THE FUEL COMPLEX OF MATURE AND IMMATURE JACK PINE STANDS IN ONTARIO

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ABSTRACT

Areas for controlled burning experiments in mature and immature jack pine stands have been established in two locations in Ontario. The mature 75-year-old stand is located near White River, Ontario and studies of the fuel components of the stand are completed. Ground, surface, and aerial fuel weights were calculated and tables for estimating these component fuel weights are available. The immature 26-year-old stand north of Thessalon, Ontario, resulted from the 1948 Mississagi fire. Similar tables for the fuel component weights of this fuel complex are available as well. The fuel weight information will be used in assessing fire behaviour in these two important forest types when controlled burning experiments are undertaken and burning indexes are developed.

RÉSUMÉ

Les auteurs ont établi, dans deux endroits en Ontario, des régions d'expérimentation de brûlages contrôlés en peuplements matures et jeunes de Pin gris. Le peuplement mature, âgé de 75 ans, est situé près de White River et les études sur les combustibles constituant le peuplement sont terminées. On a calculé le poids des combustibles du sol, de surface et aériens, et préparé des tableaux permettant l'estimation de ces combustibles. Le jeune peuplement, âgé de 26 ans, est situé au nord de Thessalon, Ontario et il provient de l'incendie de Mississagi de 1948. On a également préparé des tableaux pour le poids des combustibles de ce peuplement. Les données concernant leurs poids seront utilisées dans l'estimation du comportement des feux dans ces deux types de boisés, lorsqu'on entreprendra des brûlages contrôlés et qu'on préparera des indices de brûlage.

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INTRODUCTION

A major part of the Fire Research Program at the Great Lakes Forest Research Centre is concerned with the development of fire behaviour tables for important forest fuel types in Ontario. To date, a study has been completed on the fire behaviour characteristics of jack pine (*Pinus banksiana* Lamb.) slash under varying weather conditions (Stocks and Walker 1972) and a jack pine slash burning index has been developed (Stocks 1972). At present, fire behaviour in the mature and immature jack pine forest types of Ontario is being investigated. To this end twenty-four 0.4 ha (1-acre) burning plots have been established in a mature jack pine stand near White River, Ontario and 22 similar plots have been established in an immature stand north of Thessalon, Ontario (Fig. 1).

The mature plots are located in Welsh Township, approximately 64 km (40 miles) north of White River (48° 30' N x 85° 30' W). Four of these plots have been burned to date, with poor weather precluding further burns. The immature burning plots are located in Rioux Township (formerly Township 2E) approximately 88 km (55 miles) north of Thessalon (46° 15' N x 83° 35' W). One plot was burned in late June, 1974; however, a severe wildfire situation in July and August in northwestern Ontario precluded further burning, as all trained fire crews were needed to fight the wildfire. The purpose of this report is to describe the fuel complex of these types and the sampling techniques used in gathering the data.

Kiil (1968, 1969) has similarly described the fuel complex of lodgepole pine (*Pinus contorta* L.), and black spruce (*Picea mariana* [Mill.] B.S.P.) and Alpine fir (*Abies lasiocarpa* [Hook.] Nutt.). Muraro (1971) correlated mensurational parameters of a range of lodgepole pine stands with loading of individual fuel components and the total fuel complex. In the United States, Brown (1965) has investigated the feasibility of estimating crown fuel weights of red pine (*Pinus resinosa* Ait.) and jack pine.

The fuel complex is described under three general headings: aerial, surface, and ground fuels. In some of the sampling techniques described we refer to 27 samples or measurements taken per plot. These measurements are related to the 10-m (1/2-chain) grid we have established in each 40-m x 100-m (2-chain x 5-chain) plot, mainly for rate of spread measurements for the fires. However, we usually use this grid as a standard reference for other measurements.

DESCRIPTION OF AREAS

The White River burning area is on Abitibi Paper Company limits on which the latest logging was terminated in 1965. Most of the surrounding area has been clear-cut for spruce over the past two or three

