%
10	1	88%	2	91%	0	69%	9	87%	0	95%	0	100%	0	92%	1	92%	0	0%	13	88%
12	0	88%	1	92%	1	70%	0	87%	0	95%	0	100%	0	92%	0	92%	1	100%	3	88%
12.2	0	88%	0	92%	0	70%	0	87%	0	95%	0	100%	1	93%	0	92%	0	100%	1	89%
14	1	90%	0	92%	0	70%	0	87%	0	95%	0	100%	0	93%	0	92%	0	100%	1	89%
15	1	93%	0	92%	0	70%	2	88%	1	96%	0	100%	0	93%	0	92%	0	100%	4	89%
16	0	93%	1	93%	1	72%	0	88%	0	96%	0	100%	0	93%	0	92%	0	100%	2	90%
17	0	93%	0	93%	1	74%	0	88%	0	96%	0	100%	0	93%	0	92%	0	100%	1	90%
20	1	95%	1	94%	4	80%	6	91%	0	96%	0	100%	1	95%	0	92%	0	100%	13	92%
24.3	0	95%	0	94%	0	80%	1	91%	0	96%	0	100%	0	95%	0	92%	0	100%	1	92%
25	1	98%	0	94%	1	82%	1	91%	0	96%	0	100%	0	95%	1	93%	0	100%	4	92%
29	0	98%	0	94%	1	84%	0	91%	0	96%	0	100%	0	95%	0	93%	0	100%	1	93%
30	0	98%	0	94%	1	85%	1	92%	0	96%	0	100%	0	95%	1	94%	0	100%	3	93%
35	0	98%	0	94%	1	87%	1	92%	0	96%	0	100%	0	95%	0	94%	0	100%	2	93%
40	0	98%	0	94%	1	89%	2	93%	0	96%	0	100%	0	95%	0	94%	0	100%	3	94%
50	1	100%	0	94%	0	89%	4	95%	1	97%	0	100%	0	95%	0	94%	0	100%	6	95%
60	0	100%	0	94%	1	90%	1	95%	0	97%	0	100%	0	95%	0	94%	0	100%	2	95%
70	0	100%	0	94%	0	90%	1	96%	0	97%	0	100%	0	95%	0	94%	0	100%	1	95%
75	0	100%	0	94%	0	90%	1	96%	0	97%	0	100%	0	95%	0	94%	0	100%	1	95%
80	0	100%	1	95%	1	92%	1	97%	0	97%	0	100%	0	95%	0	94%	0	100%	3	96%
90	0	100%	0	95%	1	93%	0	97%	0	97%	0	100%	0	95%	0	94%	0	100%	1	96%
99.8	0	100%	0	95%	0	93%	0	97%	0	97%	0	100%	0	95%	1	95%	0	100%	1	96%
100	0	100%	1	96%	1	95%	1	97%	0	97%	0	100%	0	95%	1	97%	0	100%	4	97%
120	0	100%	1	96%	0	95%	0	97%	0	97%	0	100%	0	95%	0	97%	0	100%	1	97%
125	0	100%	0	96%	0	95%	1	97%	0	97%	0	100%	0	95%	0	97%	0	100%	1	97%
145	0	100%	0	96%	0	95%	1	98%	0	97%	0	100%	0	95%	0	97%	0	100%	1	97%
150	0	100%	0	96%	0	95%	0	98%	0	97%	0	100%	1	97%	0	97%	0	100%	1	97%
180.1	0	100%	0	96%	0	95%	1	98%	0	97%	0	100%	0	97%	0	97%	0	100%	1	97%
190	0	100%	0	96%	1	97%	0	98%	0	97%	0	100%	0	97%	0	97%	0	100%	1	97%
200	0	100%	0	96%	0	97%	1	99%	0	97%	0	100%	0	97%	0	97%	0	100%	1	98%
250	0	100%	1	97%	1	98%	0	99%	0	97%	0	100%	0	97%	0	97%	0	100%	2	98%
300	0	100%	0	97%	0	98%	1	99%	0	97%	0	100%	0	97%	0	97%	0	100%	1	98%
310	0	100%	0	97%	1	100%	0	99%	0	97%	0	100%	0	97%	0	97%	0	100%	1	98%
318	0	100%	1	98%	0	100%	0	99%	0	97%	0	100%	0	97%	0	97%	0	100%	1	98%
350	0	100%	0	98%	0	100%	0	99%	0	97%	0	100%	0	97%	1	98%	0	100%	1	99%
400	0	100%	0	98%	0	100%	0	99%	1	99%	0	100%	0	97%	0	98%	0	100%	1	99%
450	0	100%	0	98%	0	100%	0	99%	1	100%	0	100%	0	97%	0	98%	0	100%	1	99%
500	0	100%	0	98%	0	100%	0	99%	0	100%	0	100%	0	97%	1	99%	0	100%	1	99%
600	0	100%	0	98%	0	100%	1	100%	0	100%	0	100%	0	97%	1	100%	0	100%	2	99%
700	0	100%	0	98%	0	100%	1	100%	0	100%	0	100%	0	97%	0	100%	0	100%	1	99%
1000	0	100%	1	99%	0	100%	0	100%	0	100%	0	100%	0	97%	0	100%	0	100%	1	100%
1500	0	100%	0	99%	0	100%	0	100%	0	100%	0	100%	2	100%	0	100%	0	100%	2	100%
9000	0	100%	1	100%	0	100%	0	100%	0	100%	0	100%	0	100%	0	100%	0	100%	1	100%
TOTAL	42		112		61		233		74		7		59		87		1		678	

Table H5 : 1992 frequency distribution of detection sizes by priority zone

	RED		ORANGE		YELLOW		GREEN		WHITE		ALL ZONES	
detection size	# fires	% cumulative	# fires	% cumulative	# fires	% cumulative	# fires	% cumulative	# fires	% cumulative	# fires	% cumulative
0.1	48	35%	5	25%	8	23%	20	23%	2	11%	83	28%
0.2	9	41%	3	40%	1	26%	5	29%	0	11%	18	34%
0.3	8	47%	0	40%	0	26%	3	33%	0	11%	11	38%
0.4	3	49%	0	40%	5	40%	3	36%	0	11%	11	41%
0.5	18	62%	1	45%	2	46%	9	47%	2	22%	32	52%
0.6	1	63%	0	45%	0	46%	0	47%	0	22%	1	52%
0.8	2	64%	1	50%	3	54%	1	48%	0	22%	7	55%
0.9	0	64%	1	55%	0	54%	0	48%	0	22%	1	55%
1	19	78%	1	60%	4	66%	3	51%	1	28%	28	64%
1.2	1	78%	0	60%	0	66%	2	53%	0	28%	3	65%
1.5	3	81%	0	60%	0	66%	2	56%	0	28%	5	67%
1.6	0	81%	0	60%	0	66%	1	57%	0	28%	1	67%
1.8	0	81%	0	60%	0	66%	1	58%	0	28%	1	68%
2	10	88%	0	60%	1	69%	5	64%	1	33%	17	73%
2.1	1	88%	0	60%	0	69%	0	64%	0	33%	1	74%
2.2	1	89%	0	60%	0	69%	0	64%	0	33%	1	74%
2.4	0	89%	0	60%	0	69%	0	64%	1	39%	1	74%
2.5	2	91%	0	60%	0	69%	0	64%	0	39%	2	75%
3	3	93%	0	60%	0	69%	3	67%	0	39%	6	77%
4	1	94%	1	65%	0	69%	1	69%	3	56%	6	79%
4.1	0	94%	0	65%	0	69%	1	70%	0	56%	1	80%
4.5	0	94%	0	65%	0	69%	1	71%	0	56%	1	80%
5	3	96%	0	65%	1	71%	2	73%	0	56%	6	82%
6	0	96%	0	65%	0	71%	1	74%	0	56%	1	82%
7	1	96%	0	65%	0	71%	1	76%	0	56%	2	83%
8	0	96%	1	70%	3	80%	1	77%	1	61%	6	85%
9	0	96%	1	75%	0	80%	0	77%	0	61%	1	85%
10	1	97%	0	75%	2	86%	4	81%	0	61%	7	88%
12	0	97%	0	75%	0	86%	1	83%	0	61%	1	88%
15	1	98%	0	75%	0	86%	2	85%	0	61%	3	89%
16	0	98%	1	80%	0	86%	1	86%	0	61%	2	90%
17	0	98%	0	80%	0	86%	0	86%	1	67%	1	90%
20	1	99%	1	85%	2	91%	2	88%	2	78%	8	93%
25	0	99%	1	90%	2	97%	1	90%	0	78%	4	94%
33	1	99%	0	90%	0	97%	0	90%	0	78%	1	94%
40	0	99%	0	90%	0	97%	2	92%	1	83%	3	95%
48	0	99%	1	95%	0	97%	0	92%	0	83%	1	96%
50	0	99%	1	100%	0	97%	1	93%	1	89%	3	97%
75	0	99%	0	100%	0	97%	1	94%	0	89%	1	97%
80	0	99%	0	100%	1	100%	1	95%	0	89%	2	98%
100	0	99%	0	100%	0	100%	1	97%	0	89%	1	98%
120	0	99%	0	100%	0	100%	0	97%	1	94%	1	98%
125	0	99%	0	100%	0	100%	1	98%	0	94%	1	99%
212	1	100%	0	100%	0	100%	0	98%	0	94%	1	99%
800	0	100%	0	100%	0	100%	1	99%	0	94%	1	99%
1280.2	0	100%	0	100%	0	100%	1	100%	0	94%	1	100%
3000	0	100%	0	100%	0	100%	0	100%	1	100%	1	100%
TOTAL	139		20		35		86		18		298	

Table H6 :1992 frequency distribution of detection sizes by detection method

	tower		designated air patrol		ground patrol		public cooperation		aircraft cooperation		railway		contract aircraft		loaded helicopter patrol		1-800 line		all detection methods	
det size (ha)	# fires	% cumll	# fires	% cumll	# fires	% cumll	# fires	% cumll	# fires	% cumll	# fires	% cumll	# fires	% cumll	# fires	% cumll	# fires	% cumll	# fires	% cumll
0.1	4	18%	7	18%	8	33%	45	34%	9	20%	0	0%	5	26%	5	38%	0	0%	83	28%
0.2	1	23%	4	28%	3	46%	6	39%	1	23%	0	0%	3	42%	0	38%	0	0%	18	34%
0.3	2	32%	1	31%	0	46%	5	42%	3	30%	0	0%	0	42%	0	38%	0	0%	11	38%
0.4	0	32%	1	33%	0	46%	3	45%	2	34%	0	0%	4	63%	1	46%	0	0%	11	41%
0.5	2	41%	1	36%	2	54%	15	56%	6	48%	0	0%	3	79%	2	62%	1	25%	32	52%
0.6	0	41%	0	36%	0	54%	1	57%	0	48%	0	0%	0	79%	0	62%	0	25%	1	52%
0.8	1	45%	1	38%	0	54%	2	58%	1	50%	0	0%	1	84%	1	69%	0	25%	7	55%
0.9	0	45%	0	38%	0	54%	1	59%	0	50%	0	0%	0	84%	0	69%	0	25%	1	55%
1	1	50%	6	54%	3	67%	10	67%	6	64%	0	0%	0	84%	0	69%	2	75%	28	64%
1.2	0	50%	0	54%	0	67%	1	67%	1	66%	0	0%	0	84%	1	77%	0	75%	3	65%
1.5	2	59%	2	59%	0	67%	1	68%	0	66%	0	0%	0	84%	0	77%	0	75%	5	67%
1.6	0	59%	0	59%	0	67%	0	68%	1	68%	0	0%	0	84%	0	77%	0	75%	1	67%
1.8	0	59%	0	59%	0	67%	0	68%	1	70%	0	0%	0	84%	0	77%	0	75%	1	68%
2	2	68%	3	67%	0	67%	10	76%	2	75%	0	0%	0	84%	0	77%	0	75%	17	73%
2.1	0	68%	0	67%	0	67%	1	77%	0	75%	0	0%	0	84%	0	77%	0	75%	1	74%
2.2	0	68%	0	67%	0	67%	0	77%	0	75%	0	0%	0	84%	1	85%	0	75%	1	74%
2.4	0	68%	0	67%	0	67%	1	77%	0	75%	0	0%	0	84%	0	85%	0	75%	1	74%
2.5	0	68%	0	67%	0	67%	2	79%	0	75%	0	0%	0	84%	0	85%	0	75%	2	75%
3	1	73%	3	74%	0	67%	2	80%	0	75%	0	0%	0	84%	0	85%	0	75%	6	77%
4	0	73%	2	79%	0	67%	2	82%	2	80%	0	0%	0	84%	0	85%	0	75%	6	79%
4.1	0	73%	0	79%	0	67%	0	82%	1	82%	0	0%	0	84%	0	85%	0	75%	1	80%
4.5	0	73%	0	79%	0	67%	1	83%	0	82%	0	0%	0	84%	0	85%	0	75%	1	80%
5	0	73%	1	82%	2	75%	2	84%	1	84%	0	0%	0	84%	0	85%	0	75%	6	82%
6	0	73%	0	82%	0	75%	1	85%	0	84%	0	0%	0	84%	0	85%	0	75%	1	82%
7	0	73%	0	82%	0	75%	1	86%	1	86%	0	0%	0	84%	0	85%	0	75%	2	83%
8	1	77%	3	90%	0	75%	1	86%	1	89%	0	0%	0	84%	0	85%	0	75%	6	85%
9	0	77%	0	90%	1	79%	0	86%	0	89%	0	0%	0	84%	0	85%	0	75%	1	85%
10	2	86%	0	90%	1	83%	2	88%	1	91%	0	0%	1	89%	0	85%	0	75%	7	88%
12	0	86%	0	90%	0	83%	1	89%	0	91%	0	0%	0	89%	0	85%	0	75%	1	88%
15	0	86%	0	90%	1	88%	1	89%	1	93%	0	0%	0	89%	0	85%	0	75%	3	89%
16	0	86%	1	92%	0	88%	0	89%	0	93%	1	100%	0	89%	0	85%	0	75%	2	90%
17	0	86%	0	92%	0	88%	0	89%	1	95%	0	100%	0	89%	0	85%	0	75%	1	90%
20	0	86%	1	95%	0	88%	5	93%	1	98%	0	100%	0	89%	1	92%	0	75%	8	93%
25	1	91%	0	95%	1	92%	2	95%	0	98%	0	100%	0	89%	0	92%	0	75%	4	94%
33	0	91%	0	95%	1	96%	0	95%	0	98%	0	100%	0	89%	0	92%	0	75%	1	94%
40	1	95%	0	95%	1	100%	0	95%	0	98%	0	100%	0	89%	0	92%	1	100%	3	95%
48	0	95%	0	95%	0	100%	0	95%	0	98%	0	100%	0	89%	1	100%	0	100%	1	96%
50	0	95%	0	95%	0	100%	2	96%	0	98%	0	100%	1	95%	0	100%	0	100%	3	97%
75	0	95%	0	95%	0	100%	0	96%	0	98%	0	100%	1	100%	0	100%	0	100%	1	97%
80	0	95%	1	97%	0	100%	1	97%	0	98%	0	100%	0	100%	0	100%	0	100%	2	98%
100	0	95%	1	100%	0	100%	0	97%	0	98%	0	100%	0	100%	0	100%	0	100%	1	98%
120	1	100%	0	100%	0	100%	0	97%	0	98%	0	100%	0	100%	0	100%	0	100%	1	98%
125	0	100%	0	100%	0	100%	1	98%	0	98%	0	100%	0	100%	0	100%	0	100%	1	99%
212	0	100%	0	100%	0	100%	1	98%	0	98%	0	100%	0	100%	0	100%	0	100%	1	99%
800	0	100%	0	100%	0	100%	0	98%	1	100%	0	100%	0	100%	0	100%	0	100%	1	99%
1280	0	100%	0	100%	0	100%	1	99%	0	100%	0	100%	0	100%	0	100%	0	100%	1	100%
3000	0	100%	0	100%	0	100%	1	100%	0	100%	0	100%	0	100%	0	100%	0	100%	1	100%
TOTAL	22		39		24		132		44		1		19		13		4		298	

Appendix I Qualitative Observations from Daily Planning Sheets

1990 fire season

Northeast region 1990

During the 1990 season this region generally had three helicopters at levels 0 to 1, four to seven helicopters at levels II to III and eight helicopters at level IV, or when sustained fire action occurred. In general the region required six helicopters before bases indicated a 15 minute attack for levels III and IV. The one large fire of note from a resource requirement perspective was the Wabowden fire in July.

Northwest region 1990

In this region helicopters were maintained once man-up occurred. A fair amount of doubling up of helicopters on attack bases occurred, but since report sheets do not properly differentiate between initial attack, and sustained action placements, further analysis was not possible. Comments on the daily report sheet indicate that the fire control officer keeps good account of the "spec" resources in the region. Overall, two helicopters were in place at levels 0-1, 3-6 helicopters at levels II-III, and seven or more at level III plus.

Western region 1990

This region generally has a light helicopter available on "spec" in Swan River that is capable of meeting most initial attack needs. When heavier fire problems occur the region relies on the Northwest region to assist it with suppression and initial attack.

Interlake region 1990

Helicopters were only available in the spring with most midsummer requests denied by the duty officer.

Eastern region 1990

At levels 0 to II this region often operates with two helicopters or less. It depends on CL-215 bombers in early part of the season before they are dispatched north. At levels II to III, 4 to 5 helicopters are generally in place. At level III or more with sustained action six helicopters or more have been utilized. Regional fire control officers often recommended when excess machines were in place and indicating casual hires not be extended. Major fire event occurred in the Bloodvein in August.

Southeast region 1990

Often depends on light helicopter stationed in Rennie for coverage. The season was generally uneventful with a large number of days with no helicopters documented.

Southwest region 1990

A non fire type region, no requests, no placements.

Whiteshell region 1990

Noticed Rennie is used as an attack base center with two helicopters often doubled up when levels are at III. The "spec" helicopter machine is often in place at Rennie but not always shown on daily report. This region often depended upon the eastern region to cover off the northern portion of the region with helicopters and waterbombers.

1991 fire season

Northeast region 1991

Cl-215 waterbombers were stationed in this region for a considerable amount of time. At levels III to IV generally 5 helicopters were in place. Some doubling up of machinery did occur, but it was the exception. The region indicated a substantial amount of roving coverage where one helicopter covered two or more base areas. This roaming task was generally accomplished through the use of a medium helicopter covering off adjacent bases. Helicopter resources were often indicated as committed to transport purposes or fire action.

