ANALYSIS OF TWO 1971 WILDFIRES IN ONTARIO: THACKERAY AND WHISTLE LAKE

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Frontispiece. Severe root exposure and blowdown resulting from Whistle Lake fire.

ABSTRACT

Two wildfires in Ontario in 1971 are analyzed with respect to fire weather, fuel conditions and fire behavior, including rate of spread, fuel consumption and fire intensity. No attempt is made to assess suppression techniques or to discuss fire control costs.

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INTRODUCTION

This report describes fire weather, fuel conditions, and fire behavior of two wildfires in Ontario during the 1971 fire season. The Thackeray fire started in Swastika District on June 1, 1971 and we were present for its duration. The Whistle Lake fire started in Thunder Bay District on August 7, 1971; and through the cooperation of the Ontario Department of Lands and Forests and the Abitibi Paper Company Ltd., we were able to visit the site, in early November, 1971, to interview personnel involved in suppressing the fire and to gather available data regarding the fire's behavior. Wildfires are analyzed to increase our general knowledge of fire behavior and fuel types in Ontario.

1971 FIRE SEASON IN SWASTIKA AND THUNDER BAY DISTRICTS

The 1971 fire season in both the Swastika and Thunder Bay Districts was more severe in terms of acreage burned and number of fires than in recent years. In the Swastika District, 79 fires burned over 5,148 acres, and 138 fires in the Thunder Bay District destroyed 8,638 acres. Between April and November, 1971, 1,782 fires burned 36,199 acres in Ontario, with the Thunder Bay and Swastika Districts ranking first and second, respectively, in total acreage burned.

THACKERAY WILDFIRE (JUNE 1971)

The Thackeray fire originated from a large smoldering sawdust pile at a private sawmill located in the eastern part of Thackeray Township, approximately 25 miles ESE of the town of Matheson in the Swastika District. The fire was estimated to have escaped from the pile at 1110 hours on June 1, 1971, and was discovered at 1130 hours. Suppression action was initiated at 1255 hours when the fire had reached 75 acres, and the fire was listed as being held (BH) at 1800 hours on June 3, under control (UC) at 0700 hours on June 8, and officially out at 0700 hours on July 11.

With the exception of isolated patches within the burn perimeter and an area in the southeast corner of the fire, the burned area had been cut over in sections between 1962 and 1970. The original stands were mainly black spruce (*Picea mariana* (Mill.) B.S.P.) and jack pine (*Pinus banksiana* Lamb. = *P. divaricata* (Ait.) Dumont), together or mixed in