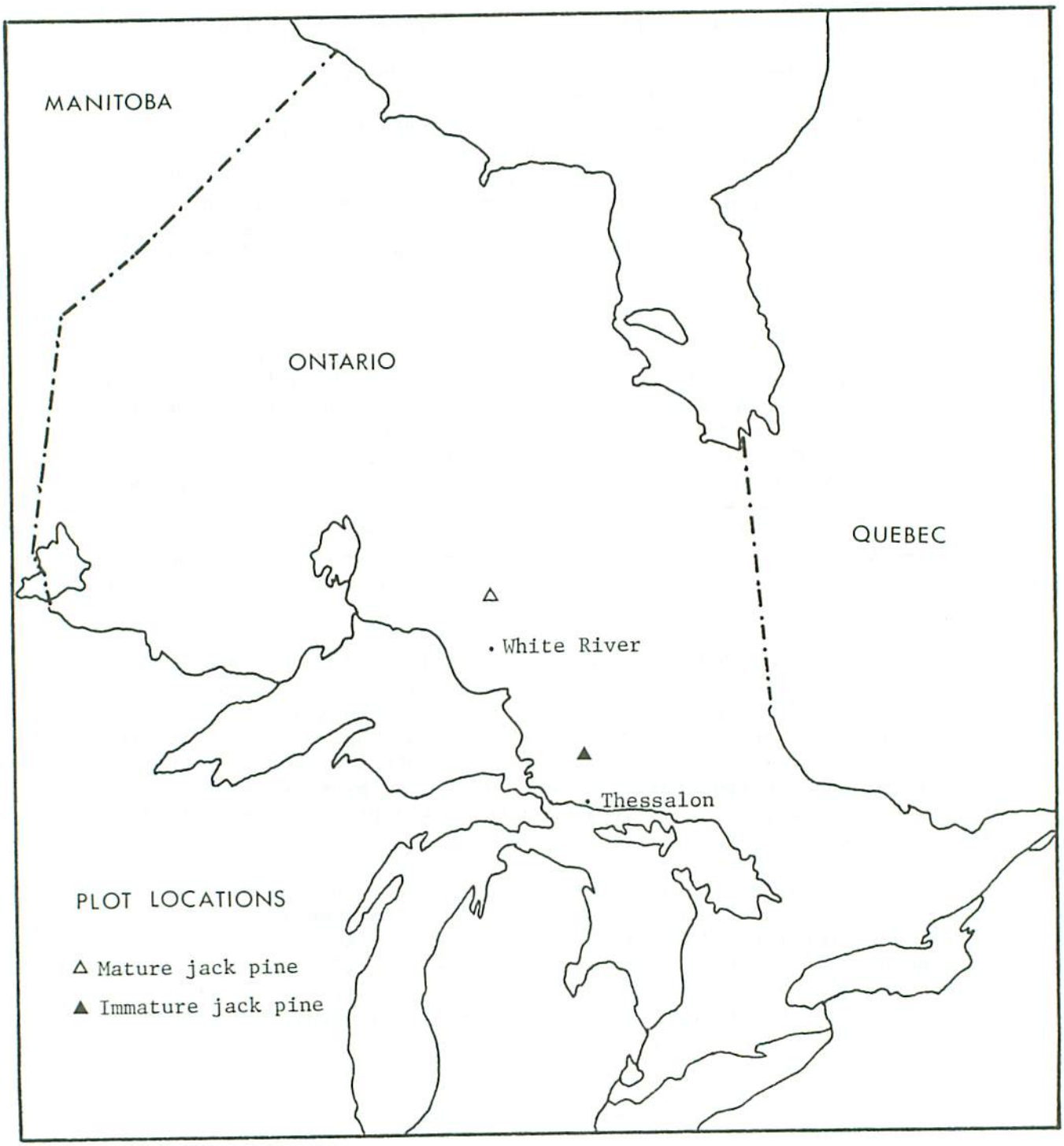

Fig. 1. Location of burning plots--mature and immature jack pine.

decades, but the jack pine has been left. The 70- to 75-year-old stand covers an area of approximately 30 ha (75 acres) and originated from a fire that occurred about 1900. It is on gently rolling terrain described as silty to sandy till ground moraine.[1] The burning plots are located in three main areas in the stand, in varying longitudinal directions to take advantage of different wind conditions (Fig. 2).

The immature jack pine plots are established in a 162-ha (400-acre) stand which resulted from the Mississagi fire of 1948 (Stocks and Walker 1973). They are located on a flat, modified end moraine of gravel and boulders.[1] The 22 plots are located in two different parts of the stand and again their longitudinal direction is varied (Fig. 3).

GENERAL STAND DESCRIPTIONS

Table 1 gives a stand description of the two areas under study (see also Fig. 4a, 4b and 5). The summaries are based on a 10% cruise of each plot in both areas. Height and crown width were determined in the aerial fuel sampling technique described later.

In addition to the mature jack pine the White River area has an understory of black spruce averaging 125 stems per acre (312.5 per ha) for trees greater than 7.6 cm (3 in.) DBH and 288 stems per acre (720 per ha) for trees less than 7.6 cm (3 in.) DBH. The height range of this understory is 1-14 m (approx. 3-45 ft). Scattered stems of white birch (*Betula papyrifera* Marsh.) and aspen (*Populus tremuloides* Michx.) are found throughout the stand.

The immature stand contains an average of 3,950 stems per acre (9,875 per ha) of standing dead trees ranging from about 1.3 to 7.6 cm (0.5-3 in.) in diameter and 1.8 to 6.0 m (6-20 ft) in height.

Figures 6, 7, 8, and 9 show the diameter distribution for the stands in the two areas.

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[1] Source: Ontario Ministry of Natural Resources, 1965 Surficial Geology Maps.

Fig. 2. Aerial view of mature jack pine burning plots near White River, Ontario.

Fig. 3. Aerial view of immature jack pine burning plots north of Thessalon, Ontario.

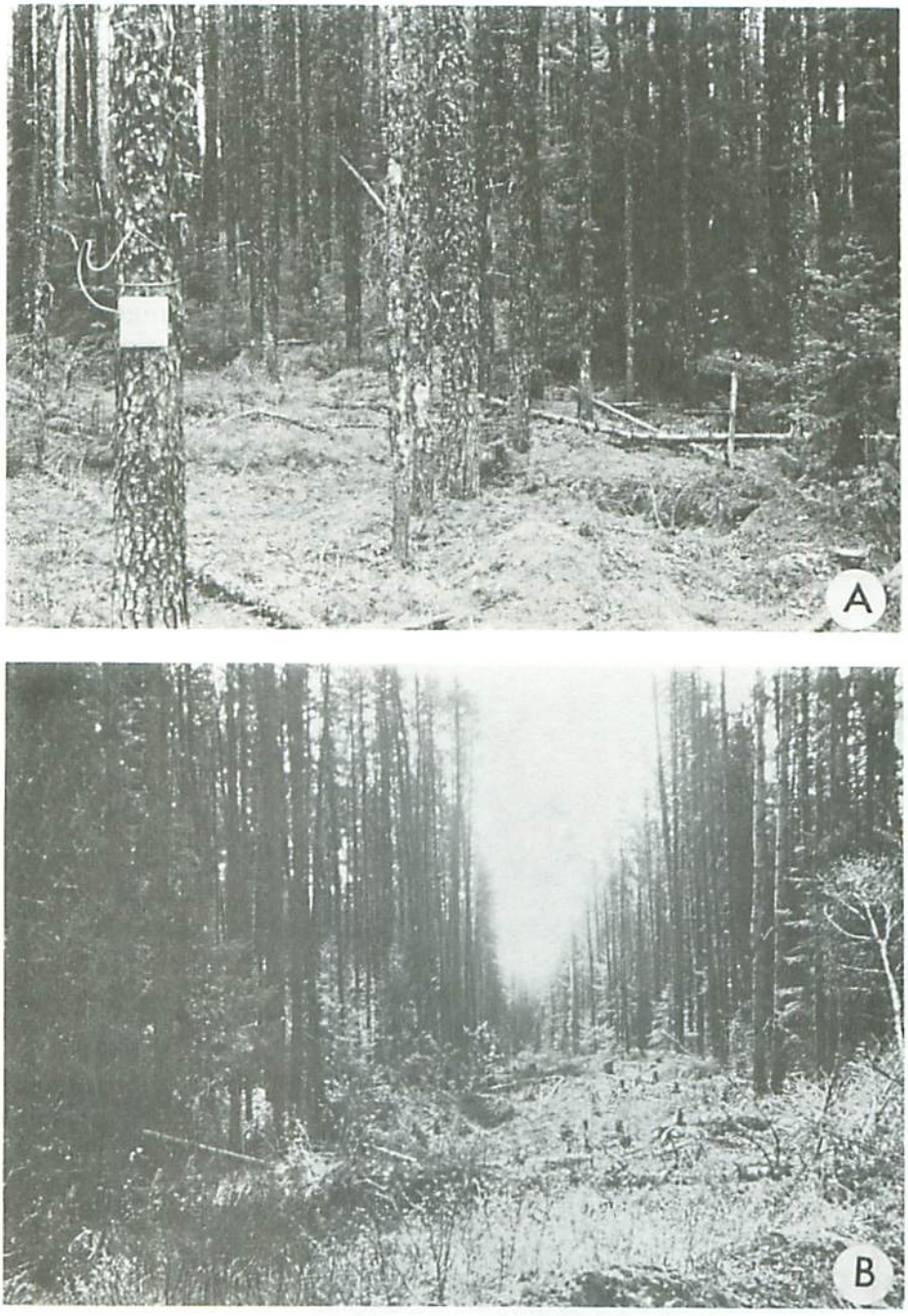

Fig. 4. Mature jack pine, White River, Ontario.

A. In stand. B. View down cleared fire line.

Table 1. Stand descriptions of mature and immature plots

Area	Stems/acre[a]	Ht (m)	DBH (cm)	Basal area m^2/ha
Mature jP (70-75 years)	635	17.7	14.7	29.7
Black spruce understory	413	0.5-13.7 (range)	<2.5-18.0+ (range)	(not determined)
Immature jP live (26 years)	3486	8.2	5.3	(not determined)
dead stems	3950	2.0-6.0 (range)	1.3-7.5 (range)	

[a] 1 stem/acre = 2.5 stems/ha

Fig. 5. Immature jack pine stand as viewed from a cleared fire line

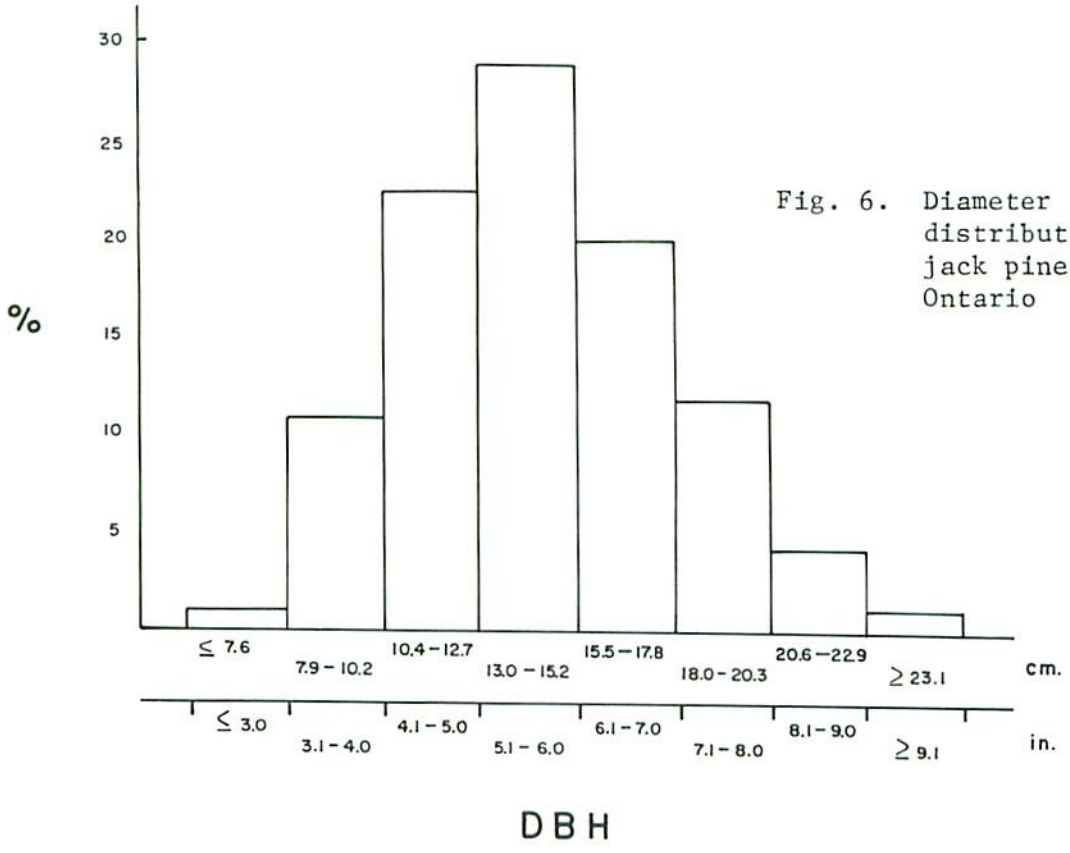

Fig. 6. Diameter (breast height) distribution--mature jack pine, White River, Ontario

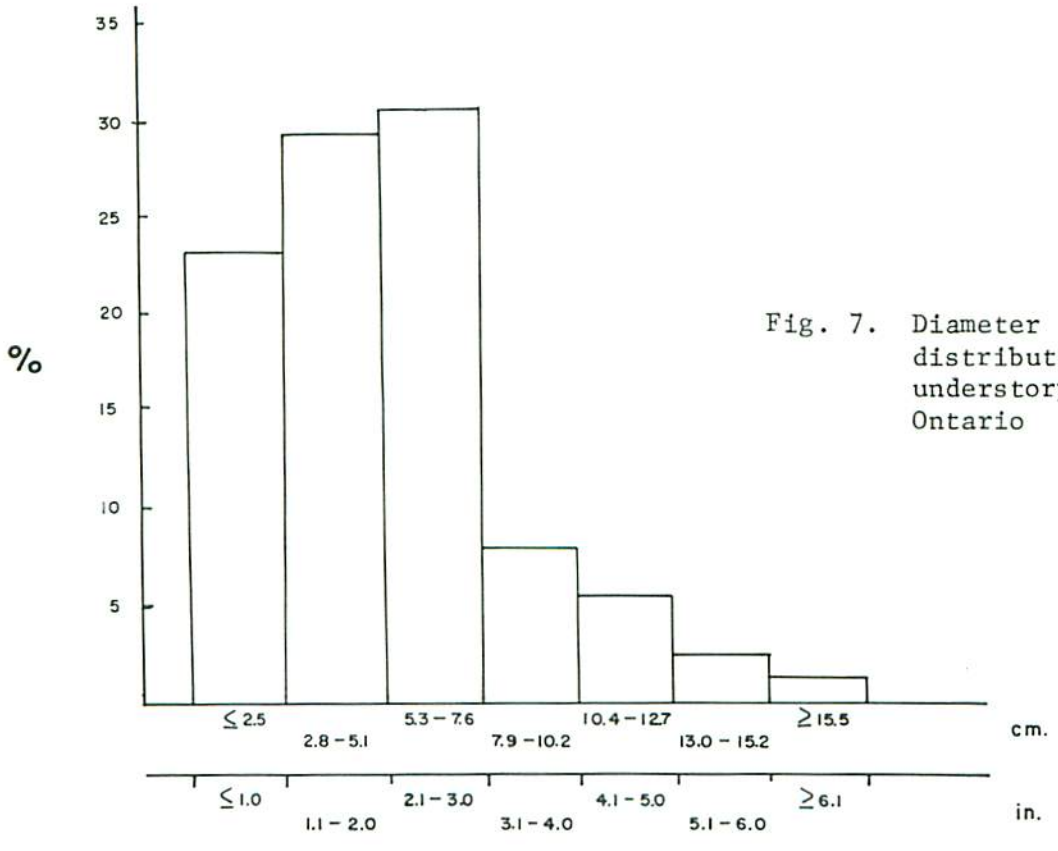

Fig. 7. Diameter (breast height) distribution--black spruce understory, White River, Ontario