Northwest region 1991

The region went through prolonged stretches of time with only one helicopter in place when alert levels were low. Most demands made by fire control officer were met. Fire control officer exceeded in communicating the available machines located in the region.

Southeast region 1991

The region often depended on Rennie for coverage. Loaded helicopter patrols were often coordinated with the eastern region. Documentation appears to indicate good inter-regional cooperation.

Eastern region 1991

Resource requests generally met with the fire control officer almost always spreading resources out across the region. Virtually no doubling up of resources, and waterbombers were often indicated as unserviceable.

Interlake region 1991

Alert levels are generally high in spring and low in the fall. Helicopter usage was generally limited to the spring and fall. Long periods of time with no helicopter resources, with Gypsumville having most placements when helicopters were listed.

Western region 1991

Utilized local light helicopter when required for loaded patrols. Medium helicopter was in place in spring time before it was required in the north.

Whiteshell 1991

Extensive doubling up of helicopter resources occurred in Rennie when more than one machine was available. This may partially be accounted for by the fact that a "spec" machine often placed in Rennie. Relied on the Eastern region for loaded patrols in northern portion of region. Prolonged periods with 1 or no helicopters

1992 fire season

Northeast region 1992

At low levels 0 to I, two or more helicopters were often based at Paint Lake. Helicopter resources are generally not spread out across the region until level III alert is in place. Level 3 resource needs are often addressed by bringing on additional light helicopters at remote locations rather than moving medium helicopters from the Paint Lake area. Prolonged periods in July when levels were at 0 to II with three machines stationed at Paint Lake.

Northwest region 1992

The majority of the season was addressed by one helicopter based out of Snow Lake. Levels were generally depressed throughout the region with very little resource movement. No documented requests for additional machinery all season.

Western region 1992

The region had almost all its needs met by a "spec" helicopter in Swan River. Long periods occurred with no need for helicopters or additional resources.

Central region 1992

Noticed when a helicopter was available in the region it was usually located at Hodgson. No resource requests documented. When two machines available in region they were usually placed in the same location.

Eastern region 1992

The season had long periods with only one helicopter. The region often coordinated the protection of the entire southeast and eastern portion of the province.

Appendix J IFMIS Size Predictions Cross Compared by Fire Type and Spread Rate

Table J1: 1991 IFMIS predictions compared to wildfire report data by fuel type and spread rate

spread rate	very slow				slow				moderate				fast				very fast				all fires			
Fuel type	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)
Spruce/lichen woodland (C1)	8	0.5	0.5	0.9	12	0.4	0.4	0.7	8	1.2	2.5	1.4	5	6.0	12.6	22.8					33	1.5	2.8	4.3
boreal spruce (C2)	41	1.0	1.0	4.9	43	0.3	0.6	3.3	32	3.7	4.4	11.1	17	2.1	44.7	15.3	2	1.0	3.5	14.0	135	1.6	7.2	7.3
mature jackpine (C3)	27	0.2	0.2	0.5	31	0.9	1.1	2.7	22	1.5	2.5	3.7	8	4.0	4.9	7.5					88	1.1	1.5	2.7
immature jackpine (C4)	9	0.1	0.1	2.9	9	0.7	1.5	6.9	8	0.3	0.4	2.0	1	0.1	3.8	2.8					27	0.3	0.8	4.0
red & white pine (C5)									1	0.1	0.1	0.1									1	0.1	0.1	0.1
leafless aspen (D1)	3	0.3	0.3	0.4	2	0.3	0.5	0.3	8	46.2	54.3	48.0	7	4.7	5.9	5.4	1	2.0	5.0	1.0	21	19.3	23.0	20.2
boreal mixed wood leafless (M1)	1	1.0	1.0	1.4	3	0.4	1.8	1.5	5	4.1	4.4	5.7	1	10.0	10.5	11.1	1	0.1	2.5	0.1	11	3.0	3.8	4.1
boreal mixed wood summer (M2)	19	0.3	0.3	2.4	17	0.6	1.4	4.5	7	0.4	0.6	2.5	5	1.1	1.7	5.0	3	15.1	16.8	18.5	51	1.4	1.8	4.3
standing grass open (O1)	15	1.1	1.4	7.5	12	3.3	3.8	18.7	27	2.6	7.1	14.1	11	30.7	64.0	46.7	1	0.1	10.0	7.7	66	7.0	14.8	18.8
jack pine slash (S1)									1	0.1	0.2	0.4	1	4.5	4.5	9.0					2	2.3	2.4	4.7
spruce balsam slash (S2)	3	0.1	0.1	1.6	2	0.3	0.3	1.8	5	4.4	4.9	5.8	3	11.7	11.7	12.8					13	4.5	4.6	5.8
ALL FUELS	126	0.6	0.7	3.3	131	0.8	1.2	4.6	124	5.2	7.2	10.5	59	8.9	28.3	18.1	8	6.2	9.4	11.5	448	3.1	6.4	7.8

Table J2: 1992 IFMIS predictions compared to wildfire report data by fuel type and spread rate

spread rate	very slow				slow				moderate				fast				very fast				all fires			
Fuel type	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)
Spruce/lichen woodland (C1)	4	2.2	2.2	2.2	9	0.9	1.4	2.0	10	1.5	2.7	2.2	3	3.4	6.2	3.4	2	5.0	37.5	6.3	28	1.9	5.1	2.6
boreal spruce (C2)	26	0.4	0.5	3.9	19	1.5	1.9	16.7	19	2.8	5.7	21.8	7	8.8	12.6	15.6	2	6.4	8.1	33.4	73	2.3	3.6	13.8
mature jackpine (C3)	12	0.7	0.7	1.2	5	1.0	1.4	1.1	11	0.3	0.4	1.4	4	0.4	0.7	0.9					32	0.5	0.7	1.2
immature jackpine (C4)	1	0.5	0.5	2.2					3	0.4	0.4	7.2	1	1.0	1.2	16.4					5	0.5	0.6	8.0
red & white pine (C5)	1	10.0	25.0	22.7																	1	10.0	25.0	22.7
red pine plantation (C6)					1	0.1	0.5	0.3													1	0.1	0.5	0.3
leafless aspen (D1)	1	0.6	0.6	0.9	4	1.5	3.1	3.3	4	16.0	19.3	18.5	4	8.3	15.3	9.4	1	2.0	7.0	3.8	14	7.5	11.3	9.2
boreal mixed wood leafless (M1)	2	0.5	0.5	2.0					3	2.4	3.9	5.0	2	1.1	1.6	4.4	1	1.0	1.5	2.5	8	1.4	2.2	3.8
boreal mixed wood summer (M2)	8	0.2	0.2	4.0	5	0.8	0.8	2.7	8	0.7	1.3	3.4									21	0.5	0.8	3.5
standing grass open (O1)	7	0.4	0.4	27.8	4	0.6	0.6	12.1	12	19.7	20.5	28.5	6	13.8	19.1	61.4	2	1.6	15.8	128.3	31	10.6	12.8	39.0
jack pine slash (S1)	2	0.1	0.1	0.6																	2	0.1	0.1	0.6
spruce balsam slash (S2)	1	0.1	0.1	0.1					2	0.6	1.3	1.5									3	0.4	0.9	1.0
ALL FUELS	65	0.7	0.9	5.9	47	1.2	1.6	8.9	72	5.4	6.8	13.0	27	7.1	10.7	20.5	8	3.6	16.4	42.8	219	3.2	4.8	12.0

Table J3: 1991 averaged IFMIS predictions compared to wildfire report data by fuel type and fire type

fire type	surface				subsurface				crown				torching				all fires			
Fuel type	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)
Spruce/lichen woodland (C1)	24	0.5	0.7	0.6	3	0.6	0.6	1.9	2	4.0	9.0	14.0	4	6.9	13.8	23.1	33	1.5	2.8	4.3
boreal spruce (C2)	77	2.1	2.5	6.6	33	0.4	0.4	4.3	5	1.2	114.6	11.3	20	1.7	10.0	14.0	135	1.6	7.2	7.3
mature jackpine (C3)	67	0.9	1.2	2.3	13	0.7	0.7	1.9					8	3.9	5.2	7.3	88	1.1	1.5	2.7
immature jackpine (C4)	22	0.3	0.7	3.3	2	0.7	0.7	4.0					3	0.1	1.7	9.1	27	0.3	0.8	4.0
red & white pine (C5)	1	0.1	0.1	0.1													1	0.1	0.1	0.1
leafless aspen (D1)	21	19.3	23.0	20.2													21	19.3	23.0	20.2
boreal mixed wood leafless (M1)	8	2.7	3.4	4.1	2	0.6	1.8	0.8					1	10.0	10.5	11.1	11	3.0	3.8	4.1
boreal mixed wood summer (M2)	40	0.9	1.5	3.7	9	0.3	0.4	3.9	1	30.0	30.0	36.3	1	0.5	1.5	3.0	51	1.4	1.8	4.3
standing grass open (O1)	60	7.7	16.2	17.0	6	0.5	0.6	36.0									66	7.0	14.8	18.8
jack pine slash (S1)	1	0.1	0.2	0.4					1	4.5	4.5	9.0					2	2.3	2.4	4.7
spruce balsam slash (S2)	9	2.0	2.0	3.3	1	0.1	0.1	0.1					3	13.4	14.0	15.2	13	4.5	4.6	5.8
ALL FBP FUELS	330	3.6	5.6	7.3	69	0.5	0.5	6.3	9	5.4	69.5	14.4	40	3.6	8.9	13.0	448	3.1	6.4	7.8

Table J4: 1992 averaged IFMIS predictions compared to wildfire report data by fuel type and fire type

fire type	surface				subsurface				crown				torching				all fires su			
Fuel type	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)
Spruce/lichen woodland (C1)	13	1.2	1.7	1.9	7	1.7	3.3	2.8	3	4.1	25.7	5.0	5	2.4	3.9	2.6	28	1.9	5.1	2.6
boreal spruce (C2)	37	1.9	2.4	7.2	12	1.9	1.9	10.7	5	6.8	10.0	18.7	19	2.0	5.1	27.4	73	2.3	3.6	13.8
mature jackpine (C3)	19	0.7	0.8	1.1	8	0.3	0.4	1.7	1	0.4	0.4	1.7	4	0.4	0.9	0.6	32	0.5	0.7	1.2
immature jackpine (C4)	2	0.8	0.8	8.2	2	0.1	0.1	3.6					1	1.0	1.2	16.4	5	0.5	0.6	8.0
red & white pine (C5)	1	10.0	25.0	22.7													1	10.0	25.0	22.7
red pine plantation (C6)													1	0.1	0.5	0.3	1	0.1	0.5	0.3
leafless aspen (D1)	13	8.0	11.6	9.7									1	2.0	7.0	3.8	14	7.5	11.3	9.2
boreal mixed wood leafless (M1)	7	1.6	2.1	3.6									1	0.5	2.5	5.0	8	1.4	2.2	3.8
boreal mixed wood summer (M2)	16	0.6	0.9	4.1	5	0.5	0.5	1.5									21	0.5	0.8	3.5
standing grass open (O1)	30	10.9	13.2	40.3	1	0.1	0.1	1.1									31	10.6	12.8	39.0
jack pine slash (S1)	1	0.1	0.1	0.1	1	0.1	0.1	1.1									2	0.1	0.1	0.6
spruce balsam slash (S2)	3	0.4	0.9	1.0													3	0.4	0.9	1.0
ALL FUELS	142	4.0	5.2	12.5	36	1.1	1.4	5.0	9	5.2	14.2	12.2	32	1.7	4.1	17.5	219	3.2	4.8	12.0

Table J5a: All fuel types fire rate/fire type cross comparison 1991

fire type	surface				subsurface				crown				torching				all fires			
Fire rate	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)
very slow	100	0.7	0.7	2.9	25	0.4	0.4	4.9					1	0.5	0.5	4.2	126	0.6	0.7	3.3
slow	100	0.9	1.4	3.8	24	0.3	0.4	7.9					7	1.2	1.6	5.8	131	0.8	1.2	4.6
moderate	97	6.2	8.5	11.0	15	0.5	0.5	7.5	2	1.4	1.6	13.9	10	3.7	5.6	9.7	124	5.2	7.2	10.5
fast	29	14.0	27.2	22.2	4	1.5	1.6	3.0	6	2.6	98.7	10.9	20	4.8	14.1	17.4	59	8.9	28.3	18.1
very fast	4	4.3	8.9	7.0	1	0.1	2.5	0.1	1	30.0	30.0	36.3	2	1.0	3.5	14.0	8	6.2	9.4	11.5
ALL RATES	**330**	**3.6**	**5.6**	**7.3**	**69**	**0.5**	**0.5**	**6.3**	**9**	**5.4**	**69.5**	**14.4**	**40**	**3.6**	**8.9**	**13.0**	**448**	**3.1**	**6.4**	**7.8**