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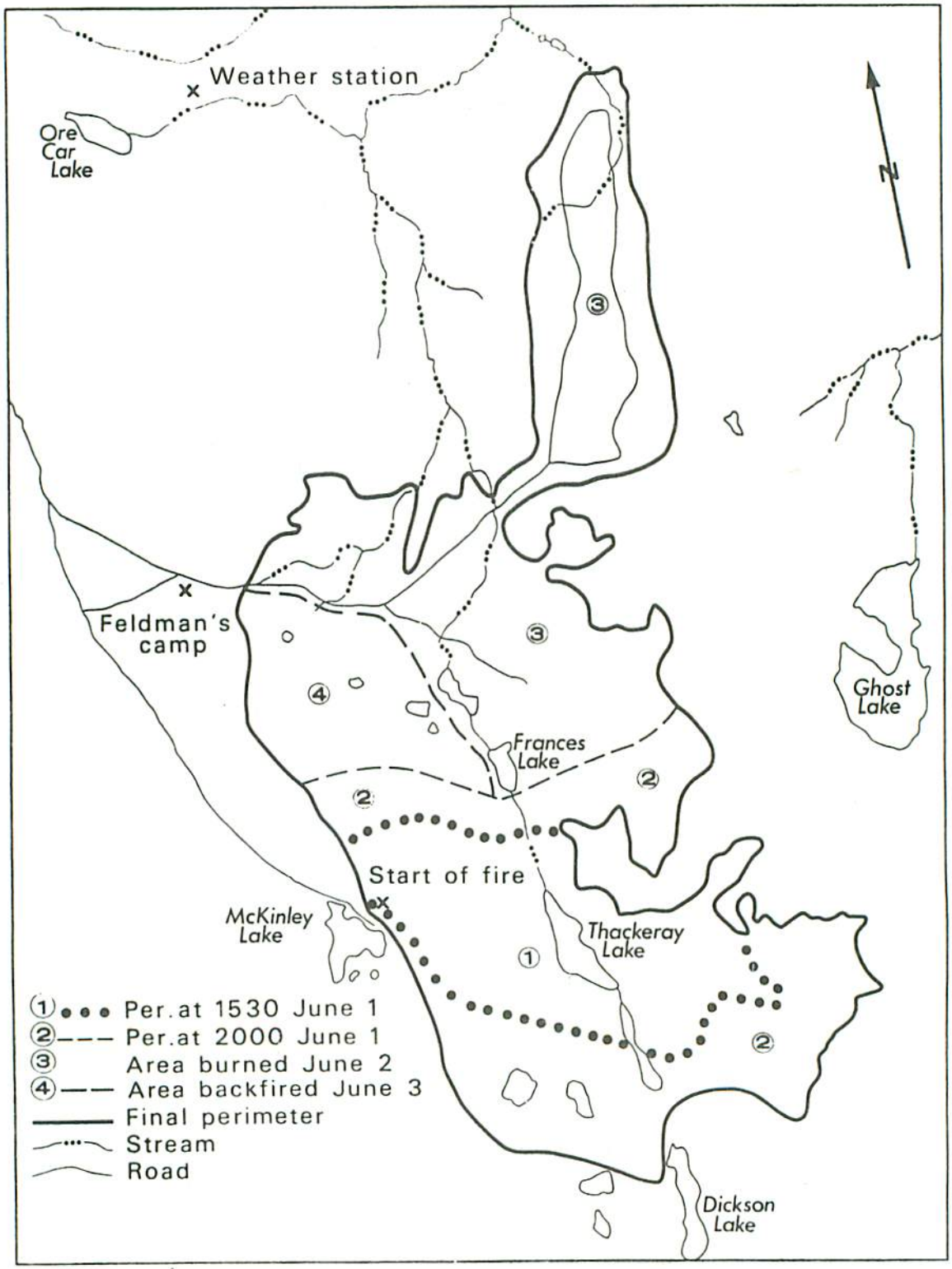

Figure 1. Map of Thackeray wildfire, Swastika District.

varying degrees with balsam fir, (*Abies balsamea* (L.) Mill.) aspen, (*Populus tremuloides* Michx.) and white birch (*Betula papyrifera* Marsh.). All stands were 90 to 100 years old, with coniferous and hardwood species yielding an average of approximately 12 and 6 cunits/acre, respectively. Jack pine and black spruce were clear cut in pure stands and removed selectively in mixed stands, leaving unmerchantable hardwoods and balsam fir standing.

Daily afternoon weather measurements, taken at a Canadian Forestry Service weather station located 4 miles north of the fire's origin (Fig. 1), were used to calculate Fire Weather Index (FWI) values (Anon., 1970). The last rain before the fire outbreak, 1.34 inches, fell on May 25 and 26. Low relative humidities and moderate winds resulted in high to extreme FWI values on June 1 and 2 when the fire was burning strongly and out of control. Little rain, high winds and low relative humidities for the remainder of June caused a drought buildup and extreme FWI values on many days resulted in numerous smokes and smudges within the fire perimeter long after the fire was under control. Table 1 shows the daily weather and computer-calculated FWI values for the duration of the fire.

Escaping from the sawdust pile at 1100 hours on June 1, the fire spread to a size of approximately 75 acres at 1255 hours. It then ran southeast past Thackeray Lake for 1.8 miles in approximately 2.5 hours before a northwest wind of 7 mph. The fire burned mostly through partially cutover stands and crowned in areas of uncut black spruce, jack pine and balsam fir. The fire was approximately 800 acres in size at 1530 hours and at 2000 hours, after considerable backfiring and burning out along the road running southeast from the mill, the fire was mapped at approximately 1,900 acres. At this time, the fire had burned into lowland black spruce on its eastern and southeastern front and was burning itself out. Between 1900 and 2000 hours, a wind shift to the southwest kept the fire moving in a northerly direction and in late morning of June 2 the fire had burned through a large area of clearcut jack pine, scheduled for a prescribed burn later in the year. Between 1100 and 1300 hours, the fire ran north through another large jack pine clearcut scheduled for burning in 1971, travelling 2.25 miles in this 2-hour period. During the last afternoon, the fire burned west for a small distance through slash and patches of standing black spruce. On June 3, the fire was relatively quiet except near the north end of Francis Lake where it was burning back to the west against the wind. A line was bulldozed south from the road slightly east of Feldman's camp and the area between this line and Francis Lake burned out with a backfire.

Table 1. Noon fire weather recorded 4 miles northwest of Thackeray Wildfire site

Date		24-hr rain	Wind (mph)		Temp.	R.H.	FFMC[a]	DMC[b]	DC[c]	ISI[d]	ADMC[e]	FWI[f]
May	18	0.10	N	8	42	100	27.1	7.5	53.1	0.1	11.0	0.1
	19	0.38	E	4	47	94	8.8	3.5	41.8	0.0	5.8	0.0
	20	0.16	SW	10	63	43	62.4	4.3	42.3	0.8	6.9	0.4
	21	--	NW	7	48	61	72.7	5.3	45.9	1.1	8.3	0.6
	22	--	NW	8	49	56	78.9	6.6	49.6	2.1	9.8	1.8
	23	--	SE	4	46	45	82.5	7.8	53.0	2.3	11.4	2.3
	24	--	SE	6	55	30	87.8	10.4	57.3	5.1	14.3	6.7
	25	0.76	E	7	43	100	4.9	4.4	28.2	0.0	6.3	0.0
	26	0.58	NE	9	55	54	52.1	3.3	10.0	0.5	3.6	0.2
	27	--	NE	8	61	36	78.0	6.2	14.9	1.9	6.1	0.9
	28	--	SE	5	75	25	89.4	11.1	21.2	5.8	11.0	6.6
	29	--	W	10	82	26	92.3	16.7	28.2	13.0	16.5	15.7
	30	--	NW	8	63	38	91.6	19.7	33.3	9.9	19.5	13.8
	31	--	N	7	53	43	90.3	21.6	37.4	7.7	21.4	11.9
June	1	--	NW	7	73	33	90.9	25.8	44.6	8.3	25.7	13.8
	2	--	SW	9	76	17	94.0	31.4	52.2	15.0	31.2	23.5
	3	--	NW	16	77	40	92.6	35.5	59.8	21.8	35.3	32.1
	4	--	NE	12	59	40	91.4	38.1	65.7	13.4	37.9	23.8
	5	--	NE	5	63	30	91.2	41.5	71.9	7.4	41.3	16.2
	6	--	SW	11	81	45	91.0	45.6	80.0	11.7	45.4	23.6
	7	--	E	6	62	55	89.2	47.7	86.1	6.1	47.5	15.1
	8	--	NE	28	55	50	88.3	49.5	91.6	32.4	49.3	48.4
	9	--	NE	15	60	40	88.6	52.1	97.5	11.8	51.9	25.5
	10	--	SW	7	73	33	90.5	56.4	104.8	7.9	56.1	19.9
	11	--	SW	11	76	32	91.2	60.9	112.3	12.0	60.7	27.9
	12	0.13	SW	5	68	63	67.3	48.3	115.3	0.7	48.3	1.5
	13	--	NE	15	78	37	86.9	52.7	123.0	9.4	52.7	21.8
	14	--	NW	6	80	32	90.6	57.7	131.0	7.4	57.6	19.3
	15	--	NE	4	83	36	91.2	62.7	139.2	6.8	62.6	18.9
	16	--	W	5	83	29	92.1	68.2	147.5	8.3	68.0	22.9
	17	--	W	12	86	45	91.5	72.7	156.0	13.6	72.5	33.0
	18	--	W	18	78	50	90.5	76.2	163.8	19.3	76.0	42.5
	19	--	W	7	87	38	91.2	81.3	172.4	8.7	81.2	25.9
	20	0.29	W	11	67	100	26.9	46.6	164.7	0.1	54.6	0.2

(continued)

Table 1. Noon fire weather recorded 4 miles northwest of Thackeray Wildfire site (concluded)

Date	24-hr rain	Wind (mph)	Temp.	R.H.	FFMC[a]	DMC[b]	DC[c]	ISI[d]	ADMC[e]	FWI[f]
June 21	0.10	NW 13	61	54	63.2	41.0	168.2	1.1	51.0	3.2
22	--	SW 13	75	41	84.5	44.9	175.7	5.9	54.8	15.8
23	0.11	W 8	74	47	76.4	39.8	179.8	1.7	51.2	5.1
24	0.16	W 18	62	51	70.6	30.4	179.6	2.4	42.7	6.5
25	--	NW 6	71	42	83.9	33.9	186.6	3.1	46.6	8.6
26	--	NW 15	68	42	87.8	37.1	193.4	10.5	50.1	23.1
27	--	W 3	69	40	88.8	40.5	200.2	4.6	53.8	12.9
28	--	S 13	79	50	89.3	44.1	208.1	11.0	57.6	25.5
29	0.07	W 7	84	53	81.4	44.8	215.7	2.5	59.0	8.3
30	1.10	S 2	58	100	7.8	16.8	153.6	0.0	26.4	0.0

[a] Fine fuel moisture code.

[b] Duff moisture code.

[c] Drought code.

[d] Initial spread index.

[e] Adjusted duff moisture code.

[f] Fire weather index.

In the two phases of the fire where it made long and fast advances, the southeast run on June 1 and the north run on June 2, it is possible to calculate accurate rates of spread. The southeast run covered 1.8 miles in 2.5 hours or *1.06 ft/sec* through partially cut and uncut stands, on a day with an FWI of 13.8 and an Initial Spread Index (ISI) of 8.3. The north run the next day (FWI:23.5, ISI:15.0) burned 2.25 miles in 2.0 hours through jack pine slash giving a rate of spread (R/S) of *1.65 ft/sec* From experimental fires conducted in July and August in jack pine slash of similar quantity and composition, it is possible to estimate slash and fuel consumption. Based on these observations, an estimate of *0.8 lb/sq ft* as total fuel consumption (0.5 lb/sq ft of organic material and 0.3 lb/sq ft of slash) seems reasonable. Total available fuel was 2.5 lb/sq ft (54.45 tons/acre), equally divided between slash and organic layers.

By using our estimated R/S and fuel consumption figures of 1.65 ft/sec and 0.80 lb/sq ft respectively, it is possible to estimate the intensity of the fire during its north run on June 2 by using the formula: I = HWR (Byram, 1959) where:

I = fire intensity in BTU/sec per ft of fire front

H = heat yield in BTU/lb of fuel

W = fuel consumption in lb/sq ft

R = rate of spread in ft/sec.

If we assume H to be *8000 BTU/lb*, then the intensity during this phase of the Thackeray fire can be estimated at *10,560 BTU/sec per ft.*

Moisture content data gathered nearby during the fire indicates jack pine slash fuel (< 2 inches diameter) had an average moisture content of 11% (oven-dry weight [o.d.w.]) and jack pine organic matter (duff) a moisture content of approximately 100% (o.d.w.) on June 1 and 2.

Although the fire generally burned itself out quickly upon entering lowland areas, the great intensity with which it carried through the slash before running into these spruce stands resulted in crowning for varying distances. With a temporary lull in the wind, the fire would drop from the crowns and, upon coming in contact with the wet (500% M.C. o.d.w.) *Sphagnum* moss on the forest floor, was subdued sufficiently to be unable to rise when the winds gusted again. Burning in both the black spruce overstory and *Sphagnum* moss was patchy. Measurements made in one burned area the day after the fire's passage show an average of 2 inches of *Sphagnum* consumed and the majority of fuel less than ¼ inches in diameter in the crowns (needles, small branches) completely destroyed. Moisture content values of needles and small branches were 87% and 64% (o.d.w.), respectively.

The fire did not spread noticeably after June 3 however, and mop-up operations on recurring smokes and smudges continued until the first substantial rain (1.10 inches) on June 30. The Thackeray fire was declared officically out on August 11, 1971 at a final size of 4,000 acres (3,200 acres cut-over, 200 acres unmerchantable timber, 225 acres of mature timber, 350 acres of immature timber and 25 acres of planted area), all of which was licensed crown land.

WHISTLE LAKE WILDFIRE (AUGUST 1971)

This fire, also referred to as Fire No. 24-34 in Ontario Department of Lands and Forests records, started in black spruce-balsam fir slash on August 7, 1971, its cause being listed as Industrial (forest). It occurred on Abitibi Paper Co. limits in their Camp 230 operating area, about 70 miles north of Thunder Bay on the Spruce River Road. The final size of the fire was 6,250 acres, with about 75% of the area burned having been cut over within the past 4 to 5 years.

The original stands in the area were described in the Abitibi inventory as mainly black spruce and balsam fir with areas of white birch and aspen mixed in, and with merchantable volumes of softwood being estimated as averaging 25 cunits/acre.

Areas of uncut timber which were destroyed generally contained large amounts of insect-damaged balsam fir and fir understory and thus burned quite fast and hot.

According to notes made by and personal communication with Abitibi personnel[1], the fire did not burn too severely the afternoon of August 7 or on August 8, despite rather extreme weather conditions (Table 2). The Fire Weather Index (FWI) (Anon., 1970) and its components were calculated from noon weather observations of wind, humidity and temperature made at Max Lake Tower, 10 miles south of the fire site and precipitation amounts recorded right at the fire site. By the evening of August 8, the fire was estimated at 500 acres.

August 9 was called "Red Monday" on the Whistle Lake fire. The high recorded in the afternoon was reported as 96°F with southwest winds of up to 30 miles/hour occurring. The fire broke away near Spender Lake at 1430 and in 6 hours had reached the Spruce River Road, some 5 miles east forcing suppression crews to retreat (Fig. 2). The fire was contained to some degree by roads on the north and probably confined to a rather narrow area by the force of the wind, while the southern flank seems to have followed the boundary of cutover and uncut areas quite closely. Considering a gross rate of spread of 5 miles in 6 hours, we can get from this an average spread of 73 ft/min (1.2 ft/sec). An investigation of full layer duff and litter on unburned areas near the fire indicated an average weight of approximately 1 lb/sq ft of this material of which an average of about 70% had apparently been consumed. Also, our experience with slash availability and consumption would indicate a probable slash fuel loading of about 1.5 lb/sq ft with an assumed slash consumption of about 50% by weight or 0.7 lb/sq ft. By using these values of spread and total fuel consumption (1.2 ft/sec and 1.4 lb/sq ft), the probable average fire intensity for this 6-hour period was calculated from Byram's formula to be *13,440 BTU/sec per ft* in the slash areas.

As the fire approached the Spruce River Road, it threatened Camp 230; however defensive effort precluded its destruction. On August 10 and 11, the fire had reached approximately 4,600 acres and several areas around its perimeter were still causing some major control difficulties.

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[1] Mr. T.H. Peacock, Abitibi assistant logging superintendent, kept extensive notes and observations of the fire's history, documented with slide and movie coverage, thus contributing to the analysis of this fire.