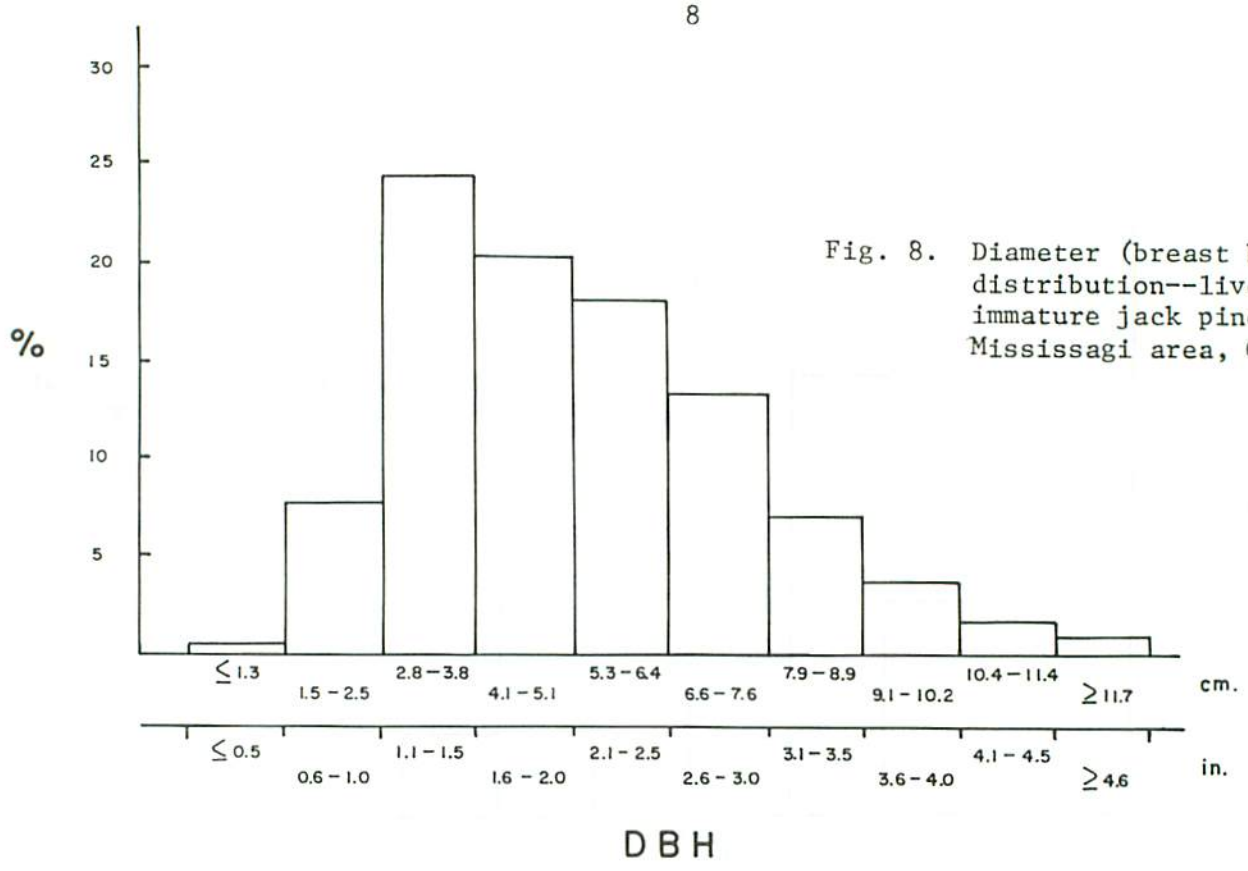

Fig. 8. Diameter (breast height) distribution--live immature jack pine stems, in Mississagi area, Ontario.