Table J5b: All fuel types fire rate/fire type cross comparison 1992

fire type	surface				subsurface				crown				torching				all fires			
Fire rate	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)
very slow	52	0.6	0.9	6.7	13	1.0	1.0	2.7									65	0.7	0.9	5.9
slow	30	0.8	1.3	4.1	10	2.1	2.2	11.4					7	1.3	2.0	25.9	47	1.2	1.6	8.9
moderate	43	8.4	9.3	14.2	12	0.3	1.2	2.3	3	1.5	2.3	10.1	14	1.3	4.6	19.0	72	5.4	6.8	13.0
fast	14	10.2	15.1	31.5	1	2.5	2.5	2.7	4	8.1	11.4	16.8	8	1.8	3.7	5.5	27	7.1	10.7	20.5
very fast	3	1.4	11.0	86.3					2	5.0	37.5	6.3	3	4.9	7.7	23.6	8	3.6	16.4	42.8
ALL RATES	**142**	**4.0**	**5.2**	**12.5**	**36**	**1.1**	**1.4**	**5.0**	**9**	**5.2**	**14.2**	**12.2**	**32**	**1.7**	**4.1**	**17.5**	**219**	**3.2**	**4.8**	**12.0**

Table J6a: C1 fire rate/fire type cross comparison 1991

fire type	surface				subsurface				crown				torching				all fires			
Fire rate	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)
very slow	7	0.6	0.6	1.0	1	0.1	0.1	0.1									8	0.5	0.5	0.9
slow	10	0.3	0.4	0.4	1	0.2	0.3	4.0					1	1.0	1.0	1.0	12	0.4	0.4	0.7
moderate	5	0.4	0.9	0.4	1	1.5	1.5	1.6					2	3.3	7.0	3.7	8	1.2	2.5	1.4
fast	2	1.1	2.5	1.1					2	4.0	9.0	14.0	1	20.0	40.0	83.9	5	6.0	12.6	22.8
very fast																				
ALL RATES	**24**	**0.5**	**0.7**	**0.6**	**3**	**0.6**	**0.6**	**1.9**	**2**	**4.0**	**9.0**	**14.0**	**4**	**6.9**	**13.8**	**23.1**	**33**	**1.5**	**2.8**	**4.3**

Table J6b: C1 fire rate/fire type cross comparison 1992

fire type	surface				subsurface				crown				torching				all fires			
Fire rate	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)
very slow	1	0.2	0.2	0.2	3	2.8	2.8	2.9									4	2.2	2.2	2.2
slow	5	0.9	1.6	1.4	3	0.9	1.2	3.6					1	0.5	1.0	0.5	9	0.9	1.4	2.0
moderate	6	1.9	2.0	2.8	1	0.5	11.0	0.5	1	2.2	2.2	2.3	2	0.8	0.8	1.1	10	1.5	2.7	2.2
fast	1	0.1	1.5	0.2									2	5.0	8.5	5.0	3	3.4	6.2	3.4
very fast									2	5.0	37.5	6.3					2	5.0	37.5	6.3
ALL RATES	**13**	**1.2**	**1.7**	**1.9**	**7**	**1.7**	**3.3**	**2.8**	**3**	**4.1**	**25.7**	**5.0**	**5**	**2.4**	**3.9**	**2.6**	**28**	**1.9**	**5.1**	**2.6**

Table J7a: C2 fire rate/fire type cross comparison 1991

fire type	surface				subsurface				crown				torching				all fires			
Fire rate	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)
very slow	26	1.4	1.4	3.9	14	0.4	0.4	6.8					1	0.5	0.5	4.2	41	1.0	1.0	4.9
slow	30	0.4	0.8	3.5	11	0.1	0.1	2.1					2	0.2	0.2	5.6	43	0.3	0.6	3.3
moderate	20	5.4	6.2	12.7	6	0.2	0.2	2.9	2	1.4	1.6	13.9	4	1.9	2.8	14.1	32	3.7	4.4	11.1
fast	1	3.0	4.0	43.7	2	2.5	2.5	3.9	3	1.0	189.9	9.5	11	2.2	16.5	16.4	17	2.1	44.7	15.3
very fast													2	1.0	3.5	14.0	2	1.0	3.5	14.0
ALL RATES	**77**	**2.1**	**2.5**	**6.6**	**33**	**0.4**	**0.4**	**4.3**	**5**	**1.2**	**114.6**	**11.3**	**20**	**1.7**	**10.0**	**14.0**	**135**	**1.6**	**7.2**	**7.3**

Table J7b: C2 fire rate/fire type cross comparison 1992

fire type	surface				subsurface				crown				torching				all fires			
Fire rate	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)
very slow	20	0.4	0.4	3.9	6	0.7	0.7	3.9									26	0.4	0.5	4.3
slow	10	0.5	0.7	3.8	4	4.1	4.1	25.0					5	1.6	2.4	36.0	19	1.5	1.9	7.3
moderate	6	5.8	7.2	21.2	1	0.1	0.2	2.1	2	1.1	2.4	14.0	10	1.5	6.0	25.8	19	2.8	5.7	2.7
fast	1	25.0	32.0	25.8	1	2.5	2.5	2.7	3	10.7	15.0	21.8	2	1.0	4.5	7.7	7	8.8	12.6	4.0
very fast													2	6.4	8.1	33.4	2	6.4	8.1	0.1
ALL RATES	**37**	**1.9**	**2.4**	**7.2**	**12**	**1.9**	**1.9**	**10.7**	**5**	**6.8**	**10.0**	**18.7**	**19**	**2.0**	**5.1**	**27.4**	**73**	**2.3**	**3.6**	**20.2**

Table J8a: C3 fire rate/fire type cross comparison 1991

fire type	surface				subsurface				crown				torching				all fires			
Fire rate	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)
very slow	24	0.2	0.2	0.5	3	0.2	0.3	0.2									27	1.5	2.8	4.3
slow	23	0.7	0.9	3.0	5	0.9	0.9	1.3					3	2.3	3.0	2.2	31	1.6	7.2	7.3
moderate	17	1.6	2.7	3.7	4	0.7	0.7	4.2					1	2.0	6.0	2.5	22	1.1	1.5	2.7
fast	3	3.0	4.0	3.1	1	1.0	1.0	1.0					4	5.6	6.6	12.4	8	0.3	0.8	4.0
very fast																	0	0.1	0.1	0.1
ALL RATES	**67**	**0.9**	**1.2**	**2.3**	**13**	**0.7**	**0.7**	**1.9**					**8**	**3.9**	**5.2**	**7.3**	**88**	**19.3**	**23.0**	**20.2**

Table J8b: C3 fire rate/fire type cross comparison 1992

fire type	surface				subsurface				crown				torching				all fires			
Fire rate	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)
very slow	10	0.8	0.8	1.4	2	0.1	0.1	0.2									12	0.7	0.7	1.2
slow	3	1.3	2.0	1.5	2	0.6	0.6	0.6									5	1.0	1.4	1.1
moderate	6	0.2	0.3	0.5	4	0.4	0.5	3.0					1	0.4	1.2	0.5	11	0.3	0.4	1.4
fast									1	0.4	0.4	1.7	3	0.4	0.8	0.7	4	0.4	0.7	0.9
very fast																				
ALL RATES	**19**	**0.7**	**0.8**	**1.1**	**8**	**0.3**	**0.4**	**1.7**	**1**	**0.4**	**0.4**	**1.7**	**4**	**0.4**	**0.9**	**0.6**	**32**	**0.5**	**0.7**	**1.2**

Table J9a: C4 fire rate/fire type cross comparison 1991

fire type	surface				subsurface				crown				torching				all fires			
Fire rate	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)
very slow	9	0.1	0.1	2.9													9	0.1	0.1	2.9
slow	7	0.7	1.7	5.1	1	1.0	1.0	5.1					1	0.1	0.4	21.6	9	0.7	1.5	6.9
moderate	6	0.3	0.3	1.7	1	0.3	0.3	2.9					1	0.2	0.9	2.8	8	0.3	0.4	2.0
fast													1	0.1	3.8	2.8	1	0.1	3.8	2.8
very fast																				
ALL RATES	**22**	**0.3**	**0.7**	**3.3**	**2**	**0.7**	**0.7**	**4.0**					**3**	**0.1**	**1.7**	**9.1**	**27**	**0.3**	**0.8**	**4.0**

Table J9b: C4 fire rate/fire type cross comparison 1992

fire type	surface				subsurface				crown				torching				all fires			
Fire rate	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)
very slow	1	0.5	0.5	2.2													1	0.5	0.5	2.2
slow																				
moderate	1	1.0	1.0	14.2	2	0.1	0.1	3.6									3	0.4	0.4	7.2
fast													1	1.0	1.2	16.4	1	1.0	1.2	16.4
very fast																				
ALL RATES	**2**	**0.8**	**0.8**	**8.2**	**2**	**0.1**	**0.1**	**3.6**					**1**	**1.0**	**1.2**	**16.4**	**5**	**0.5**	**0.6**	**8.0**

Table J10a: C5 fire rate/fire type cross comparison 1991

fire type	surface				subsurface				crown				torching				all fires			
Fire rate	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)
very slow																				
slow																				
moderate	1	0.1	0.1	0.1													1	0.1	0.1	0.1
fast																				
very fast																				
ALL RATES	**1**	**0.1**	**0.1**	**0.1**													**1**	**0.1**	**0.1**	**0.1**

Table J10b: C5 fire rate/fire type cross comparison 1992

fire type	surface				subsurface				crown				torching				all fires			
Fire rate	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)
very slow	1	10.0	25.0	22.7													1	10.0	25.0	22.7
slow																				
moderate																				
fast																				
very fast																				
ALL RATES	**1**	**10.0**	**25.0**	**22.7**													**1**	**10.0**	**25.0**	**22.7**

Table J11: C6 fire rate/fire type cross comparison 1992

fire type	surface				subsurface				crown				torching				all fires			
Fire rate	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)
very slow																				
slow													1	0.1	0.5	0.3	1	0.1	0.5	0.3
moderate																				
fast																				
very fast																				
ALL RATES													1	0.1	0.5	0.3	1	0.1	0.5	0.3

Table J12a: D1 fire rate/fire type cross comparison 1991

fire type	surface				subsurface				crown				torching				all fires			
Fire rate	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)
very slow	3	0.3	0.3	0.4													3	0.3	0.3	0.4
slow	2	0.3	0.5	0.3													2	0.3	0.5	0.3
moderate	8	46.2	54.3	48.0													8	46.2	54.3	48.0
fast	7	4.7	5.9	5.4													7	4.7	5.9	5.4
very fast	1	2.0	5.0	1.0													1	2.0	5.0	1.0
ALL RATES	**21**	**19.3**	**23.0**	**20.2**													**21**	**19.3**	**23.0**	**20.2**

Table J12b: D1 fire rate/fire type cross comparison 1992

fire type	surface				subsurface				crown				torching				all fires			
Fire rate	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)
very slow	1	0.6	0.6	0.9													1	0.6	0.6	0.9
slow	4	1.5	3.1	3.3													4	1.5	3.1	3.3
moderate	4	16.0	19.3	18.5													4	16.0	19.3	18.5
fast	4	8.3	15.3	9.4													4	8.3	15.3	9.4
very fast													1	2.0	7.0	3.8	1	2.0	7.0	3.8
ALL RATES	**13**	**8.0**	**11.6**	**9.7**									**1**	**2.0**	**7.0**	**3.8**	**14**	**7.5**	**11.3**	**9.2**

Table J13a: M1 fire rate/fire type cross comparison 1991

fire type	surface				subsurface				crown				torching				all fires			
Fire rate	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)
very slow					1	1.0	1.0	1.4									1	1.0	1.0	1.4
slow	3	0.4	1.8	1.5													3	0.4	1.8	1.5
moderate	5	4.1	4.4	5.7													5	4.1	4.4	5.7
fast													1	10.0	10.5	11.1	1	10.0	10.5	11.1
very fast					1	0.1	2.5	0.1									1	0.1	2.5	0.1
ALL RATES	**8**	**2.7**	**3.4**	**4.1**	**2**	**0.6**	**1.8**	**0.8**					**1**	**10.0**	**10.5**	**11.1**	**11**	**3.0**	**3.8**	**4.1**

Table J13b: M1 fire rate/fire type cross comparison 1992

fire type	surface				subsurface				crown				torching				all fires			
Fire rate	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)
very slow	2	0.5	0.5	2.0													2	0.5	0.5	2.0
slow																				
moderate	2	3.4	4.7	5.0									1	0.5	2.5	5.0	3	2.4	3.9	5.0
fast	2	1.1	1.6	4.4													2	1.1	1.6	4.4
very fast	1	1.0	1.5	2.5													1	1.0	1.5	2.5
ALL RATES	**7**	**1.6**	**2.1**	**3.6**									**1**	**0.5**	**2.5**	**5.0**	**8**	**1.4**	**2.2**	**3.8**

Table J14a: M2 fire rate/fire type cross comparison 1991

fire type	surface				subsurface				crown				torching				all fires			
Fire rate	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)
very slow	14	0.3	0.3	1.6	5	0.5	0.5	4.8									19	0.3	0.3	2.4
slow	14	0.7	1.7	4.9	3	0.1	0.2	2.8									17	0.6	1.4	4.5
moderate	6	0.4	0.4	2.5									1	0.5	1.5	3.0	7	0.4	0.6	2.5
fast	4	1.3	2.1	5.4	1	0.2	0.3	3.1									5	1.1	1.7	5.0
very fast	2	7.6	10.3	9.6					1	30.0	30.0	36.3					3	15.1	16.8	18.5
ALL RATES	40	0.9	1.5	3.7	9	0.3	0.4	3.9	1	30.0	30.0	36.3	1	0.5	1.5	3.0	51	1.4	1.8	4.3

Table J14b: M2 fire rate/fire type cross comparison 1992

fire type	surface				subsurface				crown				torching				all fires			
Fire rate	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)
very slow	8	0.2	0.2	4.0													8	0.2	0.2	4.0
slow	4	0.8	0.8	3.0	1	1.0	1.0	1.8									5	0.8	0.8	2.7
moderate	4	1.1	2.3	5.3	4	0.3	0.3	1.5									8	0.7	1.3	3.4
fast																				
very fast																				
ALL RATES	16	0.6	0.9	4.1	5	0.5	0.5	1.5									21	0.5	0.8	3.5

Table J15a: O1 fire rate/fire type cross comparison 1991

fire type	surface				subsurface				crown				torching				all fires			
Fire rate	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)
very slow	15	1.1	1.4	7.5													15	1.1	1.4	7.5
slow	9	4.3	5.0	9.2	3	0.2	0.4	47.3									12	3.3	3.8	18.7
moderate	24	2.8	7.9	12.8	3	0.7	0.7	24.8									27	2.6	7.1	14.1
fast	11	30.7	64.0	46.7													11	30.7	64.0	46.7
very fast	1	0.1	10.0	7.7													1	0.1	10.0	7.7
ALL RATES	**60**	**7.7**	**16.2**	**17.0**	**6**	**0.5**	**0.6**	**36.0**									**66**	**7.0**	**14.8**	**18.8**

Table J15b: O1 fire rate/fire type cross comparison 1992

fire type	surface				subsurface				crown				torching				all fires			
Fire rate	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)
very slow	6	0.4	0.5	32.2	1	0.1	0.1	1.1									7	0.4	0.4	27.8
slow	4	0.6	0.6	12.1													4	0.6	0.6	12.1
moderate	12	19.7	20.5	28.5													12	19.7	20.5	28.5
fast	6	13.8	19.1	61.4													6	13.8	19.1	61.4
very fast	2	1.6	15.8	128.3													2	1.6	15.8	128.3
ALL RATES	**30**	**10.9**	**13.2**	**40.3**	**1**	**0.1**	**0.1**	**1.1**									**31**	**10.6**	**12.8**	**39.0**

Table J16a: S1 fire rate/fire type cross comparison 1991

fire type	surface				subsurface				crown				torching				all fires			
Fire rate	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)
very slow																				
slow																				
moderate	1	0.1	0.2	0.4													1	0.1	0.2	0.4
fast									1	4.5	4.5	9.0					1	4.5	4.5	9.0
very fast																				
ALL RATES	**1**	**0.1**	**0.2**	**0.4**					**1**	**4.5**	**4.5**	**9.0**					**2**	**2.3**	**2.4**	**4.7**

Table J16b: S1 fire rate/fire type cross comparison 1992

fire type	surface				subsurface				crown				torching				all fires			
Fire rate	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)
very slow	1	0.1	0.1	0.1	1	0.1	0.1	1.1									2	0.1	0.1	0.6
slow																				
moderate																				
fast																				
very fast																				
ALL RATES	**1**	**0.1**	**0.1**	**0.1**	**1**	**0.1**	**0.1**	**1.1**									**2**	**0.1**	**0.1**	**0.6**

Table J17a: S1 fire rate/fire type cross comparison 1991

fire type	surface				subsurface				crown				torching				all fires			
Fire rate	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)
very slow	2	0.1	0.1	2.4	1	0.1	0.1	0.1									3	0.1	0.1	1.6
slow	2	0.3	0.3	1.8													2	0.3	0.3	1.8
moderate	4	0.5	0.6	1.0									1	20.0	22.0	24.8	5	4.4	4.9	5.8
fast	1	15.0	15.0	17.5									2	10.1	10.1	10.4	3	11.7	11.7	12.8
very fast																				
ALL RATES	**9**	**2.0**	**2.0**	**3.3**	**1**	**0.1**	**0.1**	**0.1**					**3**	**13.4**	**14.0**	**15.2**	**13**	**4.5**	**4.6**	**5.8**

Table J17b: S1 fire rate/fire type cross comparison 1992

fire type	surface				subsurface				crown				torching				all fires			
Fire rate	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)	# fires	avg detection size (ha)	avg arrival size (ha)	avg prediction at arrival (ha)
very slow	1	0.1	0.1	0.1													1	0.1	0.1	0.1
slow																				
moderate	2	0.6	1.3	1.5													2	0.6	1.3	1.5
fast																				
very fast																				
ALL RATES	**3**	**0.4**	**0.9**	**1.0**													**3**	**0.4**	**0.9**	**1.0**