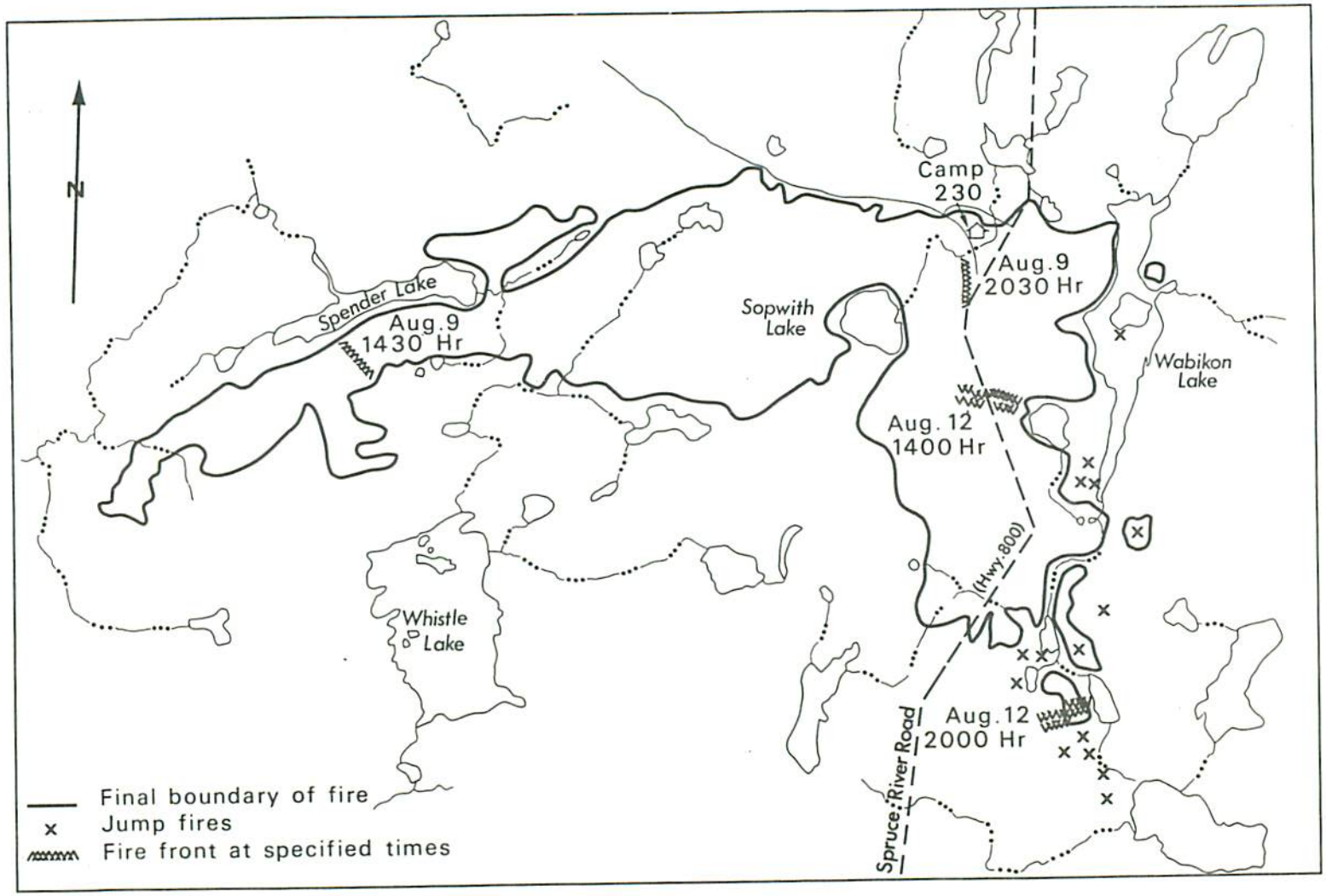

Figure 2. Map of Whistle Lake wildfire, Thunder Bay District.