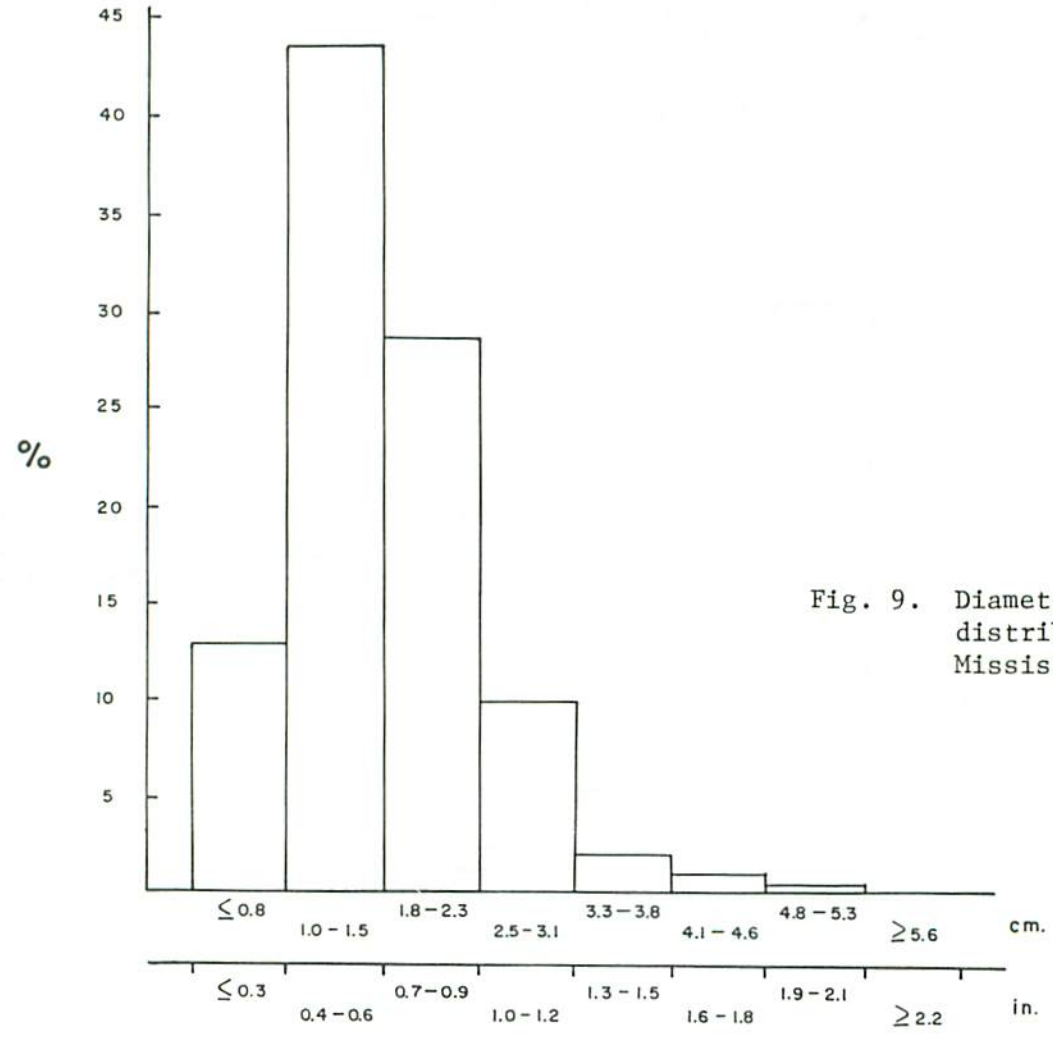

Fig. 9. Diameter (breast height) distribution--dead stems, in Mississagi area, Ontario

THE FUEL COMPLEX

Aerial Fuels

(1) Mature jack pine

The sampling technique used for aerial fuel weight determination in the mature type included cutting 30 trees of varying diameters throughout the stand. Height, height to crown, crown height, crown width, age, and diameters were then measured at 1.2-m (4-ft) intervals. Each tree was dissected into the following fuel component groups and the oven-dry weight of each component group was determined: (1) needles and shoots, (2) flakes (loose bark on bole and large branches), (3) cones, (4) dead material in three size classes: < 0.6 cm, 0.6-1.3 cm, 1.3-2.5 cm (< 1/4 in., 1/4-1/2 in., 1/2-1 in.), (5) live material in similar size classes, and (6) bole or stem of tree. Crown fuel weights excluding the bole and branchwood greater than 2.54 cm (1 in.) are summarized in Figure 10 and Table 2. The average height-to-crown and crown width *for the stand* were determined to be 11.6 m (38.0 ft) and 2.3 m (7.5 ft), respectively. Complete crown fuel weight tables for individual tree diameters have been calculated and are on file. These will be used to determine crown fuel consumption figures following post-burn assessments of the plots.

Similar techniques were used to sample the black spruce understory with 35 trees being analyzed over the wide range of diameters present. Size classes of the fuel components were as follows: (1) needles and 0-0.3-cm (0-1/8-in.) material, (2) 0.3-0.6 cm (1/8-1/4 in.), (3) 0.6-1.3 cm (1/4-1/2 in.), (4) 1.3-2.5 cm (1/2-1 in.). These fuel weights are related to stump diameters because of the large number of small-diameter trees in the understory. Table 3 and Figure 11 summarize crown fuel weights for the spruce understory. Again, complete crown fuel tables were calculated and are on file for use in post-burn fire behaviour analysis.

(2) Immature jack pine

A similar sampling technique was used to determine aerial fuel weights in the immature type. Twenty-four living and 11 dead trees were sampled from varying diameter classes. Table 4 and figures 12 and 13 summarize aerial fuel weight for the stands. A complete aerial fuel weight table with further breakdowns is on file and will be used for post-burn fire behaviour analysis.

