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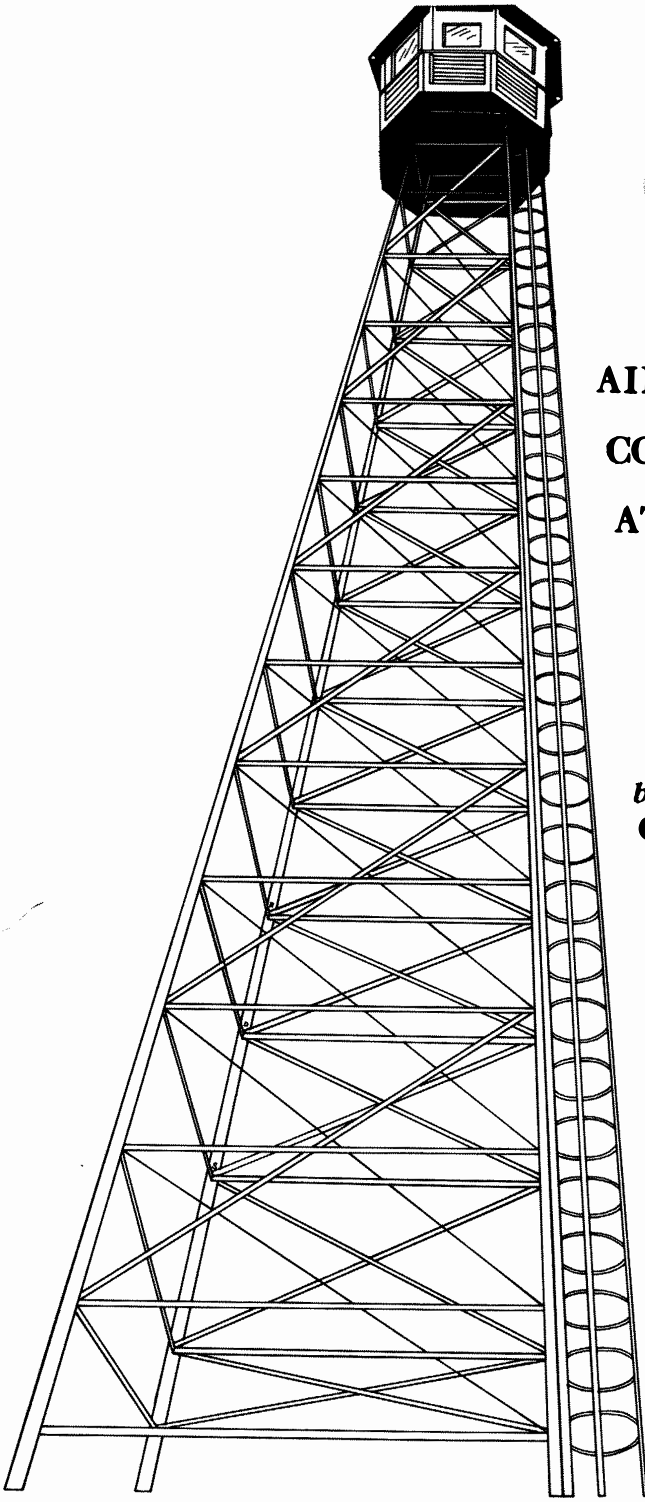

AIDS TO FOREST FIRE CONTROL PLANNING AT PETAWAWA

by
C. E. Van Wagner

ABSTRACT

A series of graphs, tables and maps are presented that form the basis of a revised fire control plan at the Petawawa Forest Experiment Station. Called aids to fire control planning, they are classified into those describing: (a) the pattern of fire weather, (b) the trends in fire occurrence, (c) the history of fire size and area burned, and (d) features of the protected area.

A French translation of this publication is available on request (Publication No. 1127F)

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Published under the authority of
The Honourable Maurice Sauvé, P.C., M.P.,
Minister of Forestry
Ottawa, 1965

ROGER DUHAMEL, F.R.S.C.
QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1965

Catalogue No. 47-1127

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AIDS TO FOREST FIRE CONTROL PLANNING AT PETAWAWA

by

C. E. VAN WAGNER[1]

INTRODUCTION

In essence, a forest fire control plan describes the organization of men and equipment for the prevention, detection and suppression of fire. It is generally based on three kinds of ingredients:

1. the policy of the forest management;
2. the costs and economics of forest fire losses and control; and
3. information about the area to be protected.

In 1948 a forest fire control plan for the Petawawa Forest Experiment Station at Chalk River, Ontario, was published (Anon. 1948) to illustrate the whole approach to forest fire control planning. Since then, the literature on the subject has grown enormously. Macleod (1956) advises on the general orientation of fire control plans, for example, and Brown and Folweiler (1953) and Davis (1959) each discuss them in detail, listing many references. A complete revision of the 1948 plan for publication is thus inappropriate. This paper is restricted to presenting and discussing a series of tables, graphs and maps that form the basis of a revised fire control plan for the Station—examples that may be helpful in fire control planning elsewhere. Economics and policy are not dealt with here.

Both historical and descriptive information are needed before the organization for fire prevention and suppression can be planned in detail. Numerous tables, graphs and maps could be prepared—many of questionable usefulness. The particular aids discussed here were chosen to fulfil one of the following functions:

(a) to illustrate the pattern of fire weather and fire danger to be expected,
(b) to show the fire history and its relation to weather and suppression efficiency, or
(c) to describe the area in some essential way.

The Station firefighting force is responsible for protecting 98 square miles of woodland within the Petawawa Military Reserve, of which the Forest Experiment Station occupies the northern 38 square miles. The forest cover is diverse, consisting of pine, spruce and hardwoods in a profusion of pure and mixed stands on a wide range of sites. The topography varies from gently rolling to precipitous, within a vertical interval of 500 feet. Two fire lookout towers 12 miles apart give good visibility coverage. Most of the protected area is within a mile of a road, and any point can be reached by walking 2 miles or less.

The history of forest fire occurrence and fire weather observation at the Station extends back to 1930. The daily fire danger was calculated every year,

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although not always for the entire fire season, which lasts usually from mid-April to early November. The method of calculation has remained basically unchanged, with two modifications during the entire period: one in 1948 (Beall) and another in 1956 (Anon.) that is currently in use. Although a brief description appears below, the reader is assumed to have a working knowledge of this fire danger rating system, which was developed initially at the Petawawa Forest Experiment Station and is used throughout most of Canada.

TABLES AND GRAPHS

Weather and Fire Danger

In the Forestry Department's forest fire danger rating system (Anon. 1956), the fire danger index, often referred to simply as the fire danger, is determined solely from three weather parameters: rainfall, relative humidity and wind speed. The fire danger index has a scale of 0 to 16, divided into five classes: Nil (0), Low (1–4), Moderate (5–8), High (9–12) and Extreme (13–16). There are two danger tables, one to be used before September 1, the other from September 1 on. The fire danger index is thus a general measure of the effect of the weather on fuel moisture and fire behaviour. In a particular forest type the actual fire behaviour associated with each level of fire danger must be determined by experience.

The fire danger data were treated in five ways to illustrate their patterns:

1. Table 1 shows the percentage frequency of danger indexes by danger class for the whole fire season and for the periods before and after September 1 (based on data for the years 1957 to 1962 inclusive). The same information appears in graphical form in Figure 1.

TABLE 1. FREQUENCY OF FIRE DANGER BY DANGER CLASS FOR THE PERIOD 1957-1962.

Fire danger		Percent of days		
Class	Index Values	Whole Season	Spring and Summer	Fall
Nil	0	13.1	11.6	16.5
Low	1– 4	27.6	22.4	39.0
Moderate	5– 8	34.6	34.8	34.0
High	9–12	20.1	25.2	8.9
Extreme	13–16	4.6	6.0	1.6

The distribution of fire danger by danger class (Figure 1) at Petawawa is centred about Moderate during spring and summer, but the mode shifts to Low during the fall. In one sense it is not quite correct to graph the danger distribution by danger classes—the Nil class consists of only one index value while the other classes contain four each.

2. For Figure 2, the daily danger indexes for the years 1957 to 1962 were arranged in increasing order and plotted cumulatively on probability paper (after Pirsko, 1961) on a uniform danger scale.

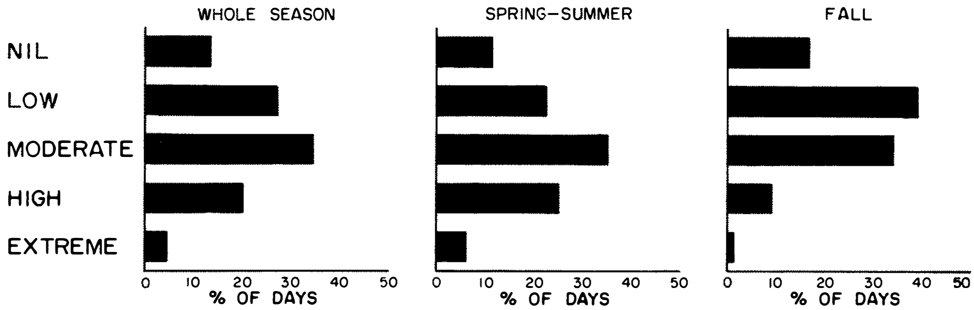

Figure 1. Frequency of fire danger by danger class for the period 1957–1962.

The method of Table 1 and Figure 1 may be adequate for many fire danger distribution studies, but the same data yield more information when treated as in Figure 2. The two curves in Figure 2, for the periods before and after September 1, show for any value of the danger index the per cent probability of a lower index. For example, on 90 per cent of the days the spring-summer index is 11 or

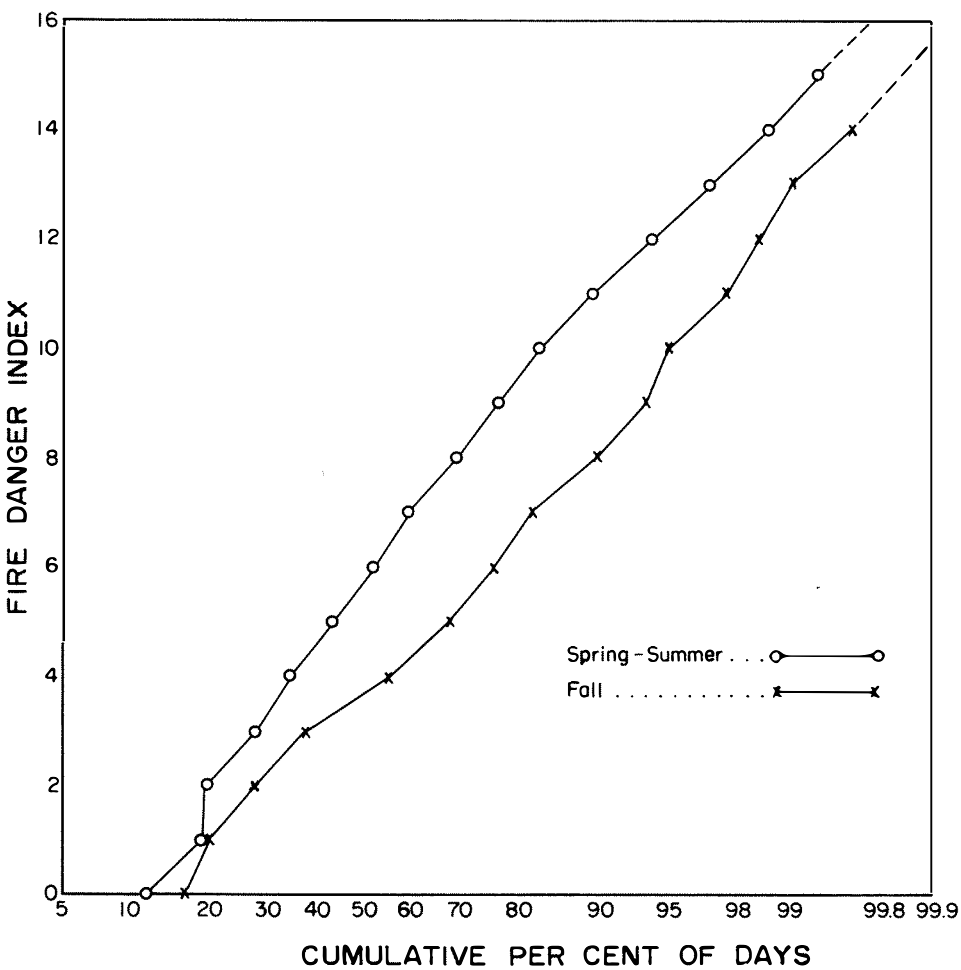

Figure 2. Daily distribution of fire danger (1957–1962).

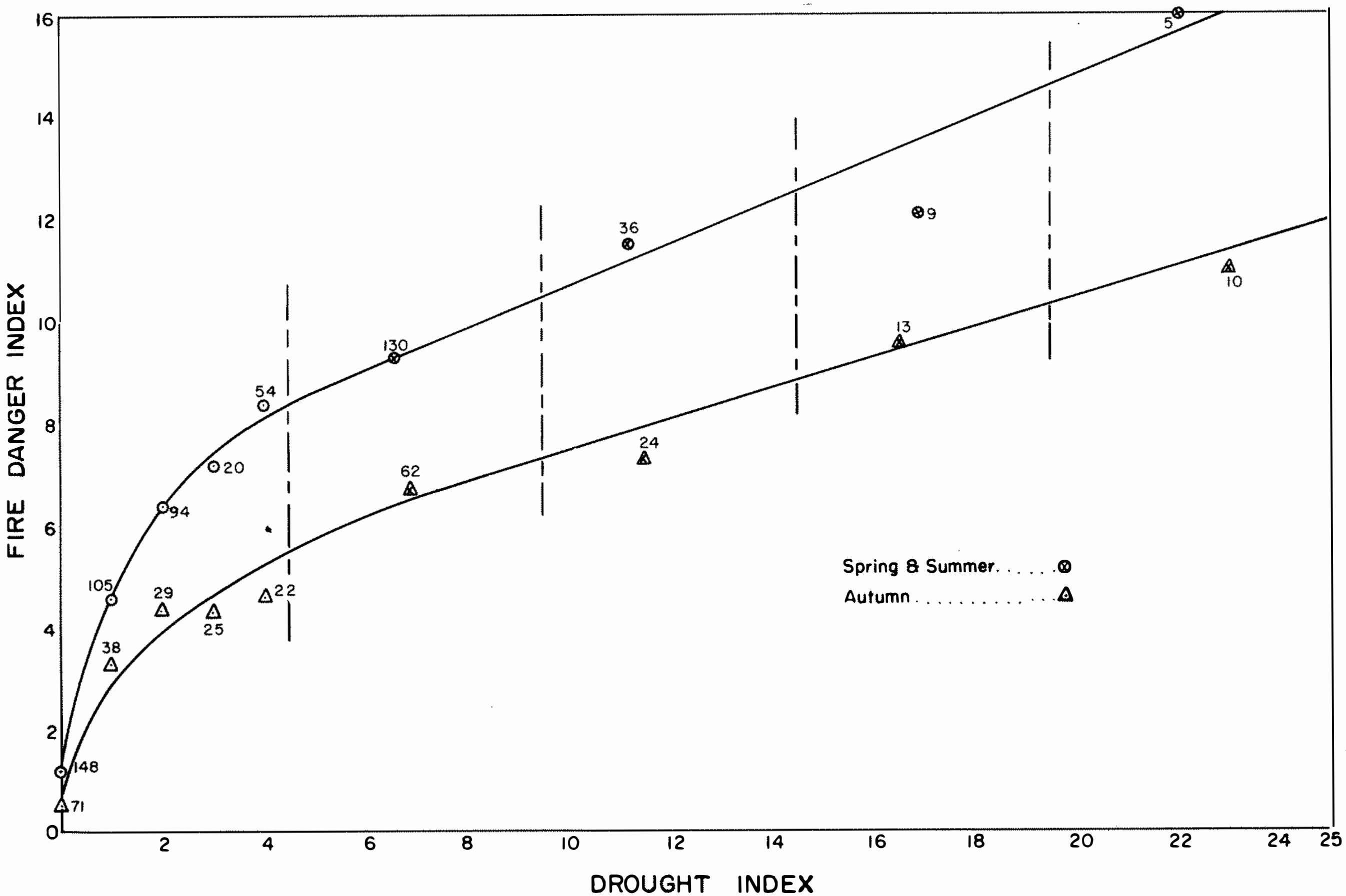

Figure 3. The relation between fire danger and drought (1957–1962).

less, and the fall index 8 or less. The curves also tell that the median fire danger is about 6 in spring and summer, and 4 in the fall. Except for the large number of zero values, the distributions for both seasons are roughly normal, indicated by near straightness on the probability scale. The position of the curves even suggests that a negative extension of the danger index scale would accommodate the concentrations at zero very nicely. This construction permits easy pictorial comparison of fire weather in different areas that use the same danger tables.