Table 2. Noon fire weather during Whistle Lake Fire, 1971

Date	24-hr rain	Wind (mph)	Temp.	R.H.	FFMC[a]	DMC[b]	DC[c]	ISI[d]	ADMC[e]	FWI[f]
July 11	0.57	E 3	70	42	65.6	15.7	151.6	0.4	25.0	0.6
12	0.15	S 20	59	74	60.1	11.6	152.6	1.7	19.5	2.4
13	0.12	NW 15	60	84	52.9	8.8	155.5	0.8	15.4	0.6
14	0.15	W 10	68	56	66.2	7.6	157.3	1.0	13.5	0.7
15	--	NW 10	68	60	79.4	9.5	164.6	2.6	16.7	3.7
16	--	NW 8	58	58	82.5	11.1	170.9	3.1	19.1	4.9
17	--	NW 15	60	50	85.4	13.0	177.4	7.8	22.0	12.1
18	--	N 3	65	54	85.9	15.1	184.4	3.1	25.1	5.9
19	--	N 5	70	57	86.1	17.4	191.9	3.8	28.3	7.5
20	--	-- 0	68	64	85.9	19.2	199.2	2.7	30.9	5.8
21	0.03	SW 15	70	73	81.9	20.6	206.7	5.1	32.9	10.7
22	--	NW 5	66	55	84.6	22.7	213.8	3.1	35.8	7.3
23	--	N 7	64	66	84.1	24.2	220.7	3.5	38.0	8.3
24	--	SW 8	68	52	86.1	26.6	228.0	4.8	41.1	11.5
25	0.06	SW 18	76	46	84.1	29.0	236.1	8.4	44.4	18.5
26	--	NW 15	52	76	82.4	29.7	241.8	5.4	45.5	13.3
27	0.04	W 5	60	74	75.5	30.7	248.3	1.2	46.9	3.4
28	0.03	NW 20	49	100	65.7	30.8	253.7	2.2	47.2	6.3
29	0.06	NW 10	48	86	55.5	30.2	259.0	0.6	46.8	0.9
30	--	W 5	62	70	69.7	31.5	265.7	0.8	48.6	2.0
31	0.06	SW 15	67	59	75.6	32.6	272.9	2.7	50.2	8.0
Aug. 1	0.06	W 5	58	78	65.0	32.4	278.5	0.6	50.2	1.2
2	--	NW 8	50	81	69.2	32.8	283.2	1.0	50.9	2.8
3	--	N 8	62	61	78.7	34.3	289.2	2.1	52.9	6.4
4	--	N 3	70	49	84.5	36.6	295.9	2.6	55.9	8.3
5	--	W 4	72	54	86.1	38.8	302.9	3.5	58.8	10.9
6	--	NW 5	78	54	87.1	41.4	310.4	4.3	62.1	13.3
7	--	W 8	80	55	87.7	43.9	318.2	5.9	65.3	17.5
8	--	SW 12	82	50	88.5	46.9	326.1	9.0	69.0	24.4
9	--	SW 18	84	51	89.2	50.0	334.3	16.3	72.7	37.3
10	0.06	NW 5	66	72	73.8	49.8	340.6	1.1	72.9	4.1
11	--	NW 10	57	48	82.2	51.4	346.1	3.5	75.0	12.7
12	--	W 20	72	58	85.3	53.4	353.0	11.5	77.5	30.6

(continued)

Table 2. Noon fire weather during Whistle Lake Fire, 1971 (concluded)

Date	24-hr rain	Wind (mph)		Temp.	R.H.	FFMC[a]	DMC[b]	DC[c]	ISI[d]	ADMC[e]	FWI[f]
Aug. 13	--	S	5	59	69	84.5	54.4	358.7	3.1	78.9	11.7
14	--	NE	5	57	72	83.4	55.3	364.1	2.7	80.2	10.7
15	--	S	12	69	45	87.2	57.8	370.8	7.6	83.2	23.9
16	0.09	--	0	76	65	68.6	51.7	375.0	0.5	76.9	1.8
17	0.09	E	5	63	100	36.6	44.7	377.9	0.1	69.0	0.3
18	--	SW	6	76	75	64.7	46.0	385.3	0.7	70.9	2.3
19	0.05	NW	5	70	57	74.0	48.0	392.0	1.1	73.5	4.2
20	--	NW	5	68	56	81.8	49.9	398.6	2.2	76.0	8.8
21	--	NW	5	69	64	83.6	51.5	405.2	2.8	78.2	10.7
22	--	NE	15	60	59	84.4	52.9	411.0	6.8	80.1	21.6
23	--	E	2	55	71	83.1	53.7	416.2	2.1	81.3	8.5
24	0.33	SE	15	46	100	13.9	29.4	390.1	0.1	49.5	0.1
25	0.03	E	3	50	93	15.7	29.6	394.8	0.0	49.8	0.0
26	--	NE	5	64	57	58.3	31.2	401.0	0.5	52.3	0.8
27	--	NW	2	70	49	76.6	33.6	407.7	1.1	55.7	3.2
28	0.11	NW	5	76	59	72.6	29.4	409.4	1.0	49.8	2.7
29	--	NW	5	70	73	78.4	30.6	416.1	1.6	51.7	4.8
30	--	NE	5	63	57	82.6	32.3	422.2	2.6	54.2	7.7
31	0.05	SE	10	66	51	80.5	34.3	428.5	2.9	57.1	9.2

[a] Fine fuel moisture code.

