A STATISTICAL SUMMARY OF FOREST FIRES IN THE YUKON TERRITORY 1966-70

by

A. D. Kiil

NORTHERN FOREST RESEARCH CENTRE
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CANADIAN FORESTRY SERVICE
DEPARTMENT OF THE ENVIRONMENT
5320 - 122 STREET
EDMONTON 70, ALBERTA, CANADA

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INTRODUCTION

Forest fire statistics are useful in analyzing the nature and effects of fires, and the costs and damages associated with fire control operations. This information can help the fire manager answer questions such as: is there a realistic allotment of funds for prevention, detection and suppression; are fire control expenditures commensurate with existing hazards; does the fire behavior rating system accurately reflect burning conditions; and, are existing fire control operations effective in reducing the loss and damage by wildfire?

The limitations of using past records as guides to future fire control planning and operations are recognized. Fire reports are often prepared weeks or even months after the event; hence, inaccurate data is a major problem facing the fire manager. Long-term averages are desirable to reduce the effects of unusual fire years, but the impact of major changes in fire control strategy and operations during this period may become lost in a myriad of figures. Nevertheless, fire managers recognize the need to obtain and use objective fire records to gauge and to improve the overall effectiveness

of fire control operations.

This study analyzes 447 Yukon Forest Service fire reports (Appendix I) covering the 5-year period 1966-70. The 5-year period was chosen for the study because it represents a wide range of burning conditions and is believed to characterize a period during which no major changes occurred in suppression activities. Also, a standard fire report form was used during this period. Data clearly inaccurate for purposes of this study have been discarded; hence, some figures in this report differ from those published by the Yukon Forest Service.

GENERAL FIRE STATISTICS

The Yukon Territory covers about 207,000 square miles, comprising 117,000 sq. mi. of "Protection Zone" and the remaining 90,000 square miles of "Non-protection Zone". The Protection Zone is generally within 25 miles of major roads, rivers and settlements. Fire control activities are normally confined to the Protection Zone but may be extended to other areas when burning conditions, fire control priorities and operational capability of the fire control agency make this necessary or possible.

During the 5-year period 1966-70, a total of 447 fires burned over 1.7 million acres in the Protection Zone of the Yukon Territory (Figure 1). This represents an average of 89 fires burning in excess of 340,000 acres annually. Fire occurrence was relatively

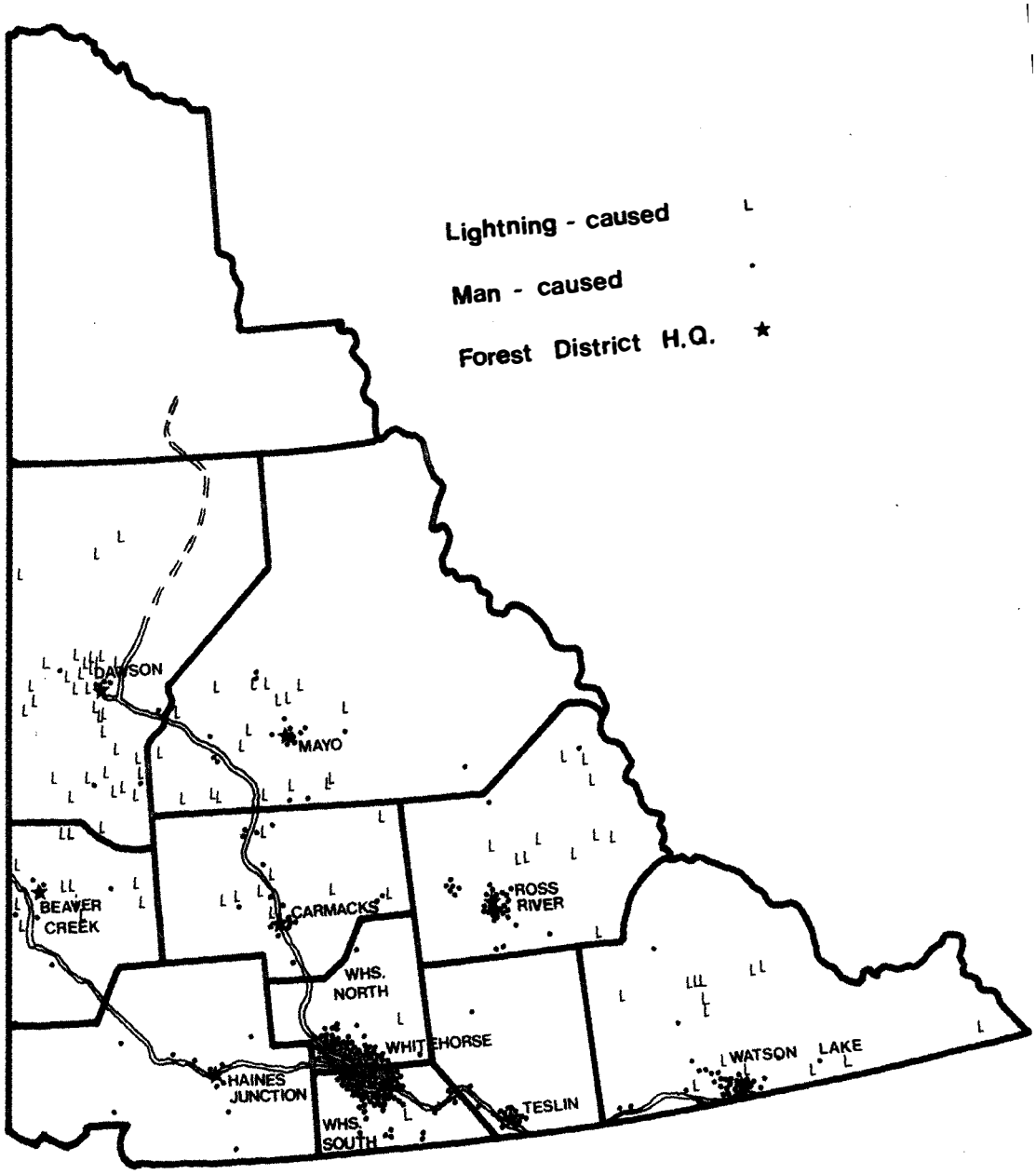

Figure 1.
Location of Forest Fires in Yukon Territory 1966-70.

constant from year to year, whereas the acreage burnt, suppression costs and damage to timber fluctuated considerably (Table I). Similarly, the average cost per fire of suppression and damage fluctuated considerably between years. Annual cost of suppression and damage averaged 459,000 dollars and 410,000 dollars, respectively.

FIRE OCCURRENCE AND BEHAVIOR

The normal fire season extends through the 6-month period from April to September, but over 70% of all fires occur in June and July (Table II). June accounted for 49% of all fires in the ten Forest Districts. July had the greatest number of fires in 1968. Only Whitehorse South had a substantial number of fires in May. With the exception of Teslin, Haines Junction and Beaver Creek, all Forest Districts had between 8 and 14 fires annually.

Of the 447 fire reports analyzed, 292 were man-caused, the remainder were attributed to lightning; a ratio of 2:1 (Table III). Recreation was the largest single cause of man-caused fires. Over 98 per cent of the lightning-caused fires occurred in June and July whereas the man-caused fires were spread more uniformly over the entire fire season. The proportion of lightning-caused fires fluctuated from 4% in 1970 to 59% in 1969. Among specific causes of ignition, matches and campfires accounted for more than 50 per cent of all man-caused fires.

Table I. Fire Statistics[1] for Yukon Territory, 1966-70.