3. Figure 3 shows the relation between fire danger index and drought index (a measure of the drying effect in depth) again based on the data for the years 1957–1962.

Since the drought index is roughly equivalent to the number of days without rain, the curves show the average fire danger to be expected as a dry spell extends. At Petawawa the fire danger increases linearly with drought above a drought index of about 5; the average rate of increase is then 0.4 fire danger units per day in spring and summer, and 0.3 units per day in the fall. Fluctuations in relative humidity and wind speed of course produce considerable variation in the actual day-to-day increase.

4. Figure 4 shows the fire season severity ratings for the years 1944 to 1962.

The fire season severity rating (Williams, 1959) is obtained by multiplying the number of days in each fire danger class (Nil, Low, Moderate, High, Extreme) by a weighting factor that accounts for the difference in fire behaviour from class to class. The severity rating is the sum of these products divided by the total number of days. Since it is based on weather records only, it provides, when plotted against number of fires or area burned, an objective means of detecting variations in fire risk and suppression efficiency from year to year. Figure 4 suggests that fire weather varies at random from year to year.

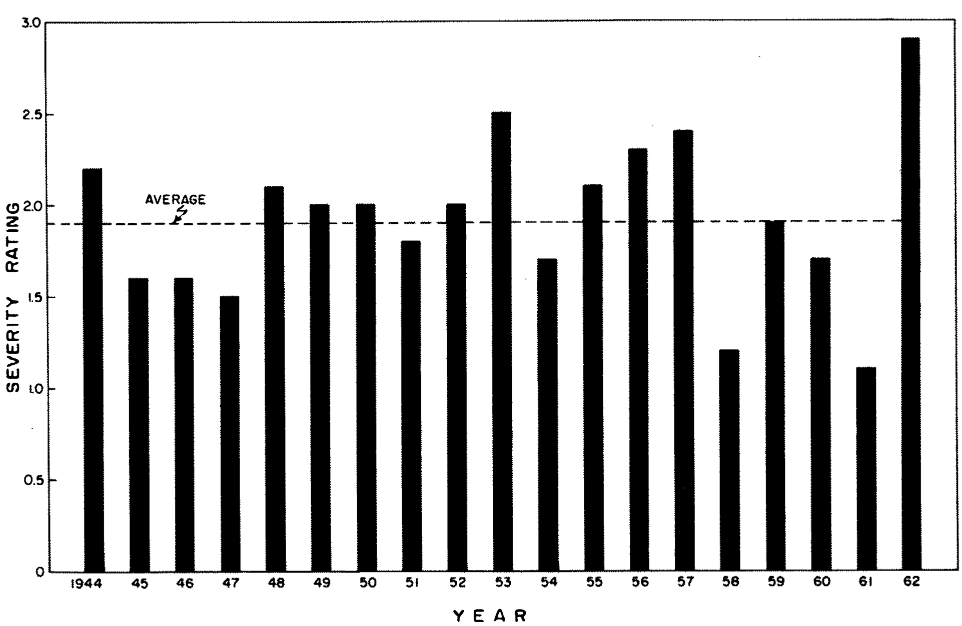

Figure 4. Fire season severity at the Petawawa Forest Experiment Station, 1944–1962.

5. Figure 5 shows the average severity by months based on data from 1949 to 1962, together with the average monthly fire frequency for two periods. A fire hazard normally exists only in the latter third of April and fire data for that month are skimpy—a single average frequency was therefore multiplied by a factor of three for purposes of Figure 5. (The severity rating for a short month does not require modification, being, by the nature of the calculation, an average value per day).

Obvious at once is the pronounced dip in the severity rating during July, a climatic phenomenon not apparent to a casual observer but readily demonstrated by the method of Figure 5. The spring peak in fire weather severity is accompanied by the known high seasonal flammability of grass and hardwood areas, a fact of obvious interest in control planning.

Fire Occurrence

The number of fires recorded from 1930 to 1962 is 110. Spread over 33 years these are too few to bring out any trend of the annual number of fires in relation

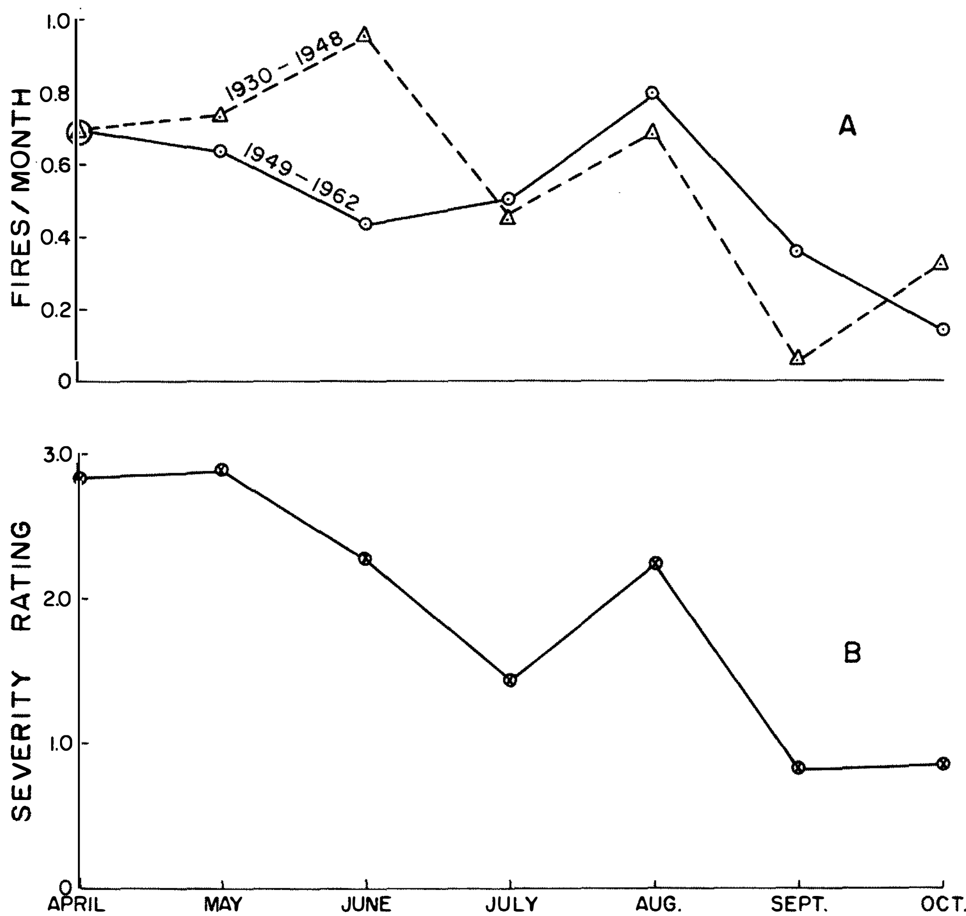

Figure 5. Detail A: average monthly fire frequency for two periods.
Detail B: average monthly severity rating 1949–1962.

TABLE 2. FREQUENCY OF FIRE BY DANGER CLASS FOR THE PERIOD 1930-1962.

Fire danger class	Fires per 100 days
Nil	0
Low	0.7
Moderate	1.7
High	4.7
Extreme	9.9

to season severity rating or change in fire risk. The fire occurrence data were arranged, however, in three ways which do illustrate features of the occurrence pattern:

1. Table 2 lists the fire frequencies for each fire danger class, showing the dependence of fire incidence on fire danger. Ninety-eight fires during 1930–1962 are included, omitting 12 for which the fire danger index was not recorded. In Figure 6 the same fire frequencies are plotted on a uniform danger index scale at the average index values within each class, based on danger data for 1957–1962. The dotted extension at extreme danger is hypothetical.

The smoothness of the curve in Figure 6 is of interest; the form is almost perfectly exponential and becomes a straight line on semi-log paper. The rapid increase in fire frequency at high danger shows up better, however, on a uniform scale. This trend to greater fire frequency at higher fire danger is very strong and constitutes a fine vindication of the fire danger rating system. A study of New Brunswick fire history by Beall (1950) yielded much the same relation. The degree of preparedness can thus be varied according to fire danger with fair

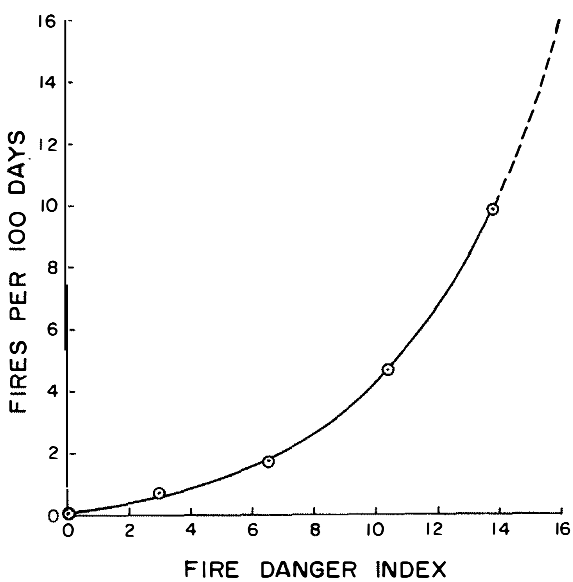

Figure 6. Fire frequency by danger class for the period 1930–1962.

confidence. Note that the greater fire frequency at higher danger may be due to increased use of the forest in fine weather as well as to the greater probability of ignition from fire brands; a combination of these two factors is probably responsible at Petawawa.

2. Figure 5, as already described, shows the average number of fires by months, April to October, for the periods 1930 to 1948 and 1949 to 1962. Monthly severity ratings averaged for the years 1949 to 1962 appear in the same figure.

Although on an annual basis the number of fires is too small to exhibit a dependence on fire weather, the monthly averages over a number of years do show such a relation. Peaks of fire incidence in spring and in August are evident, matching similar peaks in the monthly severity curve.

3. Figure 7 is a histogram of the average annual number of fires classified as to causative agent. Data are shown for two periods, 1930 to 1948 and 1949 to 1962.

The increase in the number of recorded fires caused by the military is small, considering the much wider use of the protected area for military training in recent years.

Area Burned

Two figures were constructed that summarize the data on area burned:

1. The 110 fires were arranged in order of increasing size, and the cumulative area burned plotted over the cumulative number, each as per cent of total (Figure 8).

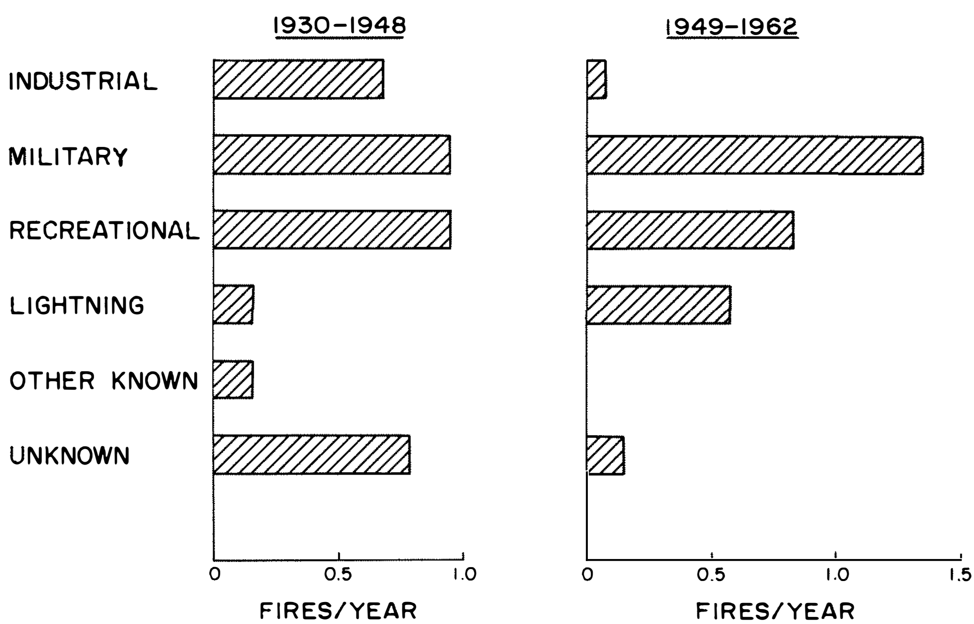

Figure 7. Annual number of fires by causes.

A few fires were responsible for the bulk of the total area burned (5,622 acres), a pattern common to most fire districts. The 75 per cent of the fires at the small end of the array, for instance, together burned only 1 per cent of the total area, whereas the largest 2 per cent of the fires accounted for 75 per cent of the area burned. With knowledge of this sort, plans can be laid to limit fire size to some acceptable maximum by improving detection, attack time, or suppression methods (Beall, 1949).

2. In Figure 9 the 10-year moving average of annual area burned is shown, plotted over the final year in each 10-year period.

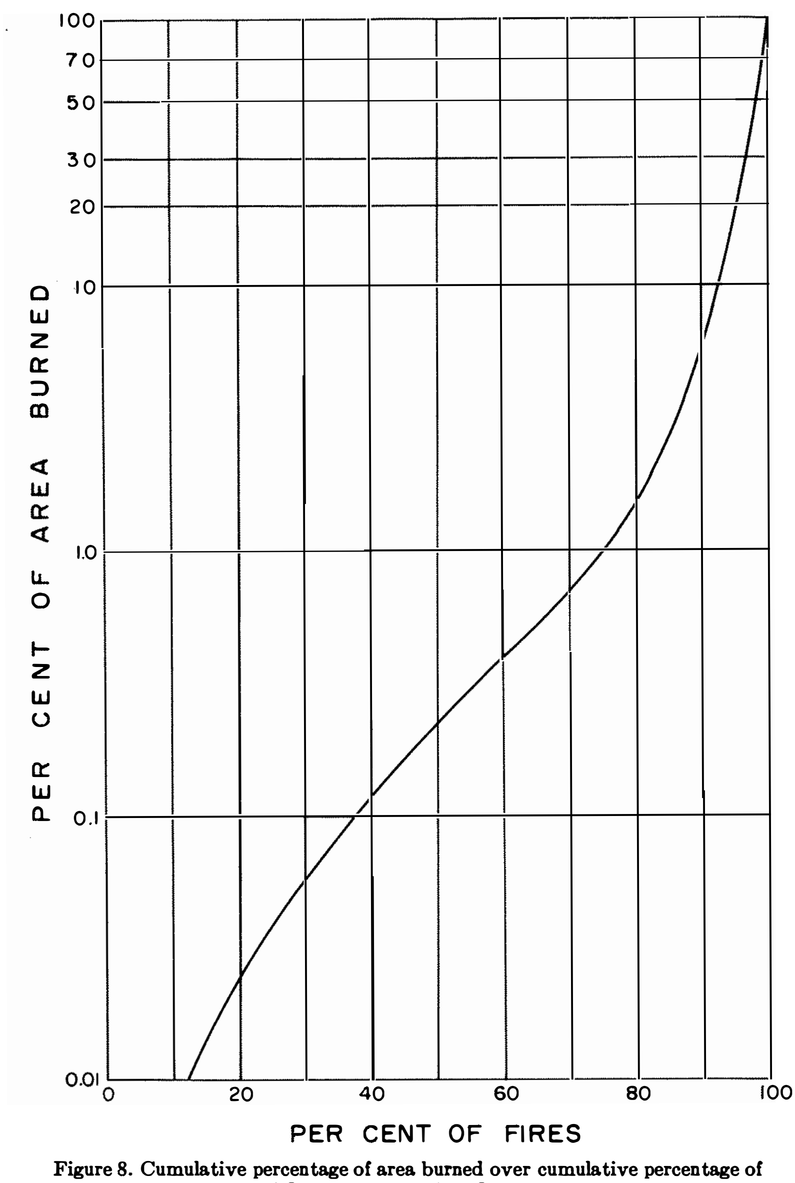

Figure 8. Cumulative percentage of area burned over cumulative percentage of number of fires, 1930–1962. (110 fires, 5,622 acres)

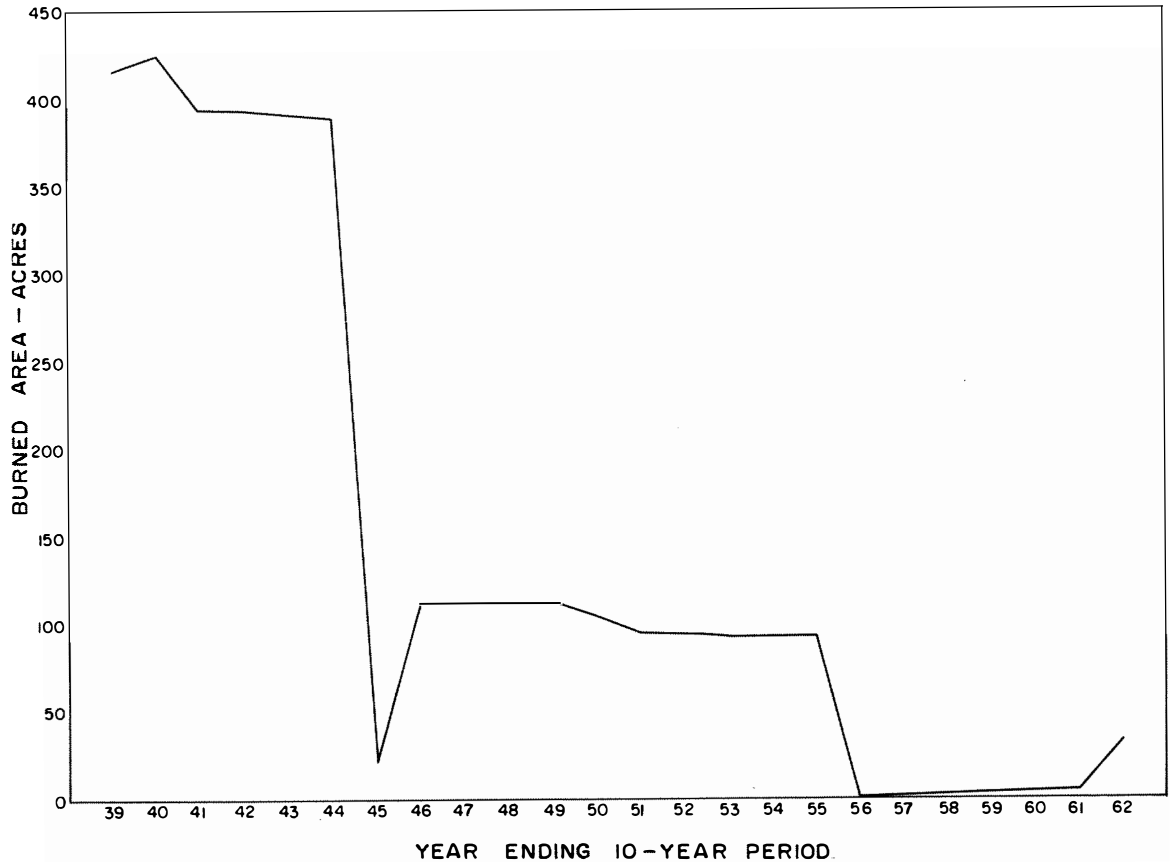

Figure 9. Area burned. Moving ten-year average 1930–1962.

The curve distinctly reflects the effect of a few large fires in the early 1930's, and also the improvement in accessibility and suppression technique since the present fire control plan was implemented in 1948.

Several relationships involving fire size and annual area burned proved to be quite erratic with the small body of data at Petawawa. For larger organizations, these might be of interest as objective measures of year-to-year efficiency:

(a) the effect of fire danger on individual fire size,
(b) the effect on final fire size of time elapsed between detection and attack, and
(c) the effect of fire season severity on annual area burned.

MAPS

Five kinds of maps were prepared: travel-time, visible-area, fuel-type, fire occurrence, and fire-plotting maps. Only the first three kinds are illustrated here. All but the fuel-type map were plotted on the Army's A.S.E. No. 35 (3rd Edition, 1958), which includes the entire Petawawa Military Reserve and Forest Experiment Station. The scale is 1: 25,000 (2.5 inches equal 1 mile, approximately), and the contour interval 25 feet. The fuel-type map was prepared on the 1961 Forest Inventory Map of the Petawawa Forest Experiment Station, which covers the northern third of the Military Reserve. It has a scale of 4 inches to 1 mile, but no contours.

Travel Time

The method of preparing the travel-time map (see Map) was straightforward, and similar to that described in the 1948 plan (Anon. 1948). Having established average speeds for all roads and enough distance landmarks along them, the operator marked the limits of the chosen time-zones along each road. There are three 15-minute time-zones followed by two 30-minute time-zones, all the protected area being accessible within 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 per hour for foot-travel and 10 miles per hour for water-travel (after a 10-minute delay for launching). Allowance was made for natural obstacles such as swamps and steep hills. Many points are equally accessible by alternate routes and methods of travel (such situations are obvious from the configuration of the time-zones), and the fire chief can use his discretion as to route.

The protected area at Petawawa is small and accessible enough to render unlikely the use of aircraft to transport fire-fighters. However, the same principles would apply in constructing a map involving air travel, whether by fixed-wing aircraft, helicopter or parachute. The accessibility pattern would depend on the availability of suitable landing places for each.

Visible Area

Individual visibility maps were first prepared for each of the two towers, then a third map of the composite coverage, showing the more favourable visibility class for each point in the protected areas. Only the latter map is included here (see Map). Four classes of visibility were used:

(a) directly visible,
(b) less than 100 feet below line of sight,
(c) between 100 to 200 feet below line of sight,
(d) more than 200 feet below line of sight.

When the atmosphere is clear the two towers, 12 miles apart, can readily be seen from one another, and coverage of the protected area is obviously very good. Under hazy conditions visibility may be limited to about half the distance between the towers. The individual maps then indicate the actual coverage.

The mapping was done in the office by the profile method and given a brief check in the field. First, the tower elevations were estimated from the contour levels, adding their heights above ground and subtracting 35 feet to account for the average height of the tree cover on the ridges. These estimates were checked with a transit, a worthwhile refinement where reference points of known elevation are near at hand. The vertical profiles were then plotted along 30 to 40 lines radiating from each tower on an exaggerated vertical scale. The hilltops were rounded smoothly above the highest contours shown on the map and lines of sight drawn to each in turn. The visibility changes were then plotted along each radius on the map, and the intervening space coloured in accordance with the contour detail.

For part of the work a profile board was used, which obviates the need for plotting the profiles separately. This neat method, described by Gowan and others (1936) and also by Catto (1960), enables the operator to keep continuous track of the vertical distance between ground and line of sight while working directly on the map. Regardless of the way the visibility is plotted along the radial lines, skill in picturing the three-dimensional contour model is required to fill in properly the detail between the lines. Chorlton (1951) illustrates and discusses some typical configurations. The actual number of radial lines required varies with the roughness of the country and the skill of the operator.

Given good contour maps, reasonably accurate visibility maps may be drawn without leaving the office, although field checks are naturally advisable. The more reliance is placed on office work, the more important it is that all sources of error be considered. One error not discussed in any of the present references is due to the curvature of the earth. In surveying, the vertical error is given in feet by the term $0.66K^2$, where K is the distance in miles. It is only 16 feet at 5 miles, but becomes 66 feet at 10 miles and 148 feet at 15 miles. The net vertical error is fortunately always less than the maximum because the intervening ridge is itself lowered due to the earth curvature, and the line of sight is slightly depressed. The error in the visible area may still be serious at the outer limit of the mapped circle, especially in flat country. Correction may be made in the profile plotting method by simply depressing each plotted point by $0.66K^2$. In the profile board method, the correction may be subtracted mentally when each line of sight is set and also when each point is tested for visibility; or, alternatively, the upper edge of the board may be cut along a curve at the proper scale, instead of in the usual straight line.

Fuel Type

The new fuel-type map of the Petawawa Forest Experiment Station (see Map) is based on a detailed forest inventory in which each stand was described according to the Department of Forestry stand classification system (Bickerstaff, 1960). Only the northern third of the protected area was mapped, no recent information being available for the rest. The blank map showing stand outlines was coloured as follows (species composition refers to basal area of trees 4 inches or more in diameter):

1. Plantations (pine or spruce)....................Red
2. Pure pine stands, more than 80% pine............Orange
3. Other conifer stands more than 80% conifer.......Violet
4. Mixed-wood stands, 50 to 80% conifer............Green
5. Hardwood stands, less than 50% conifer..........Gray
6. Swamps, marshes and clearings...................Yellow
7. Slash, clear cut or heavy partial cut...........Brown
8. Water...Blue

Stands of 20 or more acres were first coloured; the operator then treated smaller stands so as to avoid small isolated patches of colour, departing from the system where necessary. Thin bands of colour were retained where possible because they often represent natural fire-breaks.

There are actually two maps in one. Immediately available is the written description of each stand, giving species composition, age class and density class. In addition the stands have been grouped into a few broad classes that, in the best available local judgment, account for the most important differences in fire behaviour. The actual factors most considered were: potential fire intensity at extreme fire danger, nature of the surface litter, and seasonal variations in hazard.

This fuel-type map, while it implies differences in fire behaviour between types, does not attempt to rate them. The description of the differences in fire behaviour is deemed to be a separate problem, whose answers belong in a separate file rather than on the map.

The fuel-type classification should be based on the local fuel factors most responsible for differences in fire behaviour. At Petawawa the forest is fairly even-aged and the major variable is species composition. Elsewhere the presence of age differences, extensive cut overs, recent burns, insect-killed stands, etc., could be more important and dictate the basis for fuel-typing. If the fuel types cannot be reduced to a workable number for mapping purposes, then it may suffice to show a few important ones only, leaving part of the map uncoloured.

A few words in defense of this method of fuel mapping are in order, since some controversy exists about the validity and usefulness of fuel maps[2]. One classic method of fuel mapping is to rate spread and resistance to control on some arbitrary scale, such as Extreme—High—Moderate—Low, modifying the ratings according to slope and aspect. The protected area is then mapped using colours and hatching to represent the various ratings; the result is really a fire behaviour map rather than a fuel-type map. In few areas would there be sufficient numerical data to define the rating scales in absolute terms; they must then be assigned by subjective judgment.

However, the basis of any fuel mapping scheme is the fuel-type classification, which is itself a product of subjective judgment. No satisfactory objective rules for classifying fuel types have yet been formulated. Furthermore, since it is unlikely that special surveys for fuel-typing will be made in most regions, the classification must usually be based on the existing cover-type survey, which

[2]Research on fuel typing is proceeding in many parts of Canada. The concept presented here is not to be taken as the official opinion of the Department of Forestry.

hides many differences important from a fuel standpoint. If subjective fire behaviour ratings are applied to a fuel-type classification which itself is subjective, then errors in judgment are likely to be compounded. The fire behaviour map, with its four basic ratings, can accommodate any number of fuel types, since the same rating can be applied to more than one type. The greater the number of types, however, the more difficult is the consistent assignment of ratings. According to Davis (1959, p. 185) this approach, though often quoted, has not been widely used since its proposal nearly 30 years ago (Hornby, 1936).

It seemed better, therefore, to limit the fuel types to a small number, and to show them directly on the map. The fire control officer can thus see at any point what fuel type is present, rather than a fire behaviour rating that could apply to a number of different types. He may then either use his own judgment of what fire behaviour to expect or refer to separate notes on the subject. Further advantages of this simple approach (used also by Lotti, 1960) are:

(1) One map covers all seasons.

(2) The map holds for all burning conditions.

(3) The map is an ideal complement to a file of numerical fire behaviour data. It does not become obsolete as new fire experience is gained that might show up errors in a fire behaviour map.

(4) The map is easily prepared by people with limited fire experience. The original cover-type map alone might be adequate in some areas.

Fire Occurrence

A map showing the location of past recorded fires is little trouble to prepare, and pictures at a glance some trends hidden in the written records. The pattern of fire occurrence reflects the joint variations from point to point in both fire risk and fuel type. At Petawawa, lightning fires are rare and the high-risk areas are along the roads and in the artillery target zones, some of which are wooded.

Fire Plotting

Another essential map, not included here, is the fire plotting map, with circular azimuth scales overlaid and centred at the lookout towers. This feature may, of course, be combined with either the travel-time or visibility map for added utility. At Petawawa, the fire plotting map is glued to a sheet of galvanized iron, and retractable strings based at the tower sites, with magnets at their ends, are crossed to find fire positions. Bjornsen (1962) describes one method of construction.

The problem of scale arises in mapping for fire control planning. Maps of travel-time, tower visibility and fuel type are primarily for local operational use; as the scale is reduced, validity and usefulness decline. The final choice must be a compromise, depending on such factors as the scale of available cover-type and contour maps, the size of the area surrounding each fire control headquarters, the distance between towers, the nature of the country, etc. The maps at Petawawa are on a large scale, commensurate with the small size of the area and the detail available. Scales of 1 to 2 miles per inch are probably most useful, and a scale as small as 4 miles per inch may occasionally be justified.

Maps of all kinds must be kept up-to-date as conditions change. The original maps described here were coloured with crayon that permits annual erasures and corrections. If time is limited, utility should always take precedence over appearance.

CONCLUSION

Although the protected area at Petawawa is less than 100 square miles, most of the tables and graphs could, with a little modification, be applied to larger regions, either in comparing different areas or in following trends on a single area. Where a number of fire weather stations exist in a single protected area, their data may be pooled and averaged (after Beall, 1950) to depict fire weather and danger patterns (Table 1 and Figures 1, 2, 3, 4 and 5). Fire frequency and area burned (Table 2 and Figures, 6, 7, 8 and 9) may be studied on areas of any size.

The actual choice of aids will naturally depend on the specific purposes and form of the fire control plan. The literature on fire control describes a vast array of planning aids, each prompted by a particular need. Three considerations should govern the worth of a given aid: its validity, usefulness, and ease of preparation. The aids presented here possess these attributes to a satisfactory degree at the Petawawa Forest Experiment Station.

SUMMARY

A series of graphs, tables and maps was prepared that form the basis of a revised fire control plan at the Petawawa Forest Experiment Station. Called aids to fire control planning, they are listed below under four headings:

A. Aids showing the patterns of fire weather:
   1. Table and graph showing the percentage frequency of daily fire danger indexes by danger class.
   2. Graph of the cumulative frequency of danger indexes plotted on probability paper.
   3. Graph of fire danger index plotted against drought index.
   4. Graph of the fire severity rating from year to year.
   5. Graph of the monthly severity ratings averaged for a number of years.

B. Aids showing trends in fire occurrence:
   1. Table and graph showing the fire frequencies for each fire danger class.
   2. Graph of the number of fires by months, averaged for a number of years (in conjunction with A 5).
   3. Graph of the average annual number of fires caused by various agents.

C. Aids showing trends in area burned:
   1. Graph of cumulative area burned plotted over cumulative number of fires (arranged in order of increasing size).
   2. Graph of 10-year moving average of annual area burned.

D. Aids showing features of the protected area:
   1. Map of access routes and travel-time to any point.
   2. Map of visibility from fire towers.
   3. Map of fuel types.

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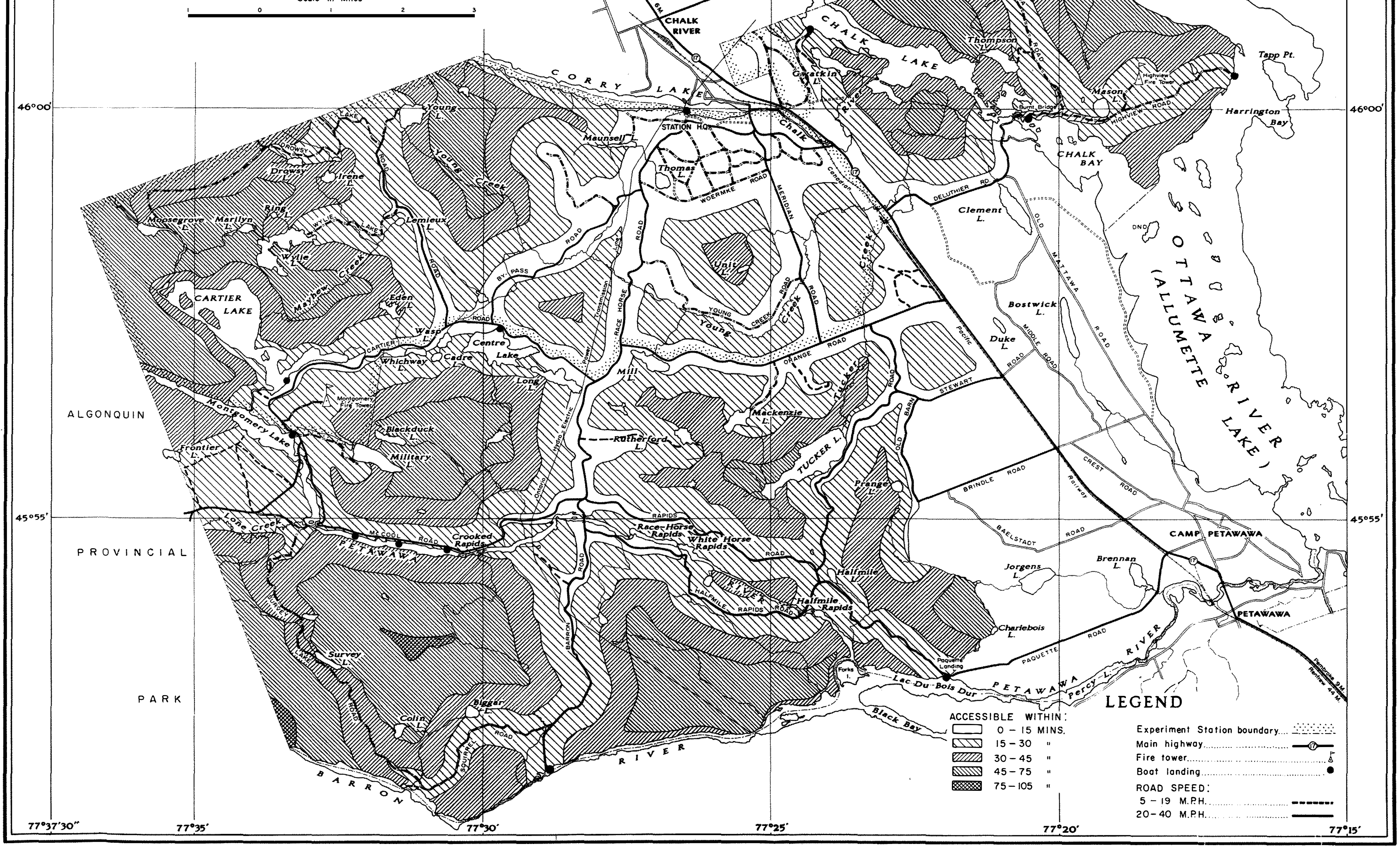
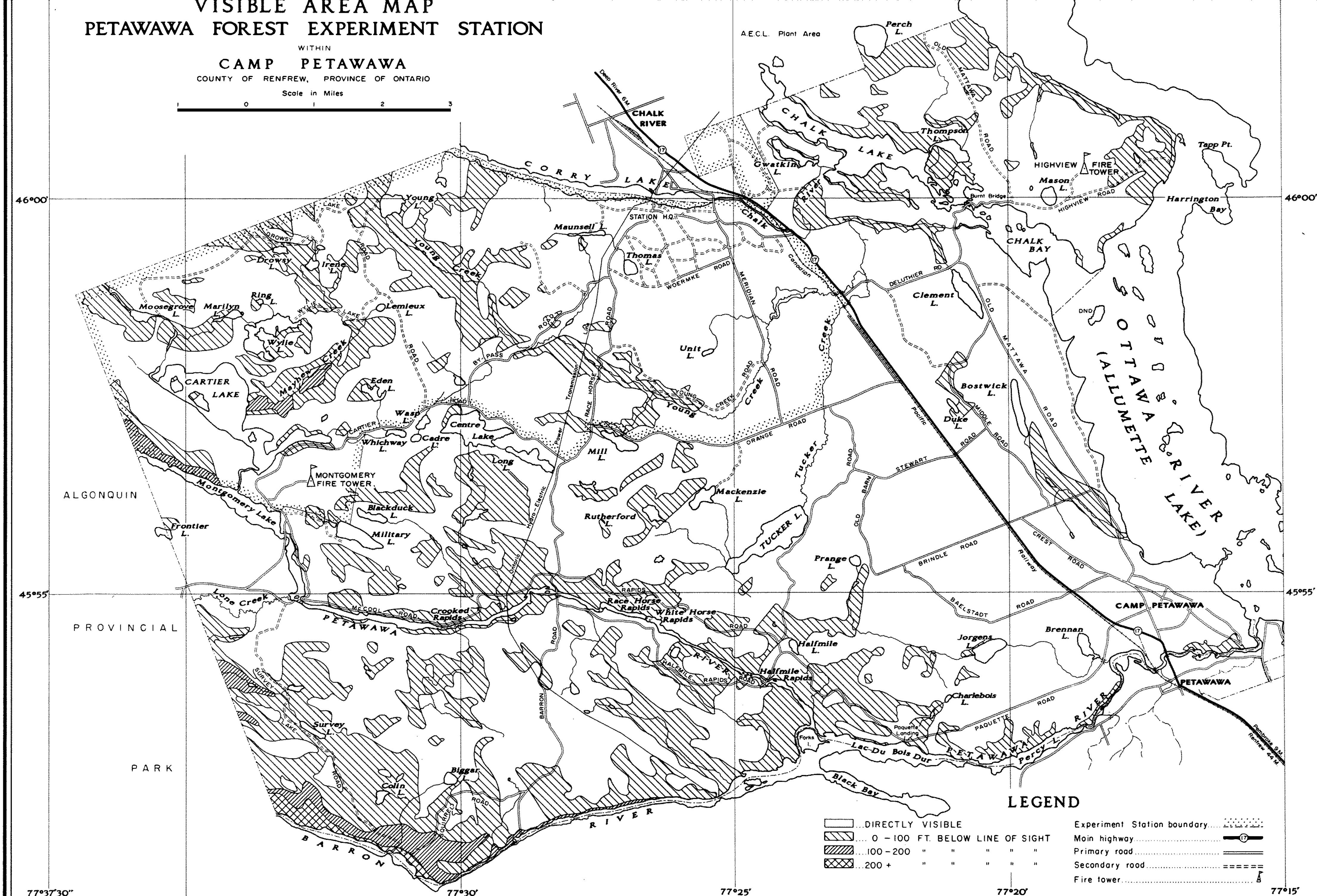
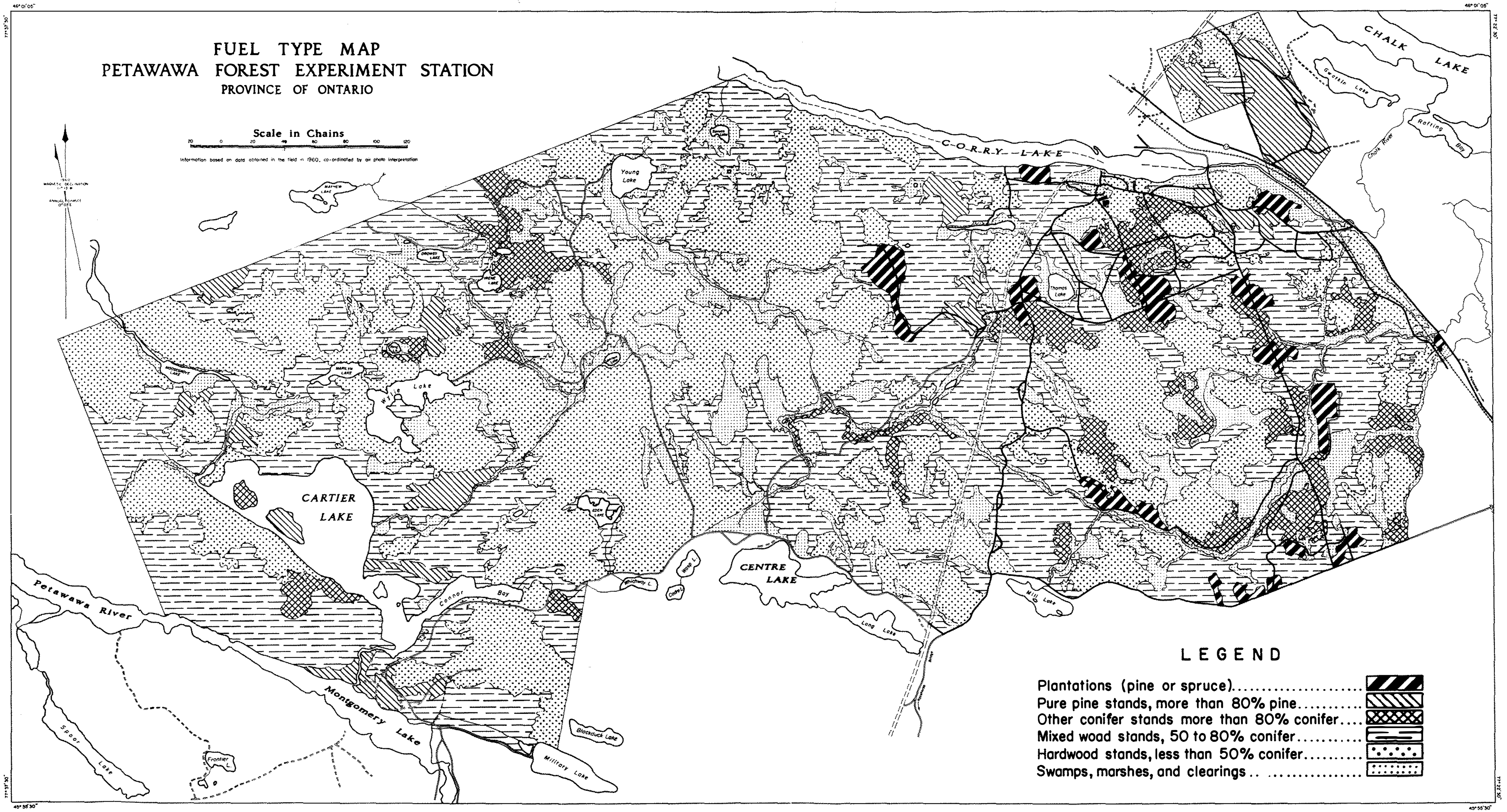
TRAVEL TIME MAP
PETAWAWA FOREST EXPERIMENT STATION
WITHIN
CAMP PETAWAWA
COUNTY OF RENFREW, PROVINCE OF ONTARIO




VISIBLE AREA MAP
PETAWAWA FOREST EXPERIMENT STATION
WITHIN
CAMP PETAWAWA
COUNTY OF RENFREW, PROVINCE OF ONTARIO
Scale in Miles
1 0 1 2 3
LEGEND
...DIRECTLY VISIBLE
... 0 - 100 FT. BELOW LINE OF SIGHT
...100 - 200 " " " " "
...200 + " " " " "
Experiment Station boundary
Main highway
Primary road
Secondary road
Fire tower
46°00'
45°55'
77°37'30"
77°30'
77°25'
77°20'
77°15'
A.E.C.L. Plant Area
Perch L.
CHALK RIVER
Deep River 6M
CORRY LAKE
CHALK LAKE
Thompson L.
Gwatkin L.
HIGHVIEW FIRE TOWER
Mason L.
Tapp Pt.
Harrington Bay
Burnt Bridge
HIGHVIEW ROAD
OLD MATTAWA ROAD
STATION H.Q.
Maunsell L.
Thomas L.
WOERMKE ROAD
MERIDIAN ROAD
CHALK BAY
DELUTHIER RD.
Clement L.
DND
OTTAWA RIVER (ALLUMETTE LAKE)
Young L.
Young Creek
Drowsy L.
Irene L.
Ring L.
Moosegrove L.
Marilyn L.
Wylie L.
WYLIE LAKE ROAD
Lemieux L.
BY-PASS ROAD
Unit L.
Chalk River
Canadian Pacific Railway
Creek
Mayhew Creek
CARTIER LAKE
Eden L.
Wasp L.
Centre Lake
Cadre L.
Whichway L.
CARTIER ROAD
YOUNG CREEK ROAD
Young Creek
Bostwick L.
Duke L.
MIDDLE ROAD
ORANGE ROAD
Transmission Line
RACE HORSE ROAD
Mill L.
Long L.
MONTGOMERY FIRE TOWER
Blackduck L.
Military L.
Montgomery Lake
Tucker Creek
STEWART ROAD
OLD BARN ROAD
Mackenzie L.
Rutherford L.
TUCKER L.
ALGONQUIN
PROVINCIAL
PARK
Frontier L.
Ontario Hydro-Electric Power
Prange L.
BRINDLE ROAD
CREST ROAD
Lone Creek
McCOOL ROAD
Crooked Rapids
RAPIDS
Race Horse Rapids
White Horse Rapids
ROAD
PETAWAWA RIVER
BAELSTADT ROAD
CAMP PETAWAWA
Brennan L.
Jorgens L.
Halfmile L.
Halfmile Rapids
HALFMILE RAPIDS ROAD
BARRON ROAD
Charlebois L.
PAQUETTE ROAD
Paquette Landing
PETAWAWA
Forks L.
Lac-Du Bois Dur
PETAWAWA RIVER
Percy L.
Black Bay
Pembroke 9M. Renfrew 44M.
SURVEY LAKE ROAD
Survey L.
Biggar L.
Colin L.
SQUIRREL ROAD
BARRON RIVER


FUEL TYPE MAP
PETAWAWA FOREST EXPERIMENT STATION
PROVINCE OF ONTARIO
Scale in Chains
20 0 20 40 60 80 100 120
Information based on data obtained in the field in 1960, co-ordinated by air photo interpretation
LEGEND
Plantations (pine or spruce)
Pure pine stands, more than 80% pine
Other conifer stands more than 80% conifer
Mixed wood stands, 50 to 80% conifer
Hardwood stands, less than 50% conifer
Swamps, marshes, and clearings
CHALK LAKE
CORRY LAKE
Chalk River
Rafting Bay
Young Lake
Thomas Lake
Wylie Lake
CARTIER LAKE
CENTRE LAKE
Long Lake
Mill Lake
Connor Bay
Petawawa River
Montgomery Lake
Spoor Lake
Frontier L.
Blackduck Lake
Military Lake