[b] Duff moisture code.

[c] Drought code.

[d] Initial spread index.

[e] Adjusted duff moisture code.

[f] Fire weather index.

On the afternoon of August 12, however, the wind changed to the northwest and drove the fire across the southern lines, a distance of 3.75 miles in 6 hours, again mainly through cutover areas. Using a slightly smaller total fuel consumption figure for this area of 1.2 lb/sq ft, we calculated a fire intensity value of *8,830 BTU/sec per ft* as an average for this run.

August 13 saw many jump fires at the southeast end of the fire but effective use of retardant bombers and fast encirclement by bulldozed lines controlled these potentially dangerous areas. Between August 14 and 18, only one major flare-up (100 acres) occurred outside the fire line and on August 19 the fire was declared BH, August 27 as UC, and

officially "out" on September 23. It is significant to note that between August 7 and August 19, less than 0.30 inches of rain fell on the fire area and this was evenly spread out in rather small amounts at a time. Thus the control effort on the Whistle Lake fire, although relatively costly, represents an extremely effective use of men, equipment and aircraft.

There is no doubt that the damage caused by this fire, especially long-term, was extremely high. Personal communication with Abitibi personnel indicates a loss of roughly 10,000 cords of standing timber. No cut wood was lost but approximately 300 acres of planted cutover were destroyed. In general, on the areas observed after the fire, mineral soil had been very shallow, lying over boulder beds and covered with from 3 to 18 inches of moss and litter. As a result, in areas where all or most of the moss and litter was removed, the remaining ash and soil has been washed down into the boulders leaving an environment which is not likely to support tree growth for a considerable period of time (Fig. 3). Areas where the burning was less severe or where a deeper mineral soil layer is present will more readily support regeneration (some of these have already been planted since the fire); however, severe erosion problems owing to exposure, lack of minor vegetation and general ruggedness of the topography are expected. In areas where standing timber was burned, consumption was so deep around the trees that most of the root systems were exposed and as a result many of the trees are easily blown over.

Figure 3. Boulder exposure and erosion on Whistle Lake fire site.

SUMMARY

The Thackeray and Whistle Lake wildfires were the two most significant fires in Ontario during the 1971 fire season and most fire control personnel in this province are familiar with them. The purpose of this report has been to analyze and describe these fires in meaningful terms that allow comparison with past and future major wildfires.

The documentation of these fires is part of a continuing study of fire behavior in major Ontario fuel types, being conducted by fire researchers at the Great Lakes Forest Research Centre. Data gathered by controlled experimental burning is augmented by information collected at wildfire sites (in cases where sufficient information is available) and used to develop means of predicting fire behavior in certain fuel types and under certain weather conditions.

REFERENCES

Anon. 1970. Canadian Forest Fire Weather Index. Canadian Forestry Service. 25 p.

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APPENDIX

APPENDIX A

METRIC CONVERSION FACTORS

CONVERSION TO METRIC UNITS

Constants to convert units in the tables in this report to the metric system:

Quantity	English unit	Constant		Metric unit	Metric abbreviation
Fuel depth	inches	x 2.54	=	centimetres	cm
Fuel loading	lb/ft^2	x 4.88	=	kilogram/square metre	Kg/m^2
	ton/acre	x 2.24	=	metric ton/hectare	MT/ha
Rate of spread	ft/min	x 0.305	=	metres/minute	M/min
Available energy	Btu/ft^2	x 0.0271	=	kilogram-calories/square metre	$Kcal/m^2$
Fire intensity	Btu/sec/ft	x 0.826	=	kilogram-calorie/sec/metre	Kcal/sec/m
Heat of combustion	Btu/lb	x 0.556	=	calories/gram	cal/gram
Wind speed	mph	x 0.447	=	metres/sec	m/sec
Bulk density	lb/ft^3	x 0.016	=	grams/cubic centimetre	g/cm^3