Year	No. of fires	Total area burned (acres)	Average area burned per fire (acres)	Total cost of suppression (dollars)	Average cost of Suppression per fire (dollars)	Total cost of damage (dollars)	Average cost of damage per fire (dollars)
1966	78	142,700	1,829	586,000	7,512	218,000	2,794
1967	67	416,300	6,213	244,900	3,655	154,000	2,298
1968	47	10,600	225	124,000	2,638	12,000	255
1969	94	1,069,000	11,372	1,281,000	13,627	1,663,000	17,691
1970	111	200	2	69,000	621	2,000	18
All	397	1,638,800	4,128	2,304,900	5,805	2,049,000	5,161

[1] Based on fire reports which contain complete information for this table. The figures are therefore not indicative of total fire business during the 5-year period covered by this study.

Table II. Fire Occurrence by Forest District and Month, 1966-70

Forest District

Month	Carmacks	Dawson	Ross R	Mayo	Whitehorse South	Whitehorse North	Teslin	Haines Junction	Beaver Creek	Watson Lake	Totals
March	1				1						2
April	2				8	5	1				16
May	6	3	11	3	15	9	1	3	1	4	56
June	22	23	35	25	16	37	7	2	12	40	219
July	6	24	10	13	11	6	2		5	15	92
August	6	1	4		8	7	2	4	1	7	40
September	2	3	3	1	4	1	1	1	1	3	20
October					1	1					2
Totals	45	54	63	42	64	66	14	10	20	69	447
Per Cent	10	12	14	9	14	15	3	2	5	16	100

Table III. Fire Occurrence by Classified Cause and Month, 1966-70

Classified Cause

Month	Recr.	Settler	Wood Oper.	Ind. Oper.	Rail Roads	Incend-diary	Publ. Projects	Misc. known	Light-ning	Unknown	Totals
March	1			1							2
April	2	2					1	7		4	16
May	13	5		4		5	5	14	1	9	56
June	20	8	7	10	1	4		27	111	31	219
July	8	4		6		3		13	41	17	92
August	17	1		4			1	9	1	7	40
September	8	1		3				2	1	5	20
October								1		1	2
Totals	69	21	7	28	1	12	7	73	155	74	447
Per Cent	15	5	2	6	0	3	2	16	35	16	100

Forty-nine per cent of all fires burned primarily in conifer fuel types (Table IV). An additional 15% burned in each of the mixedwood, grass and barren fuel types, with deciduous stands accounting for the remaining 4%. More than 50% of the fires in all fuel types occurred in June and July. Only grass fires were more prevalent in May than in July.

The size-class distribution of all fires is shown in Table V. It is interesting to note that there is a gradual decrease in number of fires from Class A to D, followed by an increase in Class E fires. Class C, D and E fires occur primarily in June and July whereas Classes A and B fires are distributed over the entire fire season. June alone accounted for 88 per cent of the total acreage burned in all Forest Districts, with an additional 9 per cent burning in July (Table VI). Carmacks and Dawson Forest Districts had the highest acreage burned; Whitehorse South and North and Haines Junction the lowest. With the exception of Whitehorse South, June had the largest acreage burned in all Forest Districts.

The area burned fluctuated from 200 acres in 1970 to over one million acres in 1969. Fifty-nine of the 100 fires analyzed for that year were lightning-caused and accounted for over 90% of the total area burned. The average size of the lightning-caused fires at discovery was 1928 acres. The majority of the lightning-caused fires appear to have been caused by a few major storms - an indication

Table IV. Fire Occurrence by Primary Fuel Type and Month, 1966-70

Month	Fuel Type					
	Conifer	Deciduous	Mixedwood	Grass	Barren	Totals
March				1		1
April	2	1	4	7		14
May	12	4	8	19	8	51
June	120	8	23	26	27	204
July	49	4	12	9	12	86
August	22	2	7	1	8	40
September	15		2		3	20
October	2					2
Totals	222	19	56	63	58	418
Per Cent	53	5	13	15	14	100

Table V. Size-class Distribution for all Fires, 1966-70.

Month	Fire Size Class[1]					
	A	B	C	D	E	Totals
March	1	1				2
April	11	5				16
May	37	15		2	1	55
June	74	34	22	18	71	219
July	33	20	13	11	13	90
August	28	9	2	1		40
September	12	5	1		2	20
October	1	1				2
Totals	197	90	38	32	87	444
Per Cent	44	20	9	7	20	100

[1] Class A - less than 1/4 acre
B - 1/4 to 10 acres
C - 11 to 100 acres
D - 101 to 500 acres
E - 501 acres and over

Table VI. Acreage Burned by Forest District and Month, 1966-70

Month	Forest District										
	Carmacks	Dawson	Ross R	Mayo	White-horse South	White-horse North	Teslin	Haines Junction	Beaver Creek	Watson Lake	Totals
March	0	0	0	0	0	0	0	0	0	0	0
April	2	0	0	0	2	2	0	0	0	0	6
May	50,517	0	119	0	5	12	0	0	0	0	50,653
June	399,045	405,289	208,991	235,181	7	697	21,700	0	152,675	139,277	1,562,862
July	2	132,033	780	15,852	4	53	30	0	3,253	2,739	154,746
August	30	5	2	0	60	0	0	1	0	15	113
September	0	8,505	2	1	0	0	0	0	0	1	8,509
October	0	0	0	0	0	0	0	0	0	0	0
Totals	449,596	545,832	209,894	251,034	78	764	21,730	1	155,928	142,032	1,776,889
Per Cent	25	31	12	14	0	0	1	0	9	8	100

of the peak fire-load possible in the Territory.

FIRE CONTROL ACTIVITIES

The public is credited with discovering 35% of the fires (Table VII). Aircraft accounted for an additional 33% of the fires and the greatest number of discoveries was in June and July. Twenty-six per cent of all fires were discovered between 2 and 4 p.m. (Table VIII) and 56% in the 6-hour period from 12 noon to 6 p.m.

Average elapsed time from "fire discovery to crew dispatch" was 15 hours. Elapsed times from "fire discovery to fire-fighting commenced" and from "fire-fighting commenced to fire under control" averaged 18 and 26 hours, respectively. Elapsed time from "dispatch to patrol stopped" was 145 hours or about 6 days. It is interesting to note that elapsed times in the Extreme danger class were generally at least double those for all danger classes combined. The elapsed time from "dispatch to patrol stopped" increased steadily with danger class from an average of 17 hours in the Nil to 223 hours in the Extreme class.

Suppression costs for 397 fires are summarized in Table IX. Equipment rental and helicopter costs accounted for more than 50% of total suppression costs. The cost of suppression per fire increased from $50 in the Nil danger class to $8,400 in the Extreme danger class. In general, the High and Extreme danger classes accounted for at least 75% of the total expenditures in each of the major categories. For any given danger class, the cost of suppressing the average-sized fire was

Table VII. Fire Discovery by Month, 1966-70

Month	Discovered by					
	Lookout	Aircraft	Patrol	Public	Other	Totals
March		1		1		2
April			2	12	1	15
May	4	5	6	31	8	54
June	44	82	24	51	7	208
July	18	37	4	27	3	89
August	5	9	2	18	5	39
September		6	1	12	1	20
October					1	1
Totals	71	140	39	152	26	428
Per Cent	17	33	9	35	6	100

Table VIII. Fire Discovery Time by Month, 1966-70

Month	Discovery Time												
	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24	Totals
March					1				1				2
April		1				1	6	3		1	1	1	14
May	2		1	2	7	5	6	8	11	6	5		53
June	4			4	12	25	30	58	24	16	17	5	195
July	1			1	3	8	11	28	15	12	4	1	84
August	2			5	4	3	4	6	9	4	1		38
September			1		5	4	5	3		2			20
October					1	1							2
Totals	9	1	2	12	33	47	62	106	60	41	28	7	408
Per Cent	2	0	0	3	8	12	15	26	15	10	7	2	100

Table IX. Suppression Costs by Danger Class, 1966-70

Danger Class [1]	No. of fires	Hired Labor	Provi-sions	Heli-copter	Aircraft	Equip-ment Rental	Govt. Labor	Misc.	Total Cost of Suppression in Dollars	Cost of Suppres-sion per fire (nearest $50)
	Nearest 100 dollars									
Nil	10	0	100	100	200	0	0	0	400	50
Low	41	13,000	4,400	12,300	7,900	1,000	1,600	0	40,200	1,000
Moderate	90	70,600	53,200	88,200	49,200	50,600	12,900	900	325,600	3,600
High	85	120,000	62,000	155,500	22,300	132,400	12,400	0	504,600	5,950
Extreme	171	254,100	212,000	361,400	154,600	433,200	18,600	0	1,433,900	8,400
Totals	397	457,700	331,700	617,500	234,200	617,200	45,500	900	2,304,700	5,800
	Percentages									
Nil	3	0	0	0	0	0	0	0	0	
Low	10	3	1	2	3	0	4	3	2	
Moderate	23	15	16	14	21	8	28	94	14	
High	21	26	19	25	10	22	27	3	22	
Extreme	43	56	64	59	66	70	41	0	62	
Totals	100	100	100	100	100	100	100	100	100	

[1] Corresponding values by using the new Canadian Fire Weather Index are:

Nil	0-1	High	13-24
Low	2-5	Extreme	25+
Moderate	6-12		

highest in June and July, indicating perhaps the relatively high rate of fire occurrence and the relatively long time required to suppress these fires during those months. Alternately, the high costs can conceivably be partly attributed to the inability of the old fire danger rating system to accurately reflect the long diurnal burning period and the build-up of drought in northern latitudes. A third contributing factor would be the cost of helicopter and airtanker contracts during this two-month period.

As expected, suppression costs increased with fire size (Figure 2). For a given fire size, these costs fluctuated widely but did not obscure the gross relationship between the two variables. The only significant duration from this gradual tendency for reduced unit costs with increasing fire size relates to a group of large fires in excess of about 60,000 acres. Suppression costs for these fires did not exceed one dollar per acre burned, indicating perhaps a change in tactics, lower priority for fire control in isolated areas and/or inadequate resources to cope with "campaign" fires. In sharp contrast to these figures is the expenditure of over $140,000 to extinguish a 300-acre fire in a high priority protection zone adjacent to Whitehorse. The suppression cost-fire size relationships shown in Figure 2 point to the need to standardize suppression expenditures commensurate with existing fire load and resource values. Available data suggest that slowness in reaching fires and lack of adequate suppression forces during periods of high fire load are primarily responsible for the fluctuations in suppression expenditures.

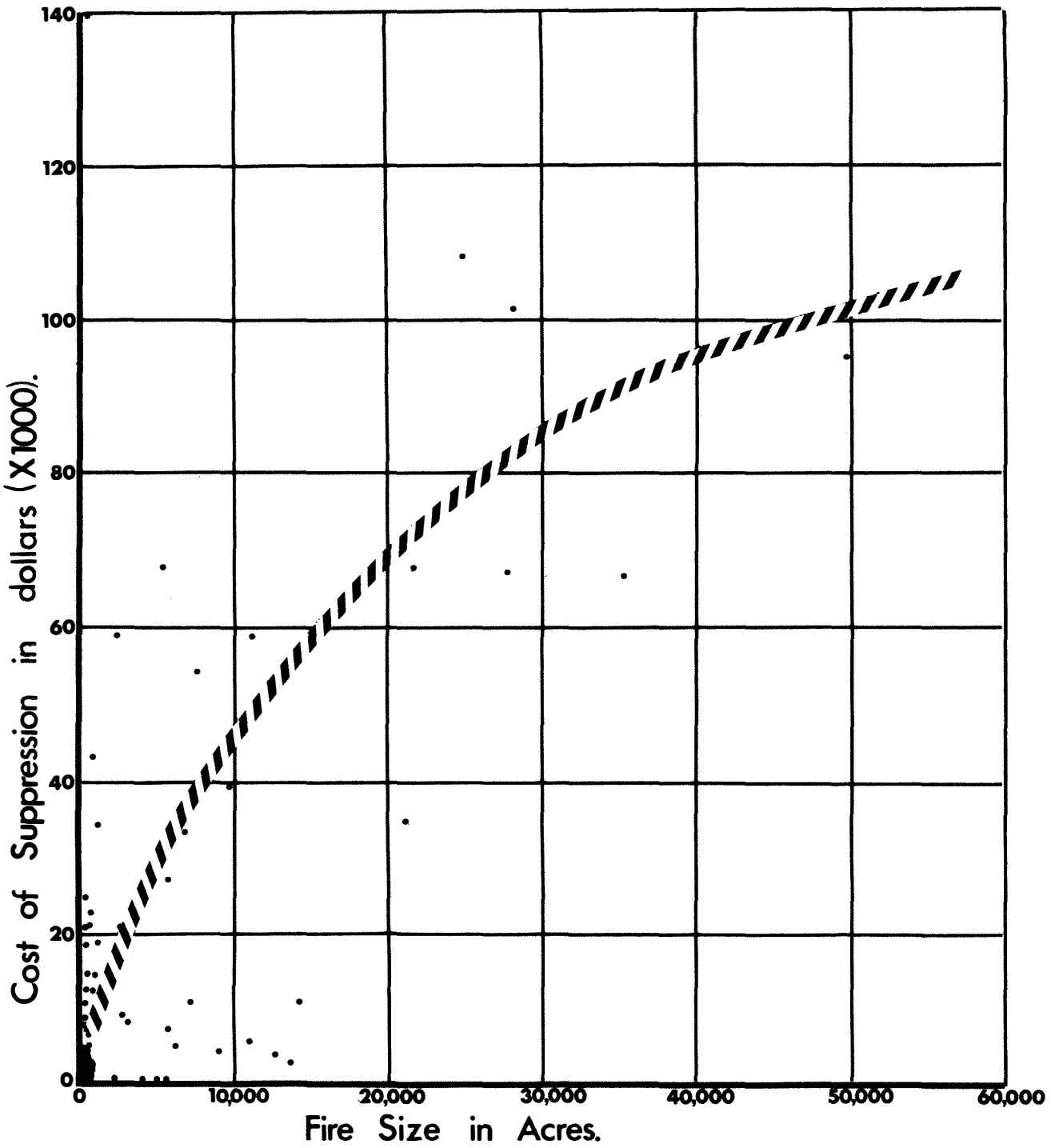

Figure 2.

Mean cost of suppression per fire.

Costs of damage to timber paralleled suppression costs, increasing from $50 per fire in the Nil danger class to $9,750 in the Extreme danger class (Table X). Damage to merchantable timber and young growth was responsible for over 75% of the total cost of damage. Ninety-six per cent of the total damage occurred in the High and Extreme danger classes. Cost of damage is based on timber values only, and does not include damage to watershed values, site conditions, or wildlife habitat.

Total costs of suppression and damage during the 5-year period 1966-70 amounted to over 4.3 million dollars (Table XI). Fire business (fire occurrence, area burned, and costs of suppression and damage) increased with increasing danger class. The suppression cost per acre burned was highest in the Low danger class and lowest in the Extreme danger class. The damage cost per acre burned was relatively constant, fluctuating from a low of $1.22 per acre burned in the Extreme danger class to $2.71 per acre burned in the Low danger class. The average cost of suppression plus damage amounted to $2.65 per acre burned.

CONCLUSIONS AND SUMMARY

This analysis of 447 forest fires reports covering the 5-year period 1966-70 provides a starting point for future fire control planning in the Yukon Territory. Many of the trends and relationships indicated by the study undoubtedly confirm the beliefs or suspicions of Yukon Forest Service fire control personnel; others may be less

obvious and of greater value in developing realistic guides for future fire control operations. From the findings of this analysis and consideration of the recent awareness of the need to protect the northern environment against damage by wildfire, the following conclusions emerge:

The "Protection Zone", confined to within about 25 miles of settlements, roads and rivers, covers over one-half the land area of Yukon Territory. While fire incidence is relatively low, the severe fire climate and presence of highly flammable fuels represent a formidable fire control challenge to the Yukon Forest Service. The results of this study clearly indicate that during the 5-year period covered by the fire reports, the fire load during periods of High and Extreme danger exceeds the capability of the fire control agency. Changing land values and future land management demands point to the need for periodic re-definition of fire control objectives to determine acceptable levels of presuppression and suppression activities. The initial approach in this direction might be to prescribe general fire control requirements for a few land-use priority zones in the Yukon Territory. Subsequent refinement would consist of delineating land values by Forest District or other management units, evaluation of both beneficial and detrimental effects of fire in the northern environment, and integration of fire control objectives and plans to provide the required degree of protection.

In the Yukon Territory the average costs of suppression and damage are $1.40 and $1.25 per acre burned, respectively. Corresponding suppression costs for Alberta and British Columbia exceed $20 and $30 per acre burned, respectively. Expenditures of this magnitude have undoubtedly contributed to a reduction in the area burned but they have not eliminated the occasional large fire or conflagration. In view of these considerations, the problem becomes one of deciding what level of expenditure or what maximum allowable burned area is acceptable in relation to land management objectives. Regardless of which concept is used, perhaps the most pressing problem is to determine the effectiveness of the suppression effort at different stages of fire development.

The average elapsed time of 15 hours from fire discovery to initial attack helps explain the fact that 20 per cent of all fires exceeded 500 acres. Initial attack time increased with increasing fire load, an indication that the fire control agency could not cope with fire control problem during periods of high fire incidence and erratic fire behavior. In 1969, the average size of 59 lightning-caused fires exceeded 1900 acres at discovery and 19,000 acres when finally under control. A reduction in the proportion of Class E fires is therefore an essential prerequisite for reducing the large acreages burned.

There are wide fluctuations in seasonal and yearly fire climates which need to be considered when evaluating the efficiency of fire control operations. Thus the use of an integrated measure of the severity of fire weather such as the Severity Rating Index should

prove extremely useful in determining relationships between fire potential and fire control expenditures.

Yukon Forest Service fire reports should be updated periodically to increase their usefulness in terms of current and future needs of the fire control agency. A critical study of past performance is essential to eliminate the likelihood of repeating mistakes and to develop realistic concepts and procedures for effective fire control. Field personnel responsible for completing the Individual Fire Report should be fully aware of the need to evaluate past performance and the value of objective fire statistics in fire control planning. Greater emphasis should be placed on increasing the accuracy of data and the gathering of information on fire behavior and expenditures on fire control. The fire report should follow a format to facilitate rapid analysis by computer.

Table X. Cost of Damage by Danger Class, 1966-70

	No. of fires	Merchantable timber	Cut-over	Young Growth	Non-productive forest	Non-forested	Other Property	Equipment lost	Total cost of damage	Cost of damage per fire (nearest $50)
					Nearest 100 dollars					
Nil	10	500	0	0	0	0	0	0	500	50
Low	41	6,700	500	100	0	100	0	1,100	8,400	200
Moderate	90	26,700	2,000	31,200	2,400	16,800	600	5,700	85,500	950
High	85	114,900	62,200	82,500	5,100	10,700	100	10,600	286,200	3,350
Extreme	171	555,700	234,100	737,700	30,100	90,900	600	19,300	1,668,400	9,750
Totals	397	704,500	298,800	851,500	37,600	118,500	1,300	36,700	2,049,000	5,150
					Percentages					
Nil	3	0	0	0	0	0	0	0	0	
Low	10	1	0	0	0	0	0	3	0	
Moderate	23	4	1	4	6	14	46	16	4	
High	21	16	21	10	14	9	8	29	14	
Extreme	43	79	78	86	80	77	46	52	82	
Totals	100	100	100	100	100	100	100	100	100	

Table XI. Total Costs of Suppression and Damage, 1966-70

Danger Class	No.of fires	Total Area burned (acres)	Area of average fire (acres)	Total Cost of Suppression plus Damage ($)	Cost of Suppression per Acre Burned ($)	Cost of Damage per Acre Burned ($)	Cost of Suppression plus damage per Acre Burned ($)
Nil	10	300	30	1,000	1.62	1.67	3.29
Low	41	3,100	75	28,500	12.93	2.71	15.64
Moderate	90	61,200	680	411,200	5.32	1.39	6.71
High	85	201,500	2,370	790,800	2.50	1.42	3.92
Extreme	171	1,372,900	8,028	3,102,400	1.04	1.22	2.26
All	397	1,639,000	4,128	4,353,900	1.40	1.25	2.65

APPENDIX I

DEPARTMENT OF INDIAN AFFAIRS & NORTHERN DEVELOPMENT

INDIVIDUAL FIRE REPORT - Yukon Territory - Fire Name _____ No. __

Ranger District _____ Time/Date Started _____ 19__

Location: Lat. ___° ___'N General Location _____

Long. ___° ___'W _____

ZONES: PROTECTED _____ BUFFER _____ UNPROTECTED _____

DISCOVERED BY: _____Lookout; _____Aircraft; _____Patrol; _____Public _____Other

Classified Cause		Classes	Fuel Type Burned
.....Recreation	....Incendiary	.... A-less than $\frac{1}{4}$ acre	....% Conifer
.... Settlement	....Public Proj.	.... B-$\frac{1}{4}$ acre to 10 acres	....% Deciduous
.... Wood Op.	....Misc. Known	.... C1-11 acres to 100"	....% Mixed
.... Ind. Op.	....Lightning	.... C2- 101 " to 500"	....% Grass
.... Railroads	....Unknown	.... D- 501 acres and over	....% Barren

SPECIFIC CAUSE: .....
(Cigarette, campfire, slash, engine spark, etc. & type of person causing fire)

		HOUR	DAY	MONTH	AREA (ACRES)
A	Discovered / Reported	.....			.....
C	Crew Dispatched	.....			.....
T	F.F. Commenced	.....			.....
I	Fire Controlled	.....			.....
O	Completely out	.....			.....
N	Patrol Stopped	.....			.....

WEATHER: Day fire started R.H. ___% Temperature ___F Wind ___MPH
Danger Index Day Fire Started: Ext.___ High ___ Mod. ___ Low ___ Nil ___
Last Rain _____inches on _____Recorded at _____
FOR FIRES OF MORE THAN THREE DAYS DESCRIBE WEATHER IN REMARKS

Cost of Extinguishing (A)		Damage (B)	Acs. ords M.F.B.M.	Value
Hired Labour	$.....	Merchantable Timber	.....	$.....
Provisions	$.....	Cut-Over	.....	$.....
Helicopter	$.....	Young Growth	.....	$.....
Aircraft	$.....	Non-Productive Forest	.....	$.....
Equip.Rental	$.....	Non-Forested	.....	$.....
Gov't.Labour	$.....	Other Property	.....	$.....
Misc.	$.....	Equipment Lost	.....	$.....
TOTAL (A)	$.....	TOTAL (B)	.....	$.....
		TOTAL COST OF EXTINGUISHING (A) & (B)		$.....

REMARKS

Date .....19.....

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