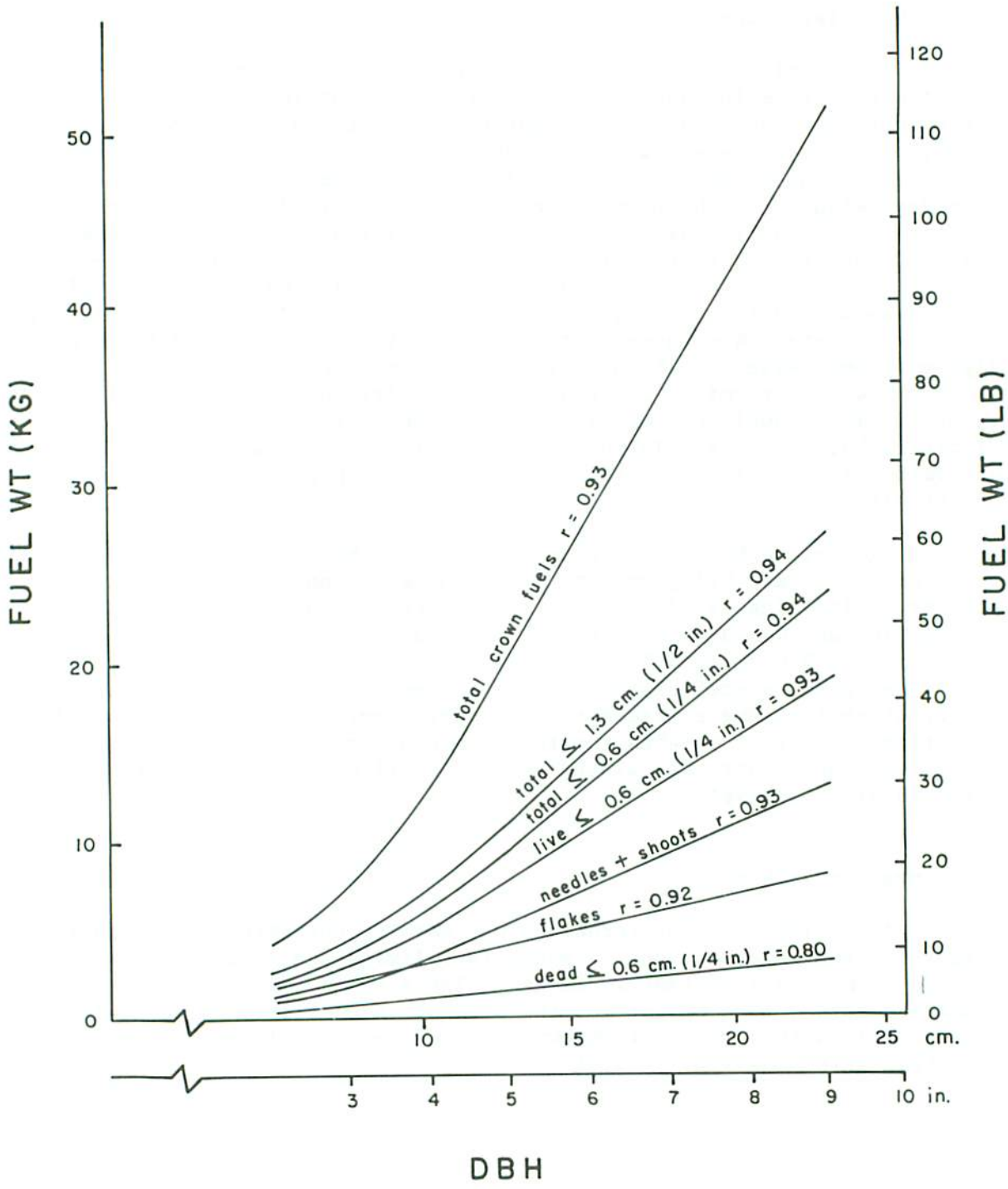

Fig. 10. Crown fuel weights--mature jack pine, White River, Ontario.

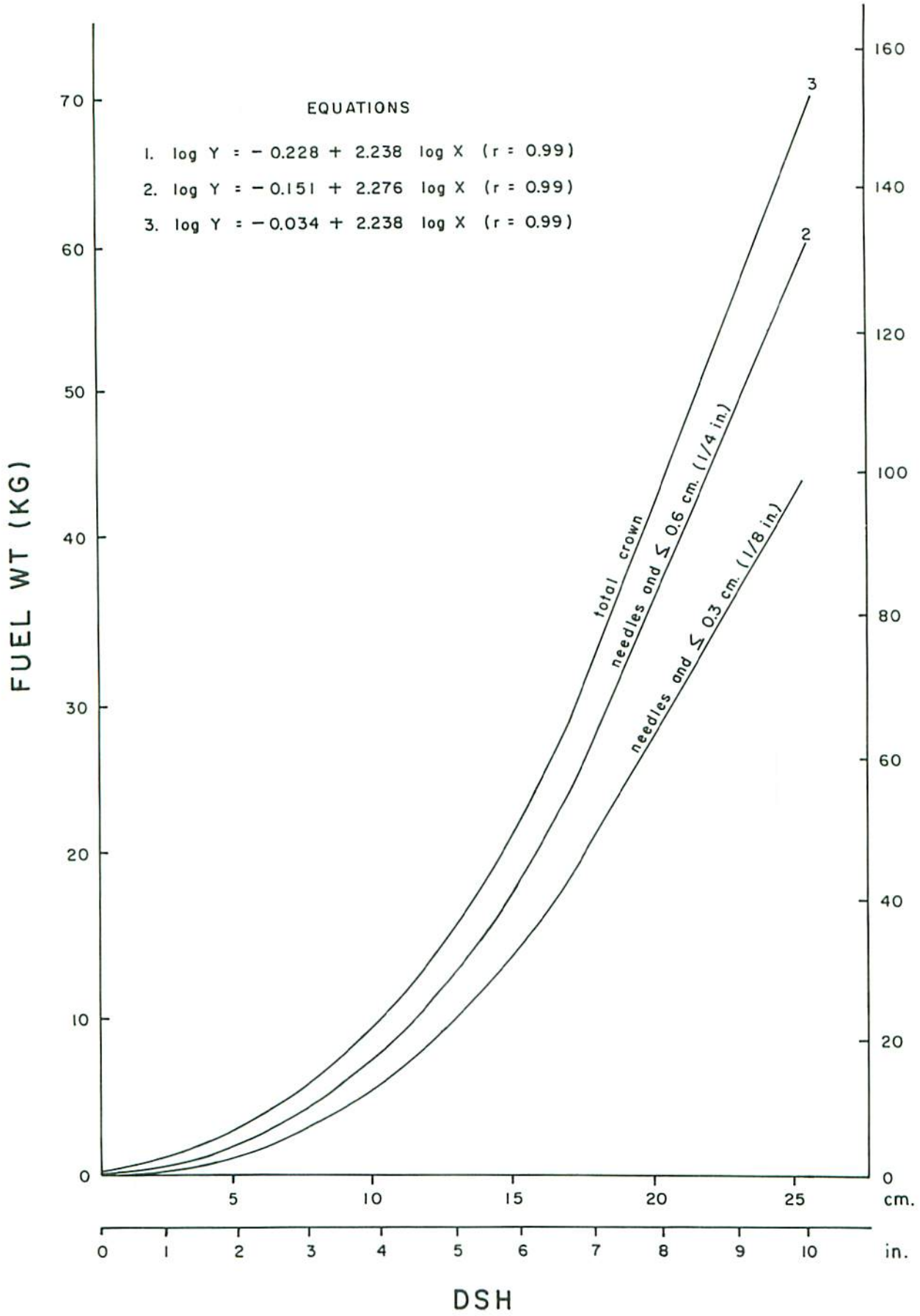

Fig. 11. Crown fuel weights--black spruce understory, White River, Ontario. (Note: based on stump diameter [DSH].)

Table 2. Mature jack pine--aerial fuel weights

		<0.6 cm Dead	Flakes	Needles and shoots	Live <0.6 cm (includes needles and shoots)	Total <0.6 cm (excludes flakes)	<1.2 cm	Total crown
Weight	(kg/ha)	2046	4914	6493	10,166	12,212	15,603	26,733
	(metric tons/ha)	2.04	4.93	6.50	10.17	12.21	15.61	25.60

Table 3. Black spruce understory--aerial fuel weights

		Total <0.3 cm (including needles)	Total <0.6 cm (including needles)	Total crown
Weight	(kg/ha)	4359	5414	6705
	(metric tons/ha)	4.37	5.42	6.70

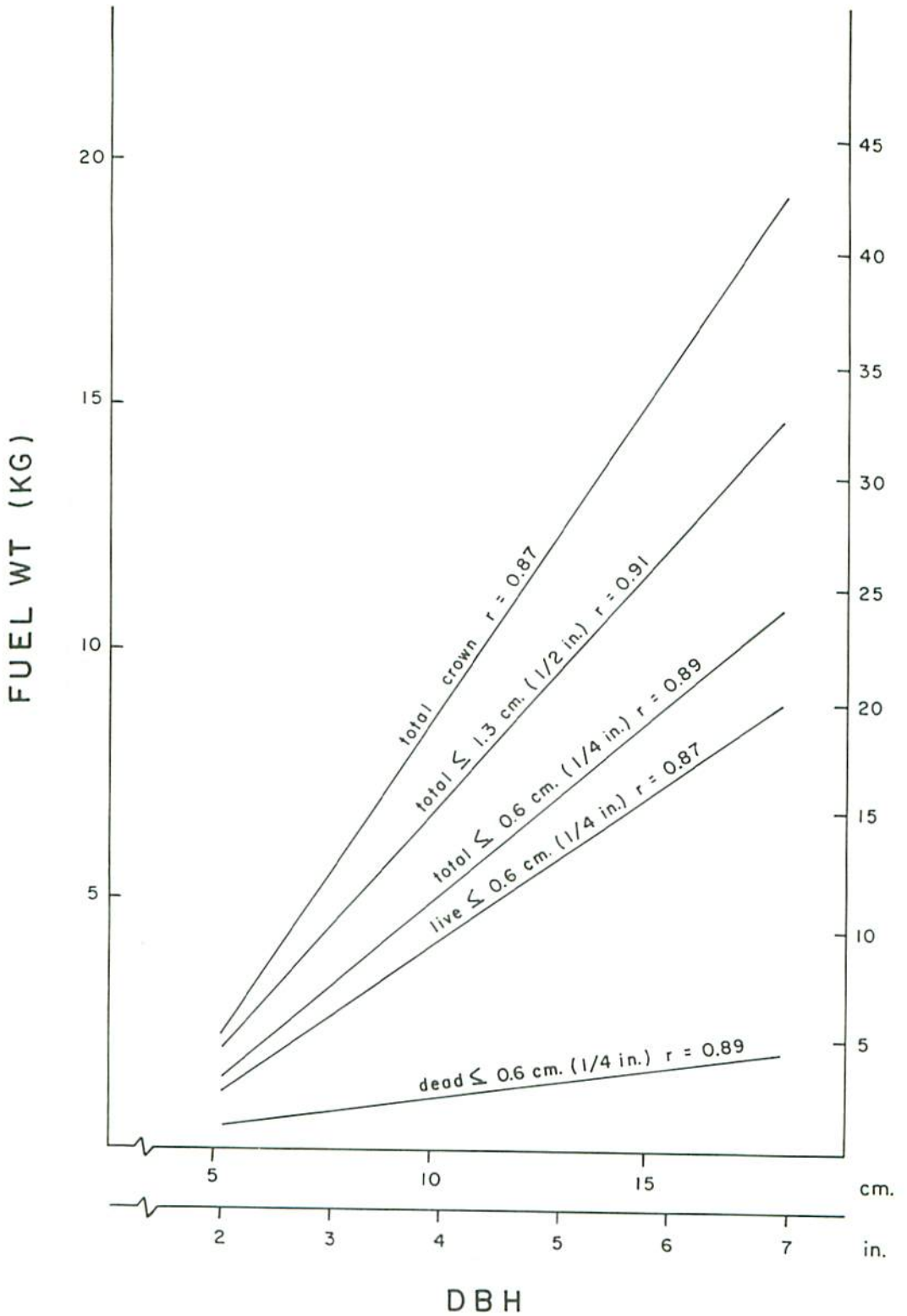

Fig. 12. Crown fuel weights--immature (live) jack pine, in Mississagi area, Ontario.

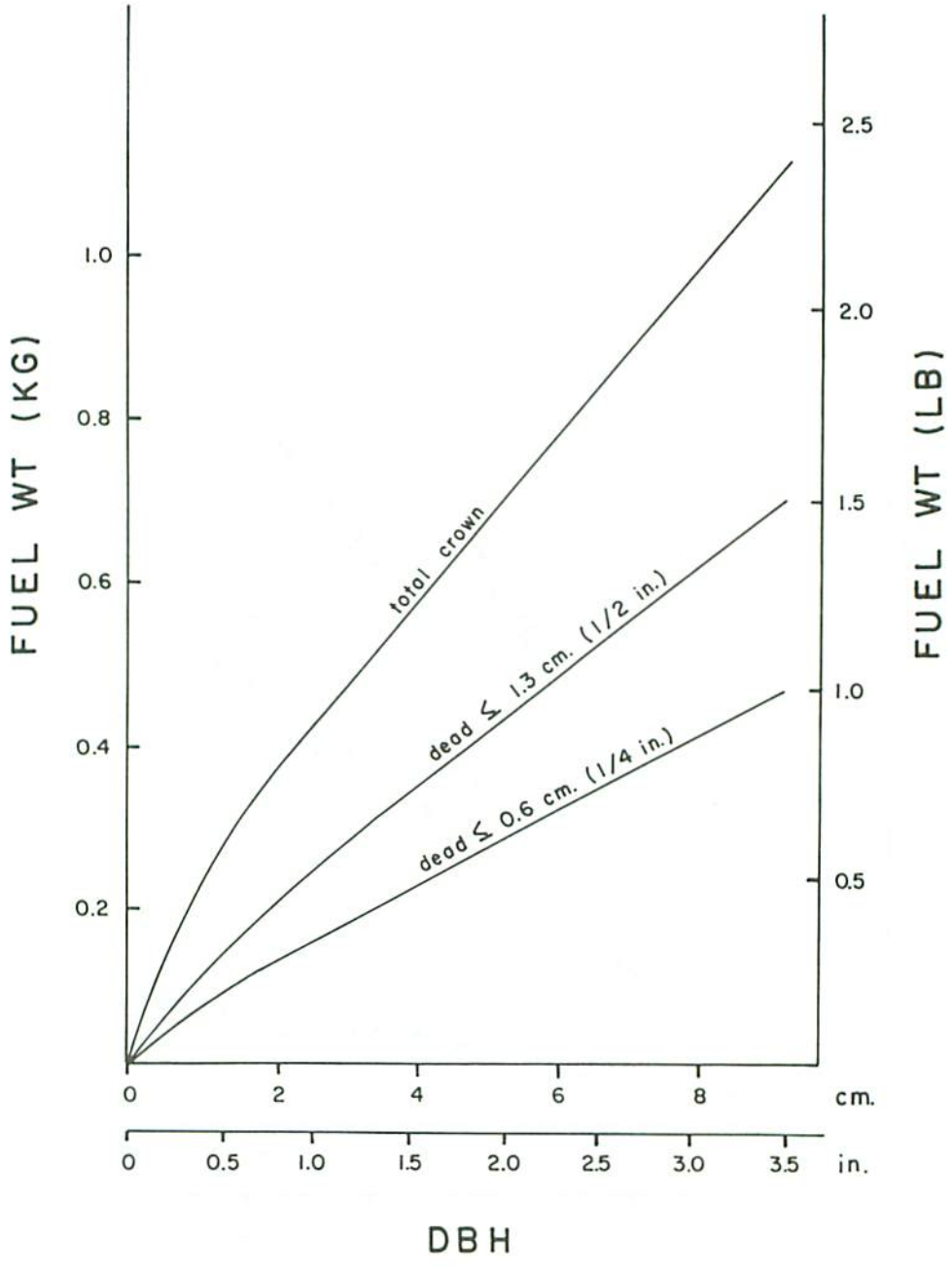

Fig. 13. Crown fuel weights--immature (dead) jack pine, in Mississagi area, Ontario

Table 4. Immature jack pine--aerial fuel weights

			Dead 0-0.6 cm	Live 0-0.6 cm	Total <0.6 cm	Total <1.3 cm	Total crown
Living trees	Weight	(kg/ha)	2803	8823	11,626	15,719	18,198
		(metric tons/ha)	2.80	8.82	11.62	15.72	18.21
Dead trees	Weight	(kg/ha)	--	--	1,104	1,656	2,963
		(metric tons/ha)	--	--	1.10	1.66	2.96
All trees	Weight	(kg/ha)	2803	8823	12,730	17,375	21,161
		(metric tons/ha)	2.80	8.82	12.73	17.38	21.17

Surface Fuels

(1) Mature jack pine

The surface fuels considered in our analysis included that woody and herbaceous material growing on and from the forest floor. In the mature type, we looked at twenty-seven 0.91-m (3-ft) square areas within each burning plot, and although in this case we tallied species by numbers present, our results are presented in terms of percent occurrence of the top ten species, i.e., the percent occurrence of the species on the sample areas for the burning plots as a whole. We present the data in this form for purposes of comparison with the technique we later developed for the immature type. Under the mature stand three species occur on over 90 percent of the area sampled, viz., bunchberry (*Cornus canadensis* L.), blueberry (*Vaccinium* spp.), and maianthemum (*Maianthemum canadense* Desf.). The 10 principal species found are listed in Table 5. In addition, we determined some oven-dry weights of this fuel component and found the average for the area to be 63.5 g/sq. m (0.01 lb/sq. ft). Dead surface fuel was determined using the line-intersect method (van Wagner 1968) on four, 30.5-m (100-ft) lines radiating from the centre of the plots. The average weights of dead surface fuel, by size classes, for seven plots assessed to date are presented in Table 6.

(2) Immature jack pine

When we moved our sampling efforts to immature jack pine we decided to set up a permanent type of sampling technique for ground vegetation. We randomly established two 3.0-m^2 (10-ft^2) areas within each burning plot. In each of the two areas we noted the occurrence of ground vegetation in twenty-five 0.6-m^2 (2-ft^2) sections and subsequently determined a percent occurrence. Our intent at this time is to reassess the plots for several years after burning, and to reassess the mature areas before and after burning of the remaining plots in the mature type. *Vaccinium* spp. occurred over 90 percent of the immature type; barren strawberry (*Waldsteinia fragaroides* [Michx.] Tratt.) and bigleaf aster (*Aster macrophyllus* L.) were next in importance. Table 5 lists the ten principal ground vegetation types for the immature type. Average oven-dry weight for ground vegetation in this type has been determined to be 83.0 g/sq. m (0.02 lb/sq. ft). Again, the line-intersect technique has been used to determine dead surface fuel weights on five immature plots. An average of dead surface fuel weights, by size classes, is presented in Table 6.

Table 5. Ground vegetation--percent occurrence in areas sampled in mature and immature jack pine

Mature jack pine	
Species	% Occurrence
Cornus canadensis L.	95
Vaccinium spp.	93
Maianthemum canadense Desf.	93
Epigaea repens L.	67
Clintonia borealis (Ait.) Raf.	46
Myrica gale L.	42
Chamaedaphne calyculata (L.) Moench.	38
Aralia nudicaulis L.	36
Gaultheria hispidula (L.) Bigel.	36
Ledum groenlandicum Oeder	26

Immature jack pine	
Species	% Occurrence
Vaccinium spp.	95
Waldsteina fragaroides (Michx.) Tratt.	73
Aster macrophyllus L.	72
Cornus canadensis L.	59
Comptonia peregrina (L.) Coult.	50
Lonicera spp.	42
Linnaea borealis L.	41
Gaultheria procumbens L.	39
Maianthemum canadense Desf.	30
Carex spp.	30

Table 6. Dead surface fuel weights (kg/m^2) in mature and immature stands determined by line intersect

Size class	<1.3 cm	1.3-5 cm	>5 cm	Total (kg/m^2)	Total (metric tons/ha)
Mature jP	0.15	0.30	1.27	1.72	17.2
Immature jP	0.10	0.15	1.22	1.47	14.7

Ground Fuels

(1) Mature jack pine

Twenty-seven 0.09-sq-m (1-sq ft) samples of "duff" were removed from each plot. The term "duff" is used rather loosely here to denote all material from the surface of the forest floor to the upper surface of the mineral soil. The average depth of this material was found to be 6.5 cm (2.58 in.) on this site. The samples were then separated into 2.54-cm (1-in.) layers, beginning at the top, which in most cases was moss (either *Pleurozium schreberi* [BSG.] Mitt. or *Hylocomium splendens* [Hedw.] BSG. or a combination of the two). The oven-dry weights were determined for each layer and are given in Table 7.

Table 7. Oven-dry weights by depth for ground fuels, mature and immature jack pine

Mature jP		Immature jP	
Layer	Weight (kg/m^2)	Layer	Weight (kg/m^2)
0-2.5 cm (top)	0.93	0-1.3 cm	0.92
2.5-5.0 cm	1.62	1.3-2.5 cm	1.22
5.0-7.5 cm	2.74	2.5-5.0 cm	2.66
7.5-10.0 cm	3.23	5.0-7.5 cm	3.76

2) Immature jack pine

A similar sampling technique was used to determine the weights of the "duff" layers in the immature type (Table 7). The average depth is 4.6 cm (1.83 in.), with the upper layer consisting mainly of moss, but

not as continuous as in the mature type and containing more needle litter. For this reason the upper 2.54 cm (1 in.) were separated into two 1.3-cm (1/2-in.) layers and 2.54-cm (1-in.) classes were used for the rest of the depth.

REMARKS

When burning experiments are completed in each area, fire behaviour characteristics as they relate to weather and fuel parameters will be described in detail. At that time we will be reporting on any individual fuel differences within the plots that may affect their ability to support a particular fire behaviour pattern. Until then this report will serve as a summary of the mature and immature jack pine fuel complex at two locations in Ontario.

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