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DEVELOPMENT OF COMPUTER PROCESSING TECHNIQUES FOR INDIVIDUAL FOREST FIRE REPORT DATA

by

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TABLE OF CONTENTS

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A project as large and complex as is described in this report, obviously could not have been completed by the authors without a great deal of assistance being provided by other persons. Of perhaps the greatest significance, without the generous cooperation of every forest fire control organization in Canada, the project could not have been undertaken, as there would have been no data to process. Several of the data processing programs were written by programmers who were associated with the project on a part-time basis: Jim Armstron, Brian Clifford, Uve Fehr, and Joe Valenzuela. Inevitably, a project of this type requires innumerable man hours of diligent yet routine efforts. That task fell to the coders: Barbara Armstrong, Dale Carle, Sharon Frezel, Tom Kerr, Audrey Laing, Hugh Moeser, Bob Rinfret, and Don turner who hand processed approximately 40,000 individual fire reports with a very low percentage of errors. To everyone mentioned above, and to the many others too numerous to mention who participated in this project -- a sincere thank you.

ABSTRACT

The relationships between varying types of problems, analytical techniques, and data availability are discussed. The nature, characteristics, and availability of forest fire data is also discussed. A data processing procedure is presented, whereby raw uncoded, incomplete, and sometimes inaccurate forest fire data is converted to a uniform, complete, and reasonably accurate data file. The last part of the report is devoted to procedures for filling in missing information. Lastly, the appendices contain all of the codes used in this project.

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I. INTRODUCTION

1. Project Background

Early in 1968, the Forest Fire Research Institute undertook an analysis of the use of aircraft for forest fire suppression. It was decided at the outset that the results would be oriented towards applicability in the field. It was decided that not only the relative but also the absolute results should be both realistic and accurate. It was hoped that fire behavior as well as every phase of the suppression operation would be predictable with reasonable accuracy, in order to determine the effects of varying aircraft suppression tactics. Further, the fact that five percent of all fires cause 95 percent of all damage implies that the cost and benefits of aircraft operations will be dependent to a large measure on the results obtained from only a small percentage of the fires. Thus, it was hoped that the predictive models would be applicable to individual fires which, in turn, suggested a deterministic data analysis. As will be discussed, a deterministic analytical approach requires a considerable amount of good quality data. Rather than attempting to acquire new data it was decided to consider data which was already available.

Forest fire control agencies in Canada have been keeping records on forest fire occurrence and suppression effectiveness in the form of reports on individual forest fires for many decades. At least 10 years of information is available on almost every forest fire which has occurred in Canada. Based on an average of 7,200 fires per year (Lockman, 1970) this amounts to about 72,000 individual forest fire reports. This is a considerable wealth of information which, until recently, has not been used to anywhere near its potential. The main reason given is often a lack of confidence in the reliability of the information. Arguments such as the area at the time of detection are only estimated or the report was completed two months after the fire was extinguished have been frequently cited. Modern analytical techniques are such, however, that inaccuracies of individual observations can no longer be cited as justification for not analyzing data from reports prepared by field personnel. Even if each entry were nothing more than an unbiased educated guess, a sufficient number of such guesses should be normally distributed about the true mean of the population. If this mass of data were subjected to analysis by currently available statistical procedures, coupled with modern data processing techniques, it could be made to yield solutions to a wide variety of problems currently facing forest fire protection managers.

The information recorded and the method of recording data varies with each fire control organization, depending on specific policies and accounting requirements. When considered individually, each of the several report forms currently available has some good and some less desirable aspects. Quite often, one type of information is ignored by one agency, while it is carefully recorded by another, and vice versa. When considered all together, it becomes possible to select the best parts of each agency's report and thereby acquire a comprehensive and reasonably reliable data bank covering almost every aspect of forest fire control.

It appeared therefore that there was sufficient data available to consider a deterministic approach to solving the airtanker problem. It was immediately realized however, that assembly and processing of all the data which would be required would be a fairly involved process. As a result, some effort was expended to insure that the final data bank would be as useful as possible for a wide range of future analyses in addition to the airtanker project, which served as the initial impetus for acquiring the data. The purpose of this report is to describe the nature of the information involved, the techniques used in processing and editing the data and some analyses for which the data have been and could be used.

2. The Role of Forest Fire Data

In designing a research program for the analysis of a forest fire problem, three basic factors must be considered: the nature of the problem, the method of analysis to use, and the availability of data. A proper solution to any problem requires that the analytical approach be compatible with the questions being asked. In practice, however, selection of an analytical approach is often governed by data availability rather than the nature of the problem. The net result of any such research will always be less than ideal. Only when all three factors are compatible with each other will research yield its maximum benefits. In the following section a general discussion of each of these factors is presented. The major advantages and disadvantages of various analytical approaches are considered as well as compatibility requirements for the types of questions being asked and data availability.

The earliest forest fire research was almost entirely descriptive. That is, the main purpose was to describe and summarize the forest fire situation. Initially, this approach involved the determination of means and frequency distributions. Numbers of fires and area burned by year, month and cause; average fire area and distributions of area burned are typical statistics which have been accumulated since the earliest days of organized forest fire control. More recently, with the use of computers, more sophisticated and detailed summaries including multilevel tables, probability distributions and analyses of variance are being prepared.

Summaries can be of two different types, depending on the uses to which they are put by the fire suppression organization. One type is designed to allow the organization to evaluate the effectiveness of its fire control activities, while the second type is primarily intended to describe the fire problem itself. Under the first category are statistics such as number of fires detected by individual lookouts or aircraft patrols, average travel times and rates of line construction for individual stations, as well as distributions of costs and losses. Under the second category would fall summaries of fire occurrence probabilities and average rates of growth by fuel type.

One of the primary advantages of this approach is a minimal requirement for data both in quantitative and qualitative terms. Another advantage is the fact that the analyses are generally simple and can be carried out relatively quickly. This approach is ideally suited to the solution of relatively simple problems, or problems in which detailed answers are not necessary for making management or policy decisions.

The major disadvantage of a descriptive approach is the fact that only general solutions are obtainable. Specific answers to detailed questions are not normally obtainable through a descriptive analysis.

In addition, complex problems involving several variables cannot be solved by a descriptive type of analysis. The number of observations per cell in a table decreases geometrically with an increasing number of variables. For example, 10,000 observations uniformly distributed through a 3-way table with 10 classes for each variable will have only 10 observations per cell. It is obvious that many fire protection problems cannot be solved through a descriptive approach.

In an effort to overcome the weaknesses inherent in a descriptive approach a more rigorous, deterministic analysis gradually evolved. This approach attempts to determine specific cause and effect relationships. Success with this type of analysis requires a high degree of dependence between the variables. The sources of most of the variation of the predicted or independent variable must be known and the relationships between the dependent and independent variables must be reasonably well understood. Multivariate regression analysis is perhaps the most commonly used deterministic technique for analyzing data from forest fire reports. Using this technique, equations have been developed from which parameters such as perimeter at the time of control and fire cost can be predicted with a reasonable degree of accuracy. Deterministic solutions are useful because they generally contain considerable detail and are readily adaptable to use in the field. The analyses are somewhat more involved than is the case for a descriptive approach. Through the use of computers and a wide variety of standard programs however, most potential analytical problems are greatly reduced.

A deterministic approach has the drawback of being the most demanding with regard to the quantity and particularly the quality of data analyzed. The random errors which seem to inevitably be associated with fire behavior and control data are often the cause of failure of deterministic analyses. These errors must be smoothed out as they quite often mask the predictable relationship contained within the data. While the data processing requirements are not particularly sophisticated they often involve a great deal of effort. It is generally not feasible to analyze a sufficient amount of data without the use of computers. Because of the above problems, it is becomming increasingly evident that while numerous deterministic solutions have been derrived through analysis of varying amounts of data, detailed examination often reveals a considerable lack of reliability when applying these solutions to specific observations.

There are a large number of problems, where sources of variation are not known, or where the relationships between the variables are not well understood. There are also problems such as fire occurrence which are inherently stochastic in nature. For example, we can predict the probability of a fire start over an area, but the actual time and place of ignition is a random and therefore unpredictable variable. For problems such as these a stochastic or probabilistic approach is generally used. Results are generally given in terms of probability distributions and expected values. One drawback of this type of solution is that the results often cannot be applied to individual observations, but must be averaged over an extended period of time. Another disadvantage is the requirement for a considerable amount of data to insure that extreme values are incorporated in the analysis.

Data requirements for a probabilistic analysis are considerably less rigorous than for a deterministic solution, although generally greater than for a descriptive solution. The analytical techniques are by far the most sophisticated of the three approaches however. There is generally a heavy reliance on Monte Carlo and game simulation techniques. Solutions to fire protection problems often require development of unique and complex computer programs and simulation models. This approach has the potential to solve even the most complex problems without the necessity of determining cause and effect relationships which, although more desirable, may be a very time consuming, laborious and in certain instances, an impossible task.

Many forest fire control problems cannot be neatly solved by one of the above three approaches.

For example, it is possible to deterministically calculate the expected rate of hand construction for a specific crew size, fuel type and width of line required. An observed value could deviate significantly from the expected value based on the degree of fatigue, experience, leadership, and motivation of the crew, all of which are random variables. Therefore, rate of line construction is neither a purely deterministic or stochastic variable but rather a combination of the two.

An analytical solution which combines a deterministic and stochastic approach would be well suited to a large percentage of fire control problems. In such an approach, a variable is allowed to randomly deviate about a deterministically calculated expected value. There are several advantages of such an approach. Understanding of the system and quality of data required are less than for a purely deterministic solution. The amount of data required is less than for a purely stochastic solution. The major disadvantage is that considerably more effort is required for a combined study which in effect, requires two separate analyses.

The above discussion is briefly summarized below.

	DATA		THE PROBLEM			
ANALYTICAL TECHNIQUES	Quality Required	Quantity Required	Maximum Complexity	Variable Relationship	Understanding Required	EFFORT
descriptive	low	low	simple	--	low	low
deterministic	high	moderate	moderate	dependent	high	moderate
stochastic	moderate	high	complex	independent	low	moderate
combination	moderate	moderate	complex	combination	moderate	high

Incompatibility of any of the three factors generally results in an excessive amount of work, a poor solution or in some cases, no solution at all. A search of current literature in the field of systems analyses of forest fire control operations discloses many theoretical studies which carefully outline an all inclusive, generally applicable method for optimizing one or more aspects of the operations of a fire control organization. Unfortunately, the authors of these analyses too often conclude with a statement to the effect that more and better data are needed to apply their models. They then go on to describe a system for acquiring the necessary data. The main benefit of such studies is a knowledge of how to properly solve the problem at some undefined time in the future when the proper data become available.

On the other hand, some researchers have performed rather elaborate analyses based on very limited data or based on theoretical rather than field data. Samples tend to be small and selection is often based on homogeneity and reasonable agreement with expected behavior patterns. Solutions thus obtained may be applicable to the specific sample selected, but rarely can the results be extrapolated to apply to situations not covered by the data. In both of the above situations, researchers may properly argue that these studies increase our knowledge in the field of fire control. On the other hand such knowledge is generally of very limited usefulness to field personnel who need generally applicable solutions today.

3. General Nature of the Data

In order to properly plan an analysis based on data from individual forest fire reports a researcher must understand the basic nature of the information contained therein. There are two main factors affecting the quality and quantity of information. They are the attitudes of the individual completing the form and the methods by which the data is acquired and recorded.

To the individual who completes the fire report form, these reports can be interpreted as measurements of production efficiency. His attitudes depend in part on past experience. In an organization where emphasis is placed on accurate and complete fire report forms, and the data contained therein is not used for rating efficiency of individuals, the individual is likely to have a good attitude, which will be reflected in the manner in which the forms are completed.

If, on the other hand, the individual's experience indicates that few, if any, checks will be made on the information contained in his report, he may attach little importance to the need for accuracy and completeness. Further, unless the proper completion of these reports is considered by his superiors to take precedence over other duties, the report can become a burden which may interfere with other activities. This in turn encourages an attitude that the reports should be dispensed with as quickly as possible. In extreme cases it is possible that an individual could develop a resentment against the imposition of having to complete a detailed fire report. Further, when completing a report the individual cannot help but consider such factors as past repercussions resulting from truthful reporting of errors and the types of information which tends to render the report readily acceptable by his superiors.

These reports either directly or indirectly form part of the overall impression that an individual's superiors have of him. As a result, regardless of the conscientiousness and integrity of the individual, there is an almost unavoidable tendency to "make the reports look good". This is not necessarily done by supplying false information, rather it is most often accomplished by simply being biased in favour of a "proper" answer when more than one choice is available.

Thus, the attitude of the individual completing the form plays a key role in determining the quality of the data contained in an individual fire report. The policies of the agency, in turn, plays a key role in determining the attitudes of the individual. If the potential effects of these two factors are overlooked, any analysis based on data from these reports runs the risk of producing erroneous or invalid results.

A second consideration is the methods by which the data is acquired and recorded. The information recorded can vary from a precise observation to an almost random guess. Assuming a total lack of bias on the part of the reporting individual, certain information is normally quite exact. Directly observed data such as fire location and time of detection are normally highly reliable and precise data. Time of detection is normally recorded as it occurs, and fire location can be pinpointed precisely on maps. In fact, all suppression activity times can be quite precise, if they are recorded as they occur, rather than estimated from memory sometime after the fire.

Some observations are based on measurements which have varying degrees of precision. Volume of forest products destroyed and final fire area can be reasonably closely measured, although as fire size increases, the difficulty of accurate measurement increases. Fire area at the start of suppression is not measured, it is normally estimated by visual observation by someone at the scene. Naturally, accuracy will decrease accordingly. Fire size at the time of detection is often indirectly estimated from a distance, hence it is likely to demonstrate the greatest percentage of error.

A few factors are naturally highly variable. During the history of a fire, fuel type, fire behavior and manpower can vary considerably. As suppression time and fire size increases, variability increases also. An average observation is normally entered. On the other hand, accuracy of some of the data can be highly variable from one fire to the next due to variability of information available. Fire cause and time of ignition are two prime examples. A ranger may have information by which either of the above two are known exactly, or he may have to estimate to the best of his ability. Some of the data is tabulated in accordance with policy guidelines. Suppression costs and damage fall into this category. Such policies may or may not be optimum. One advantage, however, is that at least such data tends to be fairly consistent.

There is another significant factor pertaining to the method of recording information which must be considered. Field personnel are concerned with fire control - not data acquisition. There are always other pressing duties which demand an individuals' time and attention in addition to accurately recording information about a fire. This applies both during and after the fire. While some relatively straightforward information is normally recorded in real time, much of the more complex data may be based on memory and perhaps a few scribbled notes. Under such circumstances some loss of accuracy and detail is unavoidable.

It can be seen therefore that irrespective of all other factors, the data itself and methods of acquisition are highly variable with respect to accuracy. There is no choice but to access each bit of information individually, taking into consideration its nature and the method by which it was probably acquired. If the required information is of a type which lends itself to accurate recording, editing problems can be relatively simple. If on the other hand the required information has a natural tendency towards inaccuracy, editing can become a major undertaking - often overshadowing the purposes for which the data was originally intended.

In an effort to alleviate the above problems, researchers have been attempting to improve the quantity and quality of fire control data ever since the first forest fire records have been kept. Over the years there have been amny significant improvements in both the quantity and quality of information recorded, but even after a period of several decades there remains a considerable gap between what is available and what researchers would like to have. Furthermore, while in all probability the gap will gradually become narrower, it will ever cease to exist.

Attempts have been made to have researchers record fire behavior information at the fire site. This improves accuracy and yields more detailed information without unduly burdening the fire control personnel. Unfortunately, success of this approach has been very limited. There are three main reasons for this: (1) the cost is great in that the researcher must often be self-sufficient, (2) one person can visit only a small percentage of the fires which occur, and (3) by the time that the presence of a fire is known by the researcher, it is often too late to acquire the most useful information. It would appear, therefore, that this approach is unlikely to provide significant improvements in either the quantity or quality of information recorded about forest fires.

4. Data Availability

The types of data available are, to a large extent, governed by the use to which the reports are put. From the point-of-view of the fire control organization, these reports have three main purposes: (1) measurement of the efficiency of the suppression organization, (2) cost accounting and (3) statistical analysis of fire occurrence trends and patterns. These uses reflect the data which is recorded. For example, all agencies record the time and place of occurrence as well as the cause of each fire. From the suppression point-of-view, the detection source is universally recorded. In addition there is an emphasis on time, in that the start of suppression, under control and fire out times are recorded by many agencies. The final size of the fire is also universally recorded. Lastly, from the accounting point-of-view, suppression cost and damage also appears on most forms.

The emphasis placed on each type of information varies considerably between agencies. To obtain an estimate of the relative importance of each type of information, the percentage of space on the various fire report forms devoted to each of a number of various major categories was determined for each agency. The range of percentages are listed in Table 1. As can be seen, all agencies are interested in obtaining fairly detailed suppression information. It can also be noted however, that some agencies place a greater emphasis on costs, damage and statistical information. In addition to a variability in emphasis, there is also a considerable range in the amount of information recorded. The number of headings on individual report forms vary from a low of 7 to a high of 67, with a total of 174 different headings for all agencies combined (see Appendix 1).

Table 1. RANGES IN PERCENTAGE OF SPACE DEVOTED TO VARIOUS TYPES OF DATA.

		Average
Statistical Data	4% to 48%	20%
Suppression Data	22% to 37%	30%
Cost Data	4% to 52%	20%
Damage Data	6% to 41%	15%
Conditions in Fire Area	0% to 20%	7%
Administrative Information	3% to 20%	8%

The percentages in Table 1 refer to space provided for information. One often overlooked yet very important consideration is completeness of the report. It is only on the largest fires that a certain amount of care is consistently taken to submit as complete report as possible. As fire size and/or costs decrease the percentage of information left blank increases. In the extreme, reports have been turned in with nothing more than the time and place of occurrence, final fire size and the ranger's signature. The more difficult information is to obtain, the more likely it is to be omitted. Not only does the percentage completeness vary with fire size, it also varies between agencies. Some agencies consistently exhibit a high percentage of completeness, indicating a fair amount of checking and feedback to the reporting individual. Percentage completeness for some agencies, on the other hand tends to be quite erratic, reflecting the conscientiousness of the individual rather than efforts of the agency.

While it is not the purpose of this report to make recommendations regarding the type of information which should be collected and fire report form layout, a brief digression into that topic is warranted. Within the constraint that a uniform method of reporting fires for all agencies in Canada is not likely to evolve, the following points should be considered when designing fire report forms.

1. Form layout should follow a logical sequence of events with major headings used to delineate various aspects of the report. The headings used in this section are one possible format. All reports should contain some information pertaining to each major heading. One exception to the sequential presentation would be the time and area sequence. Interpretation of data from the report is greatly facilitated if these are in one separate section in tabular form, listing time and fire size at the various phases of control of interest.

2. With reference to specific items, Appendix 1 contains a list of all items listed on one or more fire report forms currently in use. While the complete list is too cumbersome for any individual fire control agency, the number of times that each individual item is listed indicates the relative importance attached to it by a majority of agencies across Canada.

3. Use of a form in which the reporting officer fills in blanks with codes or words from a standard list provides the greatest amount of information in the least amount of space. Codes of "other" and space for written comments reduces the potential loss of information from this approach. This type of form is also the easiest to code for computer processing and facilitates the manual extraction of information as well. The use of a question and answer type of form is considerably less efficient with regard to space utilization. and it is also the most difficult to process for data retrieval. The least efficient type of form with regard to space utilization is one in which all possibilities of interest are listed on the form and the reporting officer simply checks off the appropriate box. This type of form provides the same information as the first type, but requires considerably more space to do so. Lastly, the form should not be cluttered with instructions for completing it. These are best placed in a separate instruction booklet or manual.

4. It is probably safe to assume that within the not too distant future all fire report forms will undergo computer processing. This should be borne in mind when designing the form itself. This applies not only to the layout of the form, but also to the manner in which the data is recorded. For example, legal or verbal descriptions of fire location are virtually impossible to process by persons not familiar with the immediate area. As a minimum, all fire locations should be in the form of a grid system. Ideally, the system should be universally accepted - such as latitude and longitude. Local systems such as township and range are readily convertable to a universal system however. Another important point is the fact that computer processing of alphabetic data is combersome relative to numeric information. The addition of a few extra code columns in order to allow numeric codes for all data is more than justified by savings in programming and computer costs.

II. DATA PROCESSING

1. Precoding Procedure

(a) Coordination with Individual Agencies

All forest fire control agencies in Canada cooperated in the data acquisition phase of the project. Prior to starting the project, letters of agreement in principle were exchanged between the Canadian Forestry Service and each agency late in 1968. These were followed early in 1969 by a visit by personnel from the Canadian Forestry Service to each agency. The purpose of these visits was four fold: (1) to explain the nature of the airtanker project, (2) to learn about each agency's operating policies with respect to airtankers, (3) to explain the requirements for the data acquisition phase of the project and, (4) to determine the nature of the data availability. Lastly, in the spring and summer of 1969 letters were sent to every agency with a specific request for individual fire report data and certain supplemental information necessary for coding.

The time lag between the request for information and its receipt by the Forest Fire Research Institute varied from one month to three years. Slightly more than half of the agencies forwarded the data within an average of four months of the receipt of the request. The remaining agencies took an average of slightly less than two years to forward the data. Reasons for the long delays are both numerous and varied and did not lend themselves to being remedied. Should similar data processing be undertaken in the future, similar delays would likely be encountered, and the possibility of such occurrences should be considered in the planning stage.

The transfer of data from each agency's files to the Forest Fire Research Institute was accomplished in a variety of ways. Three agencies forwarded the original reports, which were microfilmed and returned. For all microfilm work a positive was used for coding and a negative for permanent storage. For two agencies, the reports were microfilmed on a cost-sharing basis at the agency's headquarters. Two agencies forwarded a computer tape on which information from the individual fire reports had been coded. One was on a cost-sharing basis. One agency forwarded a deck of computer cards containing coded data from the individual reports. Two agencies forwarded copies of their individual reports for retention by the Institute. As the number of fires involved was relatively small these were not microfilmed. For one agency, Canadian Forestry Service personnel were given access to the files and performed the microfilming operation on site.

(b) Map Preparation

Some information needed for the airtanker project was not available from the fire report form. The nearest ground station, airport and weather station, as well as distance to the nearest landable lake had to be acquired from other sources for a number of agencies. In addition, several agencies had undergone changes in administrative boundaries during the period of the study. In the interests of uniformity it was desired that only the most recent boundaries would be used.

While for some agencies some of the required information could be obtained through a computer search of the coded data, some of it could not. For this reason, a set of maps and overlays containing all the above information was prepared for each fire control agency. 1:500,000 scale maps were glued onto a

4 X 6 ft hardboard backing. When more than one map board was required the maps were divided along administrative boundaries to facilitate coding.

In order that the map boards might serve for other uses, all information was plotted on overlays. Administrative boundaries and ground station locations were obtained from each fire control agency. Weather station locations were obtained from the Atmospheric Environment Service. Airport and seaplane base locations were taken from Department of Energy, Mines and Resources publications (1969a, b). Nonusable lakes and usable rivers as indicated by each fire control agency were also marked on the overlay. A second overlay was added for plotting individual fires.

(c) Data Recorded

In selecting the data to be recorded for the project and its format, the main criteria was inclusion of the basic data essential to an analysis of the use of aircraft for forest fire control. Some peripheral data of general interest was also included if it was available from a majority of the agencies. The specific codes and data formats are listed in Appendices II through IV. In addition, a more detailed and generally applicable data set is also presented as a recommendation for future research work.

The more important variables recorded for each fire are: (1) location, (2) time at various phases of fire's history, (3) area at various phases of fire's history, (4) conditions in fire area, (5) nearest facilities of various types, (6) cause and detection sources, and (7) cost and damage.

The format is based, in part, on facility of editing. For example, fire location and nearest ground station are recorded on the same card so that each can be checked against the other for verification prior to loading on tape. Consideration was also given to maximizing the amount of information available from a minimum of recorded information. For example, only the date of detection is recorded. All other times are elapsed from this base. Subsequent dates can then be readily calculated.

There are four data formats. The first is a two card format in which the data is transferred from the source documents. The emphasis for this first step was a minimization of space and coding. Data which passes the editing routine is written on Tape No. 1. The main change from the card format is an expansion of several of the abbreviated fixed decimal point fields to floating point fields. Merging the card 1 and 2 data results in the Tape No. 2 format. The major change is that each fire is now on a single record. The last format results from addition of the weather data.

2. Coding Procedure

When the individual fire reports were used as source documents all coding was done at the Institute. Two groups of coders each consisting of two persons were used. While one person coded information directly from the report, the second plotted the fire on the map and obtained the supplemental information. Plotting the fires proved to be quite difficult and time consuming in cases where only verbal or legal descriptions of the fires' location were given.

The reports were coded in order of occurrence in the file, with no attempt being made to order them prior to coding. A unique computer number was assigned to each fire as coding progressed. Since the order of the fires would be changed several times for various operations, the main purpose of the number was to permit references back to the original data set when necessary.

A certain amount of editing was done at the time of coding. For example, fire location was compared with the map which accompanied the report. When discrepencies were noted, the map was assumed to be correct. Fire sizes and times were checked for proper sequence (i.e., under control after the start of suppression). Missing dates were entered by assuming that the fire occurred in the middle of the period between the fires immediately preceeding and following the one with the missing date (all files were in some form of chronological order). When coding was completed, the data were keypunched and verified. Each card type (1 and 2) was maintained in a separate file, to be merged during the data processing phase.

When punched cards or magnetic tape were the source documents only the map information was coded by hand. Sufficient information was copied from the source document to allow the supplemental information to be merged with the source documents. A computer program was written which converted each agency's codes to the codes listed in Appendices II and IV. In one case, the input was punched cards and the file was relatively small, so the program outputed a card deck with the appropriate format. In other cases, inputs were in the form of magnetic tape and the files were considerably larger. The input tape was processed to extract the necessary data, convert the codes and produce a working tape file. The working file was merged with the supplemental data, with the output being a two card image on tape in the standard format.

3. Editing

Many steps are involved in the production of a magnetic tape record of a forest fire. At every step there is a possibility of error. The purpose of the edit routine is to remove as many errors as possible before the records are placed on magnetic tape. This section is divided into two parts, the first of which discusses sources of error while the second discusses the editing procedure.

(a) Sources of Error

One group of errors occurs only at the time of the completion of the report. These have been discussed at length in a previous section. Basically, these errors involve entering false information for administrative purposes (pay records, keeping outdated lookouts, buying equipment, etc.), or biased information for the sake of appearance. The significance of these errors can vary from nil to considerable depending on their magnitude and the specific use to which the information is being put. These errors are often difficult to detect because of a conscious effort having been made to conceal them. These errors are the exception rather than the rule. However, the possibility of their existence should be considered.

A second group of errors can occur either at the initial or coding step. There are four types of errors in this group:

(1) Estimations where knowledge is lacking or incomplete. Estimations made by the persons completing the report cannot normally be detected. A special code was used for all estimations which had to be made in the coding stage.

(2) Approximation -- rounding off is quite noticeable with respect to fire sizes. For example only a small percentage of fires are listed as 0.4 and 0.9 acres,

whereas a considerable number are listed as 0.5 and 1.0 acres. The same is true with respect to time intervals. The most popular intervals appear to be 15, 30, and 60 minutes, with a considerably reduced number of observations in between.

(3) Scale of measurement -- this varies between agencies and variables. Recorded fire location accuracy varies from ± 200 feet to ± 5 miles, while the information on tape is within ± 1 mile (when the source data permitted). Times are normally recorded in approximately 5-minute intervals, while the tape file is in 10ths of an hour (6 minutes). Many small fires are classed as "spot". This can vary from a campfire to 1/4 acre. All such fires are coded as 0.01 acres (about 20 X 20 feet).

(4) Codes -- whenever information is coded some loss of accuracy is inevitable, as it is not possible to design a code system which encompasses all possible combinations of events. This is particularly true with respect to fire cause where the current code is noticeably lacking.

The last three of the above are not likely to produce significant errors. Estimation errors may be significant, depending on their magnitude.

The last source of error - mistakes - can occur at any stage of the data acquisition process. No one is infallable and mistakes will occur. Incorrect copying of data and transposition are perhaps the most common mistakes. Typical examples are, fire locations which are exactly 30 minutes or one degree in error; switched detection and suppression start times; shifting a number by one column in the coding step; keypunching errors; etc. These types of errors are generally the most significant, and fortunately also the easiest to detect with fairly simple editing procedures.

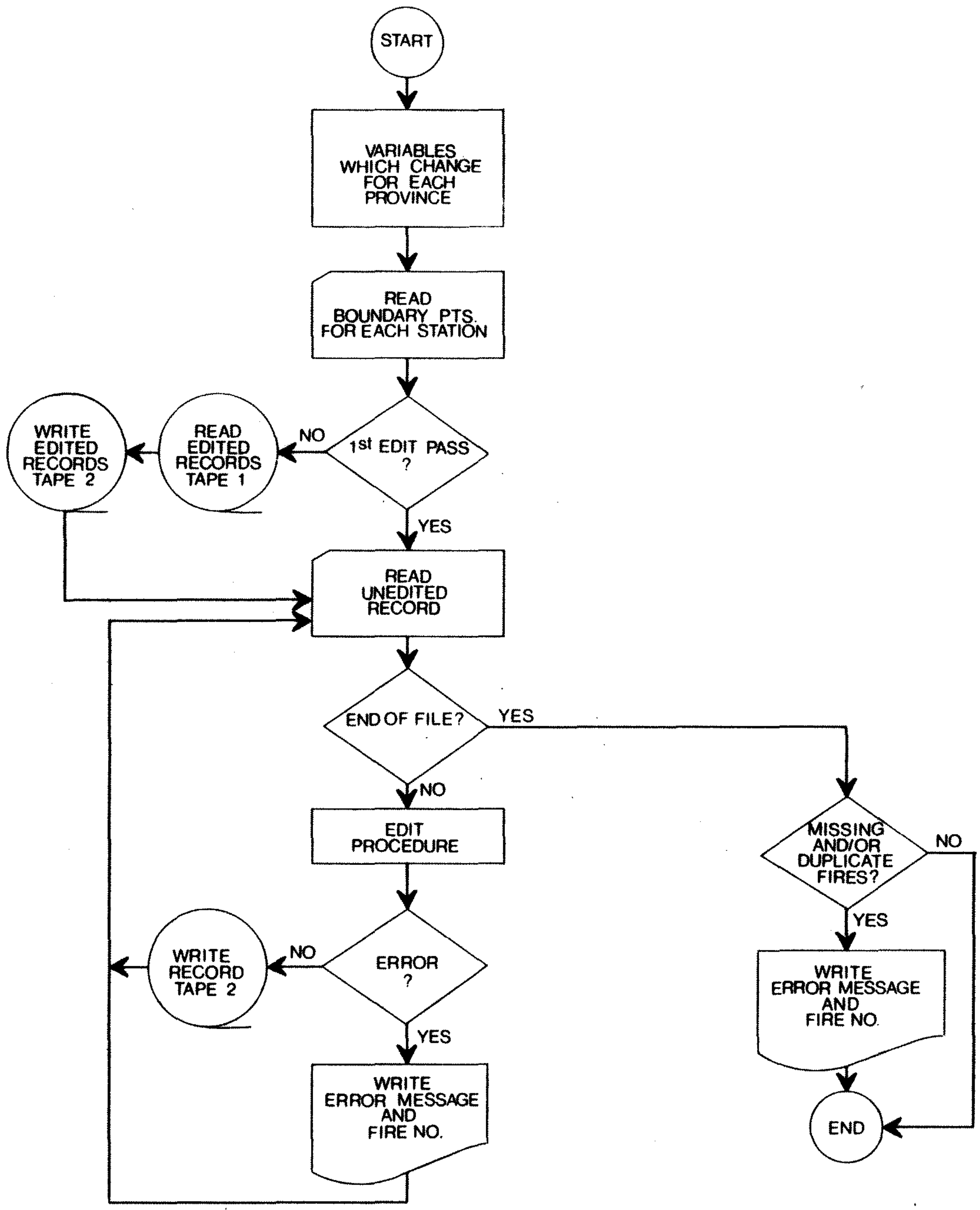
(b) Editing Procedure

There are three levels of editing which are employed. They involve checking the individual variable, comparing it with one or more other variables, and comparing calculated parameters with each other. The first check is performed on all variables. Each variable is read and checked to ensure that it lies within a range of acceptable values. For coded data the limits are absolute. For measured data (times, fire sizes and costs) all observations greater than a certain size are listed. Major errors involving a shifted column are normally readily apparent when the listings are checked by hand. This eliminates impossible data, such as missing dates, out of range codes, missing fires, etc. It cannot eliminate small errors such as a code of 3 which should have been 4.

The second edit is performed on selected variables where a more accurate check is possible. Fire sizes are checked to insure that each is equal to or greater than the previous value. Fire location is compared with the listed nearest ground station. If the location is not within the approximate boundaries of the individual station an error message results.

The current version of the edit program and procedure are flow charted in Figure 1. In general all Card Type 1's are processed first. Those cards which pass all edit checks are loaded onto magnetic tape. The fire number and specific discrepancy is listed for all rejected cards. Card Type 2's are then similarly processed with an additional check being made to insure that every No. 1 card has a corresponding No. 2 card and vice versa. All rejected cards are checked against the source documents, corrected, and re-run through the

FIGURE 1: SIMPLIFIED FLOW DIAGRAM OF THE FIRE DATA EDIT PROCEDURE



edit program until all records have been successfully processed. When tapes are used as input the procedure varies slightly in that the rejected records are punched on cards. From that point on, the procedure is the same as above.

To this point, editing has eliminated only impossible or grossly erroneous data. Once the records are loaded, more accurate checks of the measured variables are made by using calculated parameters. The following series of checks were each written for a specific analysis process and are therefore not contained in a single program. For future work all of these checks could be incorporated into a second edit program. In all cases, the computer prints a list of discrepancies, which are then checked by hand against other data to determine whether the data is more likely to be correct or in error.

The simplest of the calculated checks is a determination of the mean and standard deviation accompanied by a listing of all data more than three standard deviations from the mean. This is particularly useful if the variables do not have a wide range of valid observations. Rate of line construction, rate of mopup, and to a lesser extent, rate of fire growth were analyzed by this method. Those observations where excessive variance could not be explained were eliminated prior to further analysis (although the original observations were retained on the tape file).

Surface travel time was edited by calculating the straight line distance between the nearest ground station and the fire, and dividing by the travel time. A significant percentage of fires were found to have travel times in excess of 60 mph. There are several possible reasons for this: the recorded travel time is incorrect (i.e., in which case the dispatch or suppression start time is incorrect), the fire location is incorrect; the initial attack crew was closer to the fire at the time of dispatch; or initial attack was carried out by persons detecting the fire. While it is not possible to determine the cause of the error, such observations can be eliminated prior to a travel time analysis. Excessively slow travel times can be eliminated with knowledge of the distance walked to the fire.

The most elaborate checks were performed on rate of fire growth and rate of line construction. The recorded ratio of the rates of perimeter growth during the free burning and control intervals was compared with an expected ratio. Since it is unlikely that a drastic change would occur at the start of suppression (if aircraft are not used), it was reasoned that discrepancies between the two ratios greater than an order of magnitude would likely indicate erroneous data. Since so many variables were involved it is not possible to determine the specific error.

If only ground suppression is used to control the fire, and particularly if direct attack is used, it is possible to calculate the minimum rate of line construction which can hold the fire, if the free burning and suppression rates of fire growth are known, by using a series of equations presented by Simard (1971). This was done for all fires where sufficient information was available. Observations, where the recorded rate of line construction was less than half that required to control the fire were deleted. Again the specific source of error could be any of several variables and cannot be determined specifically.

It would be possible to edit every measured variable by comparing it with other related variables. For example, ignition time and date for lightning fires can be compared with lightning occurrence data from nearby weather stations. Excessive deviations of cost per hour of suppression time or damage per acre burned could easily be singled out. While such procedures can never eliminate all errors, they can eliminate large errors. The only hope for small errors is a large sample size wherein small errors tend to balance each other.

4. File Manipulation

There are eight steps involved in manipulating the data. The procedure is described below. A flow chart is presented in Figure 2.

(1) EDIT

The edit phase of the program was previously discussed. The output phase enlarges the fields of all real variables, and inserts appropriate decimal points. Thus, the No. 1 and No. 2 files on Tape No. 1 contain the same data as the No. 1 and 2 cards, but the formats differ. There are several advantages to processing the No. 1 and No. 2 cards separately and in random order:

(a) Improper loading by an operator does not affect the program.
(b) Out-of-order, missing or duplicate cards do not affect the program.
(c) Correct cards (the vast majority of the file) are only handled once.
(d) If sorting is done on tape, individual records cannot be misplaced.

(2) SORT 1

The random order No. 1 and No. 2 files on Tape 1 are prepared for merging. Both files are sorted in ascending order by computer fire number and file numbers. This places the record No. 2 for each fire immediately after the record No. 1 for the same fire. No format change occurs.

(3) MERGE 1

The two record types from Tape No. 1 are merged to form a single record for each fire and placed on Tape No. 2. In addition, all unused and duplicated fields as well as those not needed for further processing are eliminated. The merge program was described by Valenzuela (1970).

(4) SORT 2

The records on Tape No. 2 are sorted into ascending order by date within weather station in preparation for merging with the weather data. No change in format occurs.

(5) HISTOGRAM

This step produces a series of distributions of the basic data. The program will be described in detail in another report. The main purpose of running it within the file manipulation sequence is to produce data needed as an input to MERGE 2.

(6) MERGE 2

The fire data is merged with weather data for the same date from the nearest weather station and outputed onto Tape No. 3. See Simard (1972) for a complete description of the format of the weather data. The FWI for the day after detection is also listed. In addition, tables are produced

FIGURE 2: FILE MANIPULATION PROCEDURE

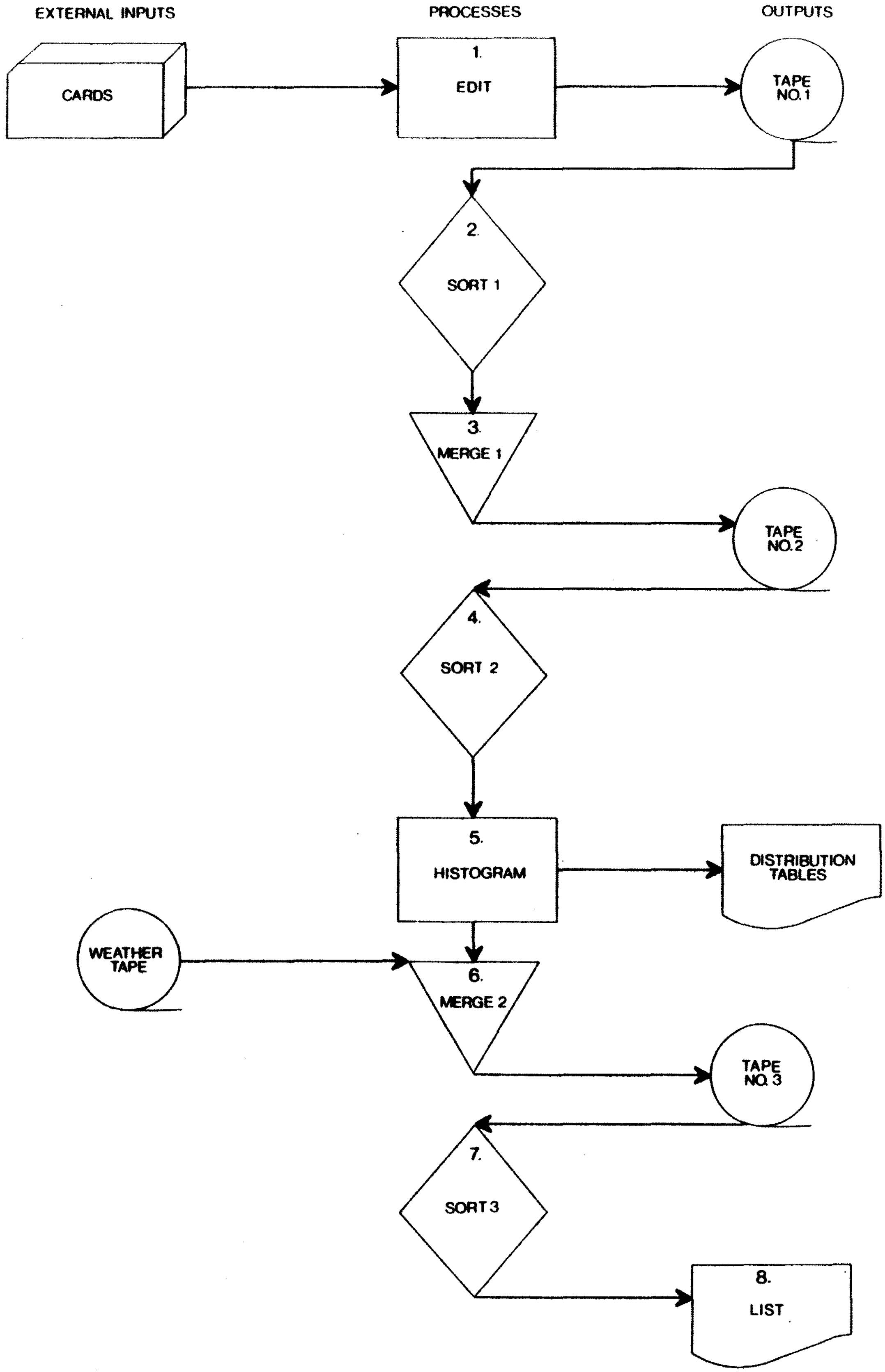
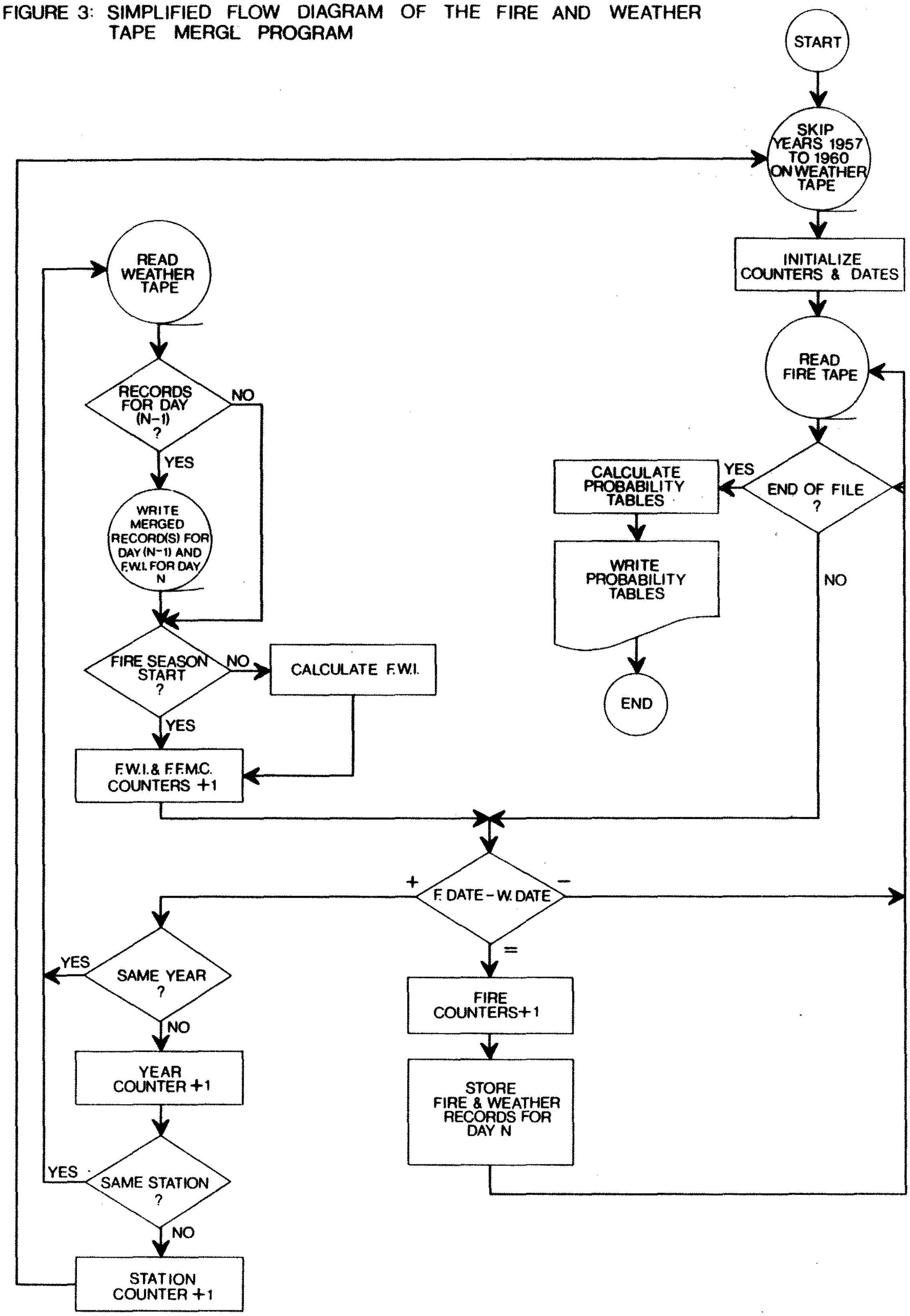


FIGURE 3: SIMPLIFIED FLOW DIAGRAM OF THE FIRE AND WEATHER TAPE MERGL PROGRAM



for each weather station and province listing the probability of occurrence of single and multiple fires caused by lightning and man as functions of the FFMC and FWI. A simplified flow chart for the merge program is shown in Figure 3. With the completion of MERGE 2, the file is complete and ready for general analytical processing.

(7) SORT 3

The Tape No. 3 file is sorted into ascending order by fire number in preparation for listing.

(8) LIST

The entire file is listed in order by fire number. The purpose of this step is to permit rapid location and examination of the data for any specific fire as analytical problems occur. It also permits rapid cross-referencing to the source document file if necessary. A standard feature of all analytical programs is a listing of the fire number whenever a problem is encountered.

III. FILLING IN THE BLANKS

The main purpose of creating a file containing information on individual forest fires was to provide input to the airtanker analysis project. It was found that a considerable number of the records were missing one or more important observations. The missing data significantly reduced the value of the file for its intended purpose. For this reason, it was decided that an effort would be made to complete all records with calculated data.

Since the data banks had been acquired for a specific purpose, the method of filling in the blanks was related to that end. For example, the data was to be used to provide a bench mark against which the use of aircraft could be compared. Therefore, data from all fires on which aircraft were used for suppression had to be modified to reflect what would have happened had the aircraft not been used.

Two methods of modelling the ground suppression system could have been used. The first would have been to retain all observed data whenever aircraft were not used and simply fill in missing observations, to form a complete record for each fire. The majority of data acquired through this procedure would have the greatest correspondence with observed conditions at the fire. This procedure would have created some inconsistencies with respect to the airtanker analysis, however. Since the analysis is based on a comparison of two fire histories, with and without the use of aircraft, the method of determining the fire histories had to be consistent. For this reason, it was decided that the fire history for both ground and air action, would be simulated with the same series of equations. Thus, some correspondence with reality was sacrificed in the interest of comparability of suppression tactics. One advantage of this approach is the elimination of grossly erroneous observations by the simulation procedure.

It was decided that the simulated histories should be based on an actual observation at some point in the fire's history. Size at the start of suppression was selected as the observed variable to retain for several reasons:

1. It is between the extremes of detection and control. Simulation from this point should involve less error at either end of the sequence than if the simulation were from one extreme to the other.

2. Fire size is normally more accurate at the start of suppression than at detection although it is less accurate than at control.

3. There are more observations of fire size at the start of suppression than at detection, although less than at control.

4. Perhaps the most important reason is the fact that airtankers are an initial attack tool. Therefore, the greatest correspondence with reality should be during the period when aircraft are most likely to be used, i.e. during the early stages of suppression.

While the procedures described below were used to simulate most of the history of each fire without aircraft use, they could very easily be used only to fill in missing information, by simply substituting observed for calculated values whenever possible. There are four steps involved in simulating the fire's history based on ground suppression. They are: (1) data analysis, (2) travel time, (3) the free burning period, and (4) the suppression period. Each will be discussed separately.

1. Data Analysis

The purpose of this section is to briefly summarize the results of a multivariate regression analysis which was carried out in order to determine the basic relationships necessary to the ground suppression simulation. The reasoning behind the techniques used as well as a detailed discussion of the various intermediate steps will not be presented here. The main purpose of this section is to provide background for the discussion of the simulation procedure which follows. Data are from the province of New Brunswick unless otherwise noted.

A. Travel Time

The first step in the analysis was removal from the sample of all data where the surface transport travel time exceeded 50 miles per hour based on the straight-line fire to base distance. The probability of the occurrence of such fires was determined for each detection source. The results are listed in Table 2.

Table 2. PROBABILITY OF SHORT TRAVEL TIME FOR EACH DETECTION SOURCE

Detection Source	Percent of Travel Times Considered to be Excessively Short
1. Lookout	10
2. Aircraft	0
3. Forestry personnel	21
4. Forest industries	0
5. Railroads	7
6. General public	15
7. Misc. - known	5
8. Unknown	19

Using data from the Province of Ontario, the following relationships were determined:

(1) $TT = 0.92 + .0357 \times D$ (Regression Analysis)

where TT = travel time in hours
D = straight-line fire to base distance (miles)

$\overline{TT} = 0.44$ hrs. $R^2 = 0.56$ $\frac{RM}{\overline{TT}} = 0.43$

RM = residual mean

(2) $DD = 0.264 + .0103 \times D$ (least squares fit to plotted data)

where DD = dispatch delay in hours
$\overline{DD} = 0.35$ hrs.

The following constants were all derrived from plotted data. If the fire is more than half a mile from a road, add 0.2 hours; if the FWI is less than 3 add 0.1 hours. If the FWI is greater than 35, subtract 0.1 hours.

(3) $\overline{ATD} = 0.05$

where $\overline{ATD}$ = average attack time delay in hours

The following adjustments were applied to the above: if the fire is more than half a mile from a road, add 0.04 hours; if the fire size at the time of attack is greater than 10 acres, add 0.03 hours.

B. The Free Burning Period

The fires were grouped into 14 samples, based on fuel type and species. The groups were:

0. unknown
1. litter
2. duff
3. grass
4. brush
5. softwood slash
6. snag
7. windfall*
8. lichen and moss
9. miscellaneous - known
10. mixedwood slash
11. hardwood slash
12. non-forest
13. overall (all fuel types together)

The above stratification was retained for the entire analysis. Since the above set of regression equations and all others which follow were developed as a means to an end (i.e. as inputs to the airtanker project), they have not yet been properly tested as ends in themselves. Therefore, at this stage no conclusion can be drawn relative to the applicability of the equations for purposes other than those for which they were originally intended. Tentative future plans call for a similar but more rigorous analysis of data from one or two additional agencies, the purpose of which will be to develop the regression equations into operationally usable predictive tools. The equations listed in this section are probably not applicable to conditions outside the range of the input data.

The first set of regression equations estimate forward rate of spread. Input variables available for selection by the regression program and the number of times each was selected are**: SFWI (3), $\sqrt{SFWI}$ (3), SSI (4), $\sqrt{SSI}$ (5), SXSI (8), $\sqrt{SXSI}$ (4), AD (8), PD (2), $\sqrt{PD}$ (8), ST (9), $\sqrt{ST}$ (10).

The overall equation is:

$$EFRS = 406. - 4.38 \text{ X } \sqrt{PD} - 380. \text{ X } \sqrt{ST} + 138. \text{ X } SXSI + 59.5 \text{ X } ST - 15.5 \text{ X } AD + .356 \text{ X } PD - 210. \text{ X } \sqrt{SXSI}$$

Results	Individual Equations Range	Individual Equations Average	Overall Equation
Average FRS	137 - 275	192	192
R^2	.37 - .99	.67	.43
R.M. as % of $\overline{FRS}$	19 - 110	81	114
No. Sig. steps	2 - 8	5.5	7
No. of observations	6 - 102	50	526

*In the analysis this fuel type was grouped with No. 6 due to an insufficient sample size.

**See Appendix V for definitions of all variables referred to in this section.

The second set of equations estimate the perimeter at the start of suppression. Input variables are*: PD (7), PGF (3), (PD + PGF) (7), ETFS (9), EFRS (11), AD (7), ST (7), $\sqrt{ST}$ (7), SFWI (4), SSI (5), SXSI (6), $\sqrt{PD}$ (8).

An overall equation for EPS was not developed.

	Individual Equations	
Results	Range	Average
Average PS	860 - 1,839	1,378
R^2	.70 - .99	.96
R.M. as % of $\overline{PS}$	14 - 72	23
No. Sig. steps	2 - 10	6.7
No. of observations	6 - 102	50

C. The Control Period

The first set of equations in this series estimates the expected rate of line construction for ground forces. Input variables are: EPS (4), $\sqrt{EPS}$ (7), ST (4), $\sqrt{ERPG}$ (9), ATC (4), ARLC (7), EFRS (7), ETFS (7), EPS/ATC (3), EPS/AFFT (2).

The overall equation is:

$$ERLC = -\ 281. + 20.5 \times \sqrt{ERPG} + .440 \times ARLC + 37.6 \times \sqrt{EPS} - 1.68 \times DC - .345 \times EPS + .154 \times (EPS/ATC)$$

	Individual Equations		Overall Equation
Results	Range	Average	
Average RLC	569 - 1,388	1,045	1,045
R^2	.27 - .84	.54	.33
R.M. as % of $\overline{RLC}$	29 - 96	69	80
No. of Sig. steps	4 - 9	5.7	6
No. of observations	12 - 101	56	664

A separate analysis of the effects of multiple simultaneously occurring fires disclosed that the average RLC for the second fire occurring on the same day within the jurisdiction of a single ground station was 20 percent less than for the first fire, while RLC for the third fire was 40 percent less than for the first. There were insufficient observations to draw any conclusions beyond this point.

The second set of equations yield a preliminary estimate of the time required to control the fire. Input variables are: EPS (7), $\sqrt{EPS}$ (5), EPG (5), FWI (1), ADMC (5), $\sqrt{ST}$ (7), ERPG (4), ATC (4), ARLC (6), ERAG (5), EPS/ARLC (9).

The overall equation is:

$$ETC1 = -\ 1.91 + 2.36 \times EPS/ARLC - .00235 \times EPS + .113 \times \sqrt{EPS} + .571 \times \sqrt{ST} - .00133 \times EPG + .0163 \times ADMC.$$

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*Use of previously estimated values as inputs to this and subsequent equations results in R^2's that measure the cumulative predictive ability of the entire set of equations rather than each individual step.

Results	Individual Equations Range	Average	Overall Equation
Average TC	1.08 - 2.76	1.56	1.56
R^2	.18 - .98	.62	.41
R.M. as % of $\overline{TC}$	43 - 142	82	159
No. of Sig. steps	2 - 8	4.4	6
No. of observations	14 - 101	56	674

The third set of equations estimates perimeter growth during suppression. Input variables are: EPS (5), EPGF (7), $ERPG^2$ (7), ATC X ERPG (8), SSI (6), ERPG (4), ETC1 (6), ERLC (4), ERPG X ETC1 (8), ERAG (9), ETFS (8), EAS (7), EAG (5).

The overall equation is:

EPGS = - 45.2 + 8.62 X ETFS - 1.2 X EPG - .0586 X ERPG X ETC + 71.7 X ERAG + 43.9 X ETC

Results	Individual Equations Range	Average	Overall Equation
Average PGS	38 - 525	250	310
R^2	.47 - .99	.69	.15
R.M. as % of $\overline{PGS}$	38 - 286	159	353
No. of Sig. steps	3 - 11	7	5
No. of observations	13 - 123	62	755

The fourth set of equations estimates the perimeter at the time of control. Input variables are: EPS + EPGS (12), EPS (4), EPGS (3), ETC1 (3), ERLC (3), ERLC X ETC1 (5), ERPG (2), EFRS (2), ETFS (2), ERAG (3), EAS (2), EPG (2), EAG (3).

The overall equation is:

EPC = - 119. + .495 X (EPS + EPGS) + .648 X EPS - 109. X ERAG + .241 X ERLC + 7.35 X ETFS - 1.91 X EPG + 147. X EAG - 41.1 X EAS.

Results	Individual Equations Range	Average	Overall Equation
Average PC	624 - 1,757	1,198	1,229
R^2	.70 - .99	.88	.70
R.M. as % of $\overline{PC}$	11 - 79	45	81
No. of Sig. steps	1 - 8	3.8	8
No. of observations	13 - 123	62	743

The last set of equations in this series yields an improved estimate of the time to control. Input variables are: EPS (0), $\sqrt{EPS}$ (2), EPG (3), FWI (1), ADMC (1), ERPGS (3), ERPG (1), EPC/ERLC (4), EPC (3), (EPC + EPS)/2 (2), EAS (1), ERLC (1), ETC1 (12), EGR (5).

An overall equation was not determined for ETC.

Results	Individual Equations Range	Average
Average TC	1.08 - 2.76	1.56
R^2	.43 - .98	.66
R.M. as % of $\overline{TC}$	15 - 112	78
No. of Sig. steps	1 - 10	3.2
No. of observations	14 - 101	56

D. The Post Control Period

The first equation in this series estimates the rate of mop-up. Input variables are: AC/ATMU (10), AC (6), PC (5), RAG (6), DC (6), RLC (6), RPG (5), $\sqrt{TC}$ (3), ADMC (2), TC (7), ARMU (5).

The overall equation is:

ERMU = - 0428 X .000587 X RLC + .000364 X PC - .00328 X PC - .012 X AC + .259 X ARMU + .0278 X RAG + .215 X (AC/ATMU).

Results	Individual Equations Range	Average	Overall Equation
Average RMU	.24 - 2.39	1.03	1.03
R^2	.07 - .99	.53	.20
R.M. as % of $\overline{RMU}$	36 - 360	182	276
No. of Sig. steps	2 - 8	5	7
No. of observations	16 - 139	71	851

The second set of equations estimates the time required for mop-up. Input variables are: AC/ERMU (5), $\sqrt{TC}$ (8), AC/RLC (6), TC (3), PC (8), AC (6), AC/ARMU (6), RAG (5), DC (9), ATMU (7), ADMC (6), ERMU (7).

The overall equation is:

ETMU = - 23.8 + .0167 X PC + .0821 X DC + .390 X ATMU + 5.21 X $\sqrt{TC}$ - 4.45 X ERMU - 3.55 X AC + .0377 X (AC/ERMU) + .0619 X (AC/ARMU) + .539 X TC.

Results	Individual Equations Range	Average	Overall Equation
Average TMU	16.9 - 33.8	25.8	25.8
R^2	.37 - .89	.69	.54
R.M. as % of $\overline{TMU}$	66 - 198	110	149
No. of Sig. steps	4 - 9	6.3	9
No. of observations	16 - 139	71	851

The last equation in the series estimates suppression costs. Input variables are: TC (5), TT (2), TMU (10), AC (3), TC X RLC (9), (TC + TT) X RLC (5), TC + TT (7), TMU X RMU (5), FWI (5).

Several separate regression analyses were attempted using the above variables. One used a linear form of all variables, while others used exponential and square root versions. The linear form was best for four fuel types and the overall equation; the exponential was best for seven, and the square root was best for one type. Combinations of the variable forms generally produced the highest R^2's and the lowest residual means, but several of the equations were not acceptable in that the calculated minimum cost occurred at points where the input variables were greater than zero. Therefore, the simple variable forms were used for all equations. This is the only equation set where consideration was given to rationalizing the form of the output function.

The overall equation is:

$$EC = -130. + 9.28 \times TMU + .210 \times TC \times RLC - .117 \times (TC + TT) \times RLC + 4.46 \times FWI + 91.5 \times TT + 48.5 \times AC - 45.8 \times TMU \times RMU.$$

Results	Individual Equations Range	Individual Equations Average	Overall Equation
Average C	117 - 388	249	249
R^2	.45 - .96	.76	.57
R.M. as % of $\bar{C}$	31 - 172	101	198
No. of Sig. steps	3 - 7	5	7
No. of observations	15 - 153	76	914

Table 3 summarizes the results of the regression analysis by variable and fuel type.

Table 3. AVERAGE R^2 BY VARIABLE AND FUEL TYPE

BY VARIABLE			BY FUEL TYPE	
Variable	Average R^2	R.M. as % of Mean	Fuel Type	Average R^2
FRS	.67	81	0	.58
PS	.96	23	1	.73
RLC	.54	69	2	.82
PGS	.69	159	3	.62
PC	.88	37	4	.83
TC	.66	75	5	.67
RMU	.53	182	6	.83
TMU	.69	110	8	.91
C	.76	101	9	.72
			10	.67
			11	.70
			12	.77
			13	.46

In general, prediction of fire perimeter met with the greatest success. Fire costs were second, but considerably less accurate. Prediction of rates (fire growth, control, mopup) were generally the least accurate, with the other variables falling in between. Examination of the predictive accuracy by fuel types indicate that the overall equations are significantly less accurate than the individual equations. The lowest R^2's are for the unknown (0) and grass (3) fuel types. The highest (8) is a reflection of small sample sizes of only 15 to 25 observations. Between these extremes there is a relatively small range of variation (.67 to .83) by fuel type.

Examination of the data contained in Table 3 indicated that a deterministic use of the regression equations would lead to fairly substantial errors on individual fires. The average error varied from 23 percent to 182 percent of the mean value of the predicted variable. As a result it was concluded that the regression equations were not sufficiently accurate for prediction of all phases of individual fire behavior and control activity.

The fairly large sample of fires (3,000) suggests that errors on individual fires might not be particularly significant with respect to the overall results of the airtanker analysis. Individual errors should be self compensating if the sample size is sufficiently large. Aircraft are used on only a small percentage of fires however. In all probability on only 250 to 500 fires from the above sample will the use of aircraft be justified. The savings incurred through the use of aircraft on the majority of these fires will be small to moderate. In all liklihood, the majority of the total savings incurred will result from actions on not more than 50 to 100 fires. This is, in reality, the relevant sample size with respect to aircraft operations. Thus, individual errors on the order of 100 percent or more could be quite significant with respect to the overall result of a deterministic solution.

As a result of the above reasoning, it was decided that a combined deterministic and stochastic analysis would be used. The regression equations will be used to generate an average value for the first parameter. A deviation from the average will be determined by generating a random number. The calculated value adjusted by the deviation will then be used as input to the next equation where the process will be repeated, using a new random number. The process is repeated until each variable has been calculated. The adjusted values will then be used as inputs to the airtanker simulation. When every fire has been processed in the above manner, the results for the simulation run will be tabulated. If differences between the results of successive runs is small, only a few runs will be needed. If the differences are large, a higher number of runs will be necessary to insure that the results are representative.

2. Travel Time Simulation

In the sample of data processed, only the total time between detection and the start of suppression was recorded. As a result, two operations had to be performed: divide the total into its component parts (dispatch, travel and attack time delay), and simulate data whenever necessary. A simplified flow diagram of the procedure is presented in Figure 4.

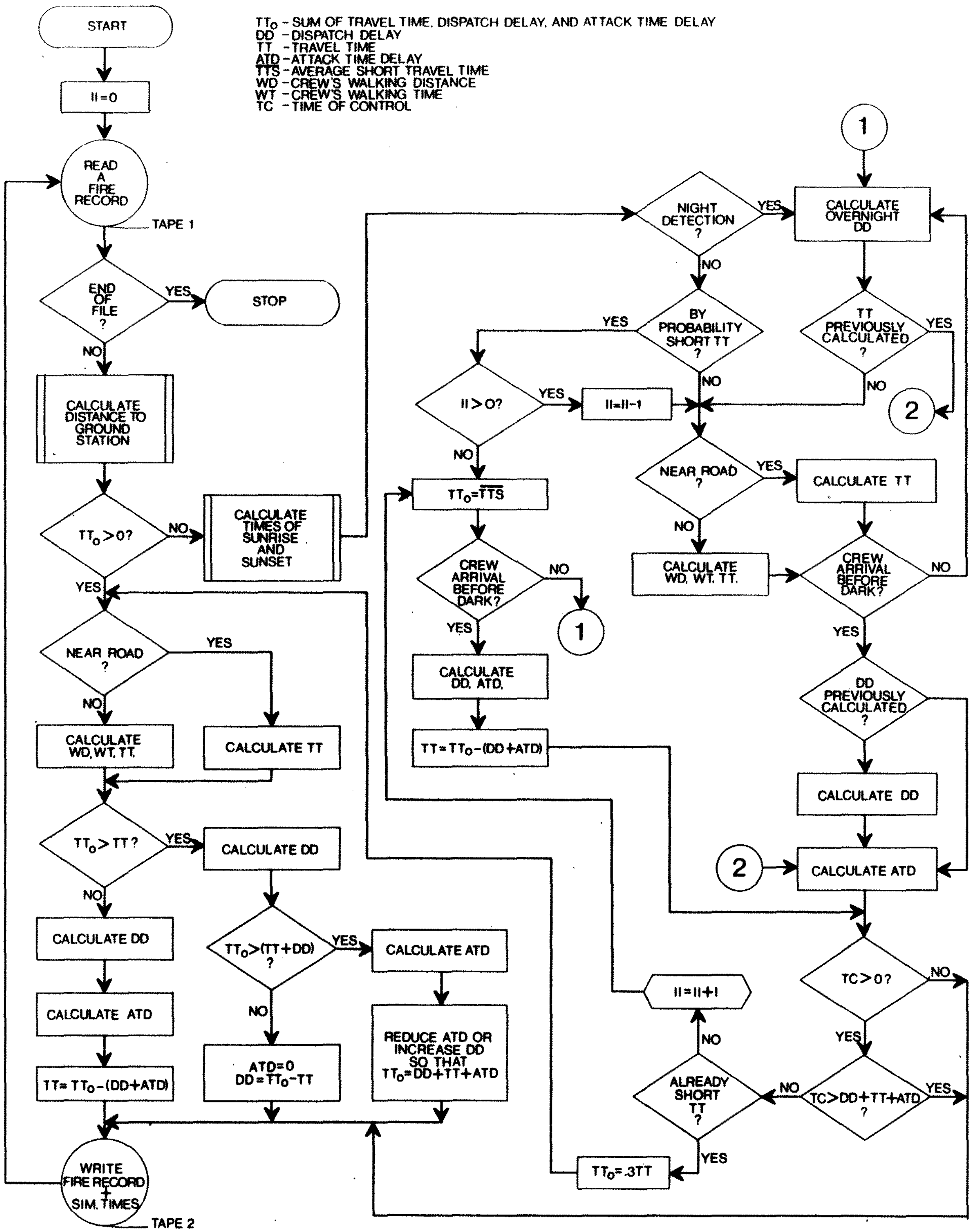
First, the straight-line fire to ground station distance is calculated using GEO*. From this point the program is divided into two sections: (a) a valid surface transport, detection to start of suppression time is available, or (b) either there is no observation for the detection to suppression start interval, or aircraft were used for transport.

A. Surface Transport Observation is Available

The first step involves calculation of the travel time. If the fire is within 0.5 mile of a road, a simple regression equation based on the straight-line fire to base distance is used to determine travel time. If the fire is more than half a mile from a road, the average walking distance for the block within which

*GEO is a distance calculation subroutine developed by J. Valenzuela (F.F.R.I.). Inputs are latitude and longitude, output is distance in miles. Accuracy is within ± 0.25 percent up to 1,000 miles.

FIGURE 4: TRAVEL TIME FLOW CHART



the fire is located (each block is 15 X 15 minutes or approximately 12 X 17 miles), is multiplied by 2.5 miles per hour to determine the walking time. This rather crude approximation was necessitated by the lack of data on distances walked to individual fires. The walking distance is subtracted from the straight-line fire to base distance and the regression equation under Part 1 of this section is used to determine surface transport time. Travel time is simply a total of the two times.

If the calculated travel time is less than the observed total time, a second regression equation is used to determine the dispatch delay. If the travel time plus dispatch delay is less than the observed total time, an attack time delay is added to the dispatch delay, and the two delay times are adjusted so that the total of the three computed times equals the observed total time. If the travel time plus dispatch time is greater than the observed total, the attack time delay is set equal to zero, and the dispatch time is set equal to the total observed time minus the calculated travel time.

If the calculated travel time is greater than the observed time, the dispatch delay is set equal to either 12 minutes (0.2 hours) or 0.4 times the total observed time, whichever is smaller. The attack time delay is set equal to 3 minutes if the sum of the two delay times is less than half of the total time, otherwise the attack time delay is set equal to zero. The travel time is the total observed time minus the sum of the two calculated delay times.

B. Surface Transport Observation is Not Available

The first step requires calculation of the time of sunrise and sunset, using SUND*. If the fire is detected at night, an overnight dispatch delay (until one half hour before sunrise) is calculated. This assumes that crews are not dispatched at night, in keeping with current operating policies. If the fire is detected in the day, a computer generated random number is compared with a table of short travel time probabilities for each ground station and detection source to determine whether or not the travel time will be short. At this point a second major branch occurs: one for short and one for normal travel times.

If the travel time is to be normal, the travel time is calculated in the same manner as for an observed total time. If the crew can arrive at the fire not later than one half hour after sunset, a dispatch and attack time delay are calculated as in (A) above. If the crew cannot arrive before dark an overnight dispatch delay and normal attack delay are calculated.

If a short travel time is indicated, a check is first made of a probability adjustment array to determine whether any previous normal travel times (based on probability) had to be reclassified as short (based on observation). If the indication is positive, the appropriate counter in the probability adjustment array is reduced by one, and the program returns to the normal travel time routine above. If a short travel time is indicated, the average short travel time for the nearest ground station is taken as the total time between detection and the start of suppression. If the crew cannot arrive at the fire before dark, an overnight delay is calculated. If the time of arrival is before dark, the

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*Subroutine SUND calculates the time of sunrise and sunset for the date of detection. Inputs are month, date, longitude, latitude and central longitude for the time zone. Outputs are based on a 24-hour clock and decimals (i.e., 21.50 = 2130). Accuracy is within 2 minutes throughout the year, at all latitudes.

dispatch delay is set equal to 0.4 times the total time or 12 minutes, whichever is shorter. The attack time delay is set equal to 3 minutes or zero, depending on whether or not the total of the two delay times is less or greater than half of the total time. The travel time is the total time minus the sum of the delay times.

Having thus calculated the three times by either the short or normal routine, their total is compared with either the control or final time (the latter if the control time is unavailable) to determine whether the times are possible within the constraints of the other observed times. If the total for the three times is less than the control (or final) time no further calculations are made. If the total is greater than the observed, a check is made to determine whether or not the computed times were short. If not, the appropriate probability counter is increased by one, and the program returns to the short travel time routine. If the time was already short, the detection to suppression interval is set equal to 0.3 times the detection to control interval, and the program returns to the observed time available (A) section.

In the final step, the program simply writes the three calculated times, as well as the total. The entire observed record for each fire is also copied. The program thus processes each record in turn until the entire file has been processed. The program requires 86K bites of storage. Running time on the IBM 360/65 is approximately 0.5 minutes per 1,000 records, with an additional 0.2 minutes being required for completion.

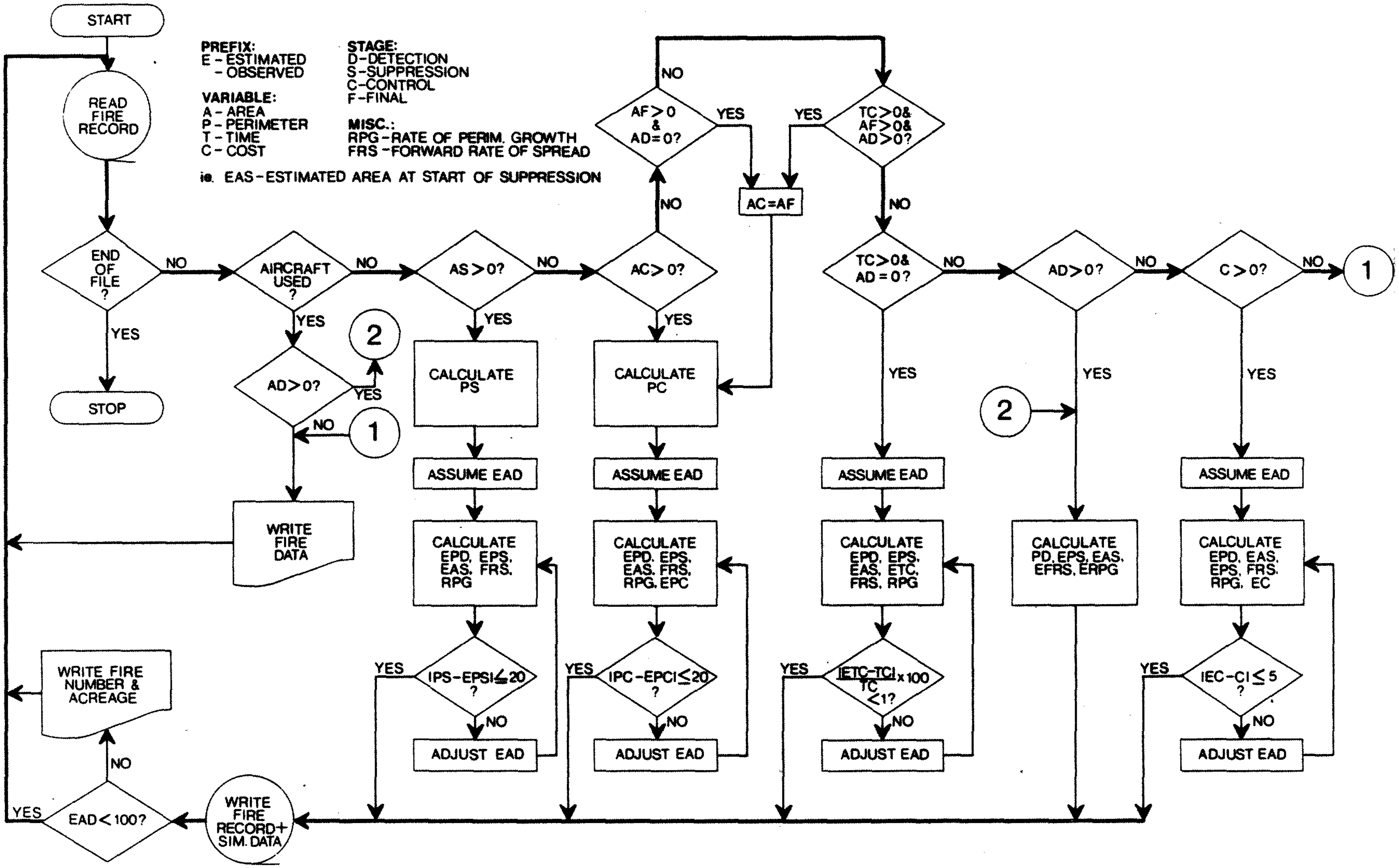
3. Simulation of the Free Burning Period

The purpose of simulating the free burning period is to calculate the perimeter of each fire at the time of detection (PD) which would have yielded the observed perimeter at the start of suppression (PS). If an observed PS relative to the ground suppression system is not available it is calculated from other observed parameters. There are five branches in the routine. Each fire is processed by one of the branches, the selection of which depends on data availability and applicability. The program is flow charted in Figure 5.

The first decision is based on whether or not aircraft were used for transport or air attack. If aircraft were used, the area at detection is the only observed parameter which can be considered to have been uninfluenced by the use of aircraft. The program therefore branches directly to the AD routine. If aircraft were not used, and if an observed AS is available the AS routine is used. If AS is unavailable and an observed AC is available, the AC routine is used. AF is substituted for AC if the latter is unavailable. Branch selection continues by choosing, in order of priority, the TC, AD, or C routine. AC and TC have priority over AD because it was found that a lack of accuracy in observed values of AD often resulted in inconsistencies relative to other observed data during the simulation of the later stages of the fire's history. If none of the above parameters are available, the available fire record is examined by hand and a reasonable value for PS is assumed. Fires which are totally lacking in data are invariably small and of no consequence to the final outcome. In fact, no such fires were found in the first province analyzed.

Of the five branches, only AD is a simple progression. When this branch is used, the program simply calculates PD, EFRS, EPS, EAS, and ERPG in that order. The regression equations described under (B) of the data analysis section are used. The other four branches involve the use of loops. Their logic is identical, with only the variables and termination tests being different. In

FIGURE 5: SIMPLIFIED FLOW DIAGRAM FOR SIMULATION OF THE FREE BURNING PERIOD



the AS branch, the first step is calculation of PS. For the first iteration, EAD is assumed to be one half of AS. From this point the same five variables that were calculated in the AD branch are calculated. This is followed by a comparison of PS and EPS. If they differ by less than either 20 feet or 1 percent, whichever is greater, the program branches to the output section. As in the previous simulation the complete observed record is copied when the simulated data is written on tape. If the difference is greater than minimum requirement, EAD is adjusted in proportion to the relative difference, and the program returns to the beginning of the calculation sequence.

As soon as the desired EAD is bracketed (one trial higher and one lower than the desired value), the adjustment is made to the center of the range, which decreases with each successive step. The convergence procedure is reasonably efficient in that most fires require only 3 to 7 repetitions to meet the accuracy test. The EAD adjustment is limited to 25 iterations. An inner loop (not shown in the flow chart) is used when it is not possible to meet the accuracy requirement by simply adjusting EAD, or when the adjusted value appears to be inconsistent with expected results. The inner loop adjusts FRS in a manner similar to EAD. The program switches between the loops in such a manner as to obtain the most reasonable result. The FRS adjustment is also limited to 25 iterations.

The AC branch differs only slightly from the AS branch. PC and EPC are the test variables. The initial EAD is assumed to be 20% of AC. The only other difference is that the first four equations from part C of the data analysis section (ERLC, ETC1, ERPGS, and EPC) are used in addition to those used in the AD branch. In the TC branch, TC and ETC are the test variables, and the minimum requirement is a difference of 6 minutes or 1 percent whichever is greater. In the cost branch, C and EC are compared, and the maximum allowable difference is $5 or 1 percent. In addition, equations from part (D) (RMU, MUT, and EC) of the data analysis are added to the previous series.

No attempt was made to determine the number of times that each branch was used. This will be done for future applications. It is known, however, that only 6 out of 3,000 fires (0.2%) were processed by the last (cost) step. The program requires 120 K bites of storage. Execution time on the IBM 360/65 is 1.13 minutes per 1,000 records, with an additional compiling time of 0.22 minutes.

4. Simulation of the Suppression Period

This is by far the simplest of the simulation sequences. The program uses the results of the previous simulation as inputs to the "C" and "D" series of regression equations to simulate the remainder of the fire's history.

The only step not previously discussed is an adjustment of ERLC for multiple fires and overnight suppression. The regression equation for ERLC is based on daytime rates for single fires. The calculated value is reduced by 20 percent for the second fire and 40 percent for the third and subsequent fires. If the fire cannot be controlled during daylight hours, the daylight value of ERLC (adjusted for multiple fires if necessary) is reduced by 50 percent.

IV. SUMMARY

In any research project, three factors must compliment each other if the results are to be successful: the nature of the problem, the analytical techniques and data availability. Descriptive techniques are suited to relatively simple problems and are not demanding with respect to data requirements. Deterministic techniques can solve somewhat more involved problems but they are also the most demanding with respect to requirements for data. Stochastic techniques can solve complex problems with a moderate amount of data availability. A combination of techniques can be used to solve the most complex problems.

There are two basic factors affecting the quality and quantity of data available from individual forest fire reports. They are: the attitude of the individual completing the form and the methods by which the data is acquired and recorded. The first factor is governed, to a large measure, by the importance attached to the proper and accurate completion of the form by the fire control agency. The second factor is most often a reflection of the characteristics of the data itself. Directly observed information is normally precise and reliable. Accuracy of measured variables is related to the measurement techniques being used. Failure to assess the potential uses and limitations of each bit of information in the early stages of an analysis can lead to considerable difficulties in more advanced stages.

The range in the amount of information available from the fire report forms used by fire control agencies across Canada is considerable. On the basis of the average percentage of space devoted to each type of data, fire control agencies place the greatest emphasis on suppression information (30%) followed by cost and statistical data (20% each) and damage (15%). Conditions in the fire area and administrative data total 15 percent. From the research point-of-view, the percentage of suppression data and surrounding condition information are increased at the expense of administrative and statistical data.

Editing was the most important phase of the data processing procedure. Three levels of editing are used. Each variable is checked individually to insure that it lies within a range of acceptable values. Some variables are compared with other related variables to insure that they are in agreement. Lastly, computations, based on several variables are checked to insure reasonable conformity with expected behavior patterns. While it is impossible to remove all errors by editing, most large or significant errors can be detected. The only way to eliminate the effect of small errors is with a large sample size.

Upon completion of the file manipulation procedure a series of routines was developed for the purpose of simulating a complete history for every fire. While the specific application was a simulation of the ground suppression system, the techniques would be equally applicable to simulate only missing information to form a complete record.

There are four major steps involved. The first step is a multivariate regression analysis using available data to determine the basic relationships. Second, a complete travel time sequence is determined for each fire. This is followed by simulation of the history of the free-burning period and the suppression period.

Through application of computer processing techniques discussed in this report, raw, uncoded, incomplete and sometimes inaccurate forest fire data can be converted to a uniform, complete and reasonably accurate data bank. Such a data bank would be an invaluable source of information for both managers and researchers. Its availability on magnetic tape greatly increases both the speed with which information can be extracted as well as the complexity of the questions which can be answered. There is little doubt that as the complexity of the questions asked by managers and investigated by researchers continues to increase, computerized data banks such as described in this report, will gradually evolve into a predominant source of information.

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APPENDIX 1

TYPES OF INFORMATION AVAILABLE AND NUMBER OF AGENCIES REPORTING

1. Statistical

   a. Identification

Fire number	9	Size class	6
Fire name	5		

   b. Fire Location

Long. and Lat.	3	Other division	7
Grid system	8	Ownership	5
Verbal or legal	4	Map	8
Forest or region	5	Within protected area	3
Ranger district	6		

   c. Ignition

Date	8	Known or estimate	2
Time	7		

   d. Cause

General	9	Known or estimate	2
Specific	9	Verbal description	1
Type of person	6	Person or companies in fire area	1

2. Suppression

   a. Detection

Primary source	11	Time	9
Detection source name	7	Fire size	7
Secondary source	1	Visibility	1
Date	10	Detection plan	1

   b. Reporting

Time of report	6	Method of report	1
Reported to	3	Action taken	2

   c. Dispatch

Dispatch time	3	Number of men	3
Name of crew	2	Number of supervisors	1
Number and type of equipment	3	Aircraft dispatched	1
Dispatch agency	2	Other dispatched	1

d. Travel

Travel time	3	Distance travelled by type	5
Method of travel	5	H.Q. to fire distance	4
Total distance travelled	7		

e. Initial Attack

Time of arrival	3	Suppression start time	9
Fire size at arrival	1	Fire size at start of supp.	6

f. Suppression Action

Time fire being held	1	Time of arrival and departure of crews	1
Fire size at being held	1	Aircraft/airtankers used	6
Time fire under control	8	Number and types of aircraft	2
Fire size at under control	3	Hours of aircraft use	2
Final perimeter	8	Equipment used	5
Total perimeter constructed	4	Number and types of equipment	2
Perimeter constructed by type	4	Hours of equipment use	2
Perimeter lost	4	Suppression agency	4
Perimeter held	4	Daily summary	3
Perimeter that went out by itself	2	Elapsed times	3
Number of men	6	Description of tactics	4
Number of man hours	6	Length of access roads const.	1
Type of manpower	3	Difficulty of line const.	1
Where men were obtained	2	Provisions used	1

g. Mop-up

Time of mop-up	1	Time patrol stopped	7
Time fire declared out	9	Number of man hours for mop-up	1
Final fire area	11		

3. Costs

Total cost	11	Transportation	5
Permanent labour	7	Miscellaneous	4
Casual labour	4	Equipment lost	9
Overhead	4	Insurance and compensation	1
Supplies	8	Cost paid by other agencies	4
Equipment	7	% cost charged to fire	1
Aircraft	4	Cost by administrative area	1
Airtankers	2	Recommendation for cost recovery	4
Helicopters	2	Out-of-pocket costs	1
Fuel	1		

4. Damage

Total damage	11	Non-forest losses	8
Total volume lost	8	Property damage	9
Area burned by timber size class	10	Soil damage	4
Volume lost by timber size class	9	Volume salvageable	4
Value lost by timber size class	9	Value of salvage	4

Area burned by timber type	4	Percent of timber killed	1
Volume lost by timber type	2	Timber condition before fire	1
Value lost by timber type	3	Percent area well stocked	1
Loss of cut forest products	4	Salvage recommendation	1
Loss by administrative area	5		

5. Conditions in Fire Area

a. Weather

General weather	3	Relative humidity	2
Fire danger index	7	Precipitation	3
Wind speed	6	Nearest weather station	2
Wind direction	5	Date of weather report	2
Wind characteristics	1	Daily weather summary	3
Temperature	1		

b. Fuels

Forest type	7	Fuel depth	1
Fuel type	4	Fuel continuity	1
Fuel type at point of origin	4	Fuel moisture	1

c. Topography

Slope	3	Soil type	2
Aspect	2	Topography	2
Elevation	1		

d. Written remarks 10

6. Administrative

a. Legal

Investigation	5	Action taken	2
Infraction of law	3	Responsibility for fire	2
Prosecution	2	Name and address of landowner	2
Conviction	1		

b. Signatures

Reporting officer	11	Supervising officer	4
His position	8	His position	3
Date of report	10	Date of approval	3
Head office approval	2		

c. Miscellaneous

Name of fire boss	4	Head office ledger entry	2
His training	1	Report coded	2

APPENDIX II

DATA FORMAT

Variable	Card Location (cols.)	Tape No. 1 Location (cols.)	Tape No. 2 Location (cols.)	Final Tape Location (cols.)	Final Tape Format
Fire number	1-5	1-5	1-5	1-5	I
Ignition time	6-9	6-11	6-11	6-11	F6.1
Detection time	10-13	12-15	12-15	12-15	I
Detection year	14-15	16-17	16-17	16-17	I
Detection month	16-17	18-19	18-19	18-19	I
Detection day	18-19	20-21	20-21	20-21	I
Dispatch time	20-23	22-27	22-27	22-27	F6.1
Suppression start time	24-27	28-33	28-33	28-33	F6.1
Under control time	28-31	34-39	34-39	34-39	F6.1
Action stop time	32-35	40-45	40-45	40-45	F6.1
Detection area	36-40	46-53	46-53	46-53	F8.2
Suppression start area	41-45	54-61	54-61	54-61	F8.2
Under control area	46-51	62-70	62-70	62-70	F9.2
Action stop (final) area	52-57	71-79	71-79	71-79	F9.2
General cause	58	80	80	80	I
Specific cause	59	81	81	81	I
Type of person	60	82	82	82	I
Reported by	61	83	83	83	I
Species	62-63	84-85	84-85	84-85	I
Size class (timber)	64-65	86-87	86-87	86-87	I
Fuel type	66	88	88	88	I
Slope	67	89	89	89	I
Exposure	68	90	90	90	I
Elevation	69	91	91	91	I
Aircraft used	70	92	92	92	I
Fire type	71	93	93	93	I
Type of aircraft used	72	94	94	94	I
Blank	73	-	-	-	-
Attack time delay	74-75	95-97	95-97	95-97	F3.1
Training fire	76	98	98	98	I
Map Number	77	99	99	99	I
Island fire	78	100	100	100	I
Outside protected area	79	101	101	101	I
Card (file) Number	80	102	-	-	-
Fire Number	1-5	1-5	-	-	-
Longitude	6-10	6-10	102-106	102-106	I
Latitude	11-14	11-14	107-110	107-110	I
Nearest ground station No.	15-17	15-17	111-113	111-113	I
Near road	18	18	114	114	I

(cont.)

DATA FORMAT (cont.)

Variable	Card Location (cols.)	Tape No. 1 Location (cols.)	Tape No. 2 Location (cols.)	Final Tape Location (cols.)	Final Tape Format
Distance to lake	19-20	19-22	115-118	115-118	F4.1
Nearest airport No.	21-22	23-24	119-120	119-120	I
Nearest seaplane base No.	23-24	25-26	121-122	121-122	I
Blank	25	27	123	-	-
Forest or region No.	26-27	28-29	124-125	123-124	I
Ranger district No.	28-29	30-31	126-127	125-126	I
Nearest weather station No.	30-32	32-33	128-130	127-129	I
Total suppression cost	33-38	35-40	130-136	130-135	F6.0
Cost remarks	39	41	137	136	I
Equipment lost	40-45	42-47	138-143	137-142	F6.0
Total damage	46-51	48-53	144-149	143-148	F6.0
Non-forest damage	52-57	54-57	150-155	149-154	F6.0
Blank	58-74	60	-	-	-
Insufficient data	75	61	156	194	I
Blank	76-79	62-101	-	-	-
Card (file) Number	80	102	-	-	-
Fine fuel moisture code	-	-	-	155-157	I
Duff moisture code	-	-	-	158-161	I
Drought code	-	-	-	162-165	I
Initial spread index	-	-	-	166-170	F5.1
Adjusted duff moisture code	-	-	-	171-174	I
Today's fire weather index	-	-	-	175-177	I
Missing weather flag	-	-	-	178-179	I
Temperature	-	-	-	180-181	I
Relative humidity	-	-	-	182-183	I
Wind direction	-	-	-	184-185	I
Wind speed	-	-	-	186-187	I
Rainfall	-	-	-	188-190	I
Tomorrow's fire weather index	-	-	-	191-193	I
Blank	-	-	-	195-200	-

APPENDIX III

GENERAL CODES

Fire Number: A sequential number unique to each fire. Starting values are:

Newfoundland	00001	Alberta	45001
Nova Scotia	05001	Manitoba	50001
New Brunswick	10001	Saskatchewan	55001
Quebec	20001	British Columbia	60001
Ontario	30001	Yukon and N.W.T.	75001

All federal lands are numbered within the province of location. This numbering system is adequate for approximately 10 years of data. Further expansion will require revision. Addition of a single digit will probably be sufficient for a considerable period of time.

Year, month, date: Self explanatory.

Ignition Time: Elapsed time from the ignition time to the time of detection.

Detection Time: Real time on a 24-hour clock, i.e. 3:40 pm = 1540.

Dispatch Time: Elapsed time from detection to crew dispatch.

Attack Time Delay: Elapsed time between crew arrival and the start of suppression. This is in 10ths of an hour up to 1 hour, and whole hours from 1 to 9. This format should be increased to F6.1.

Suppression Start Time: Elapsed time between dispatch and the start of suppression.

Under Control Time: Elapsed time between the start of suppression and the fire under control.

Action Stop Time: Elapsed time between fire under control and action stop.

All times except detection are in hours and tenths. For future work, time of report would be a useful addition. In addition, time for mop-up should be added to differentiate between this phase and patrolling.

Areas: All areas are in acres, to two decimal places. All spot fires are coded as 0.01 acres. The under control and final areas should be expanded to F10.2.

General Cause:

0 Unknown
1 Lightning
2 Settlement
3 Forest Industries
4 Other Industries
5 Railroads
6 Construction
7 Recreation
8 Incendiary
9 Miscellaneous Known

Specific Cause:

0 Unknown
1 Smoking
2 Campfire
3 Refuse and Debris Burning
4 Equipment Exhaust
5 Prescribed Fire
6 Land Clearing, Range Burning
7 Burning Building or Vehicle
8 Blasting, Brake Shoe, Power Saw
9 Miscellaneous Known

Type of Person:

0 Unknown
1 Settler
2 Local Resident
3 Seasonal Resident
4 Recreationist
5 Forest Worker
6 Worker (other than Forest Worker)
7 Woods User (other than Forest Worker)
8 Children
9 Miscellaneous Known

Each of the above three should be expanded to a 2-column field as the current classification is insufficient to describe the available information. A two part code with each decile represented by a broad classification similar to those above and each unit containing more detail would be well suited to both broad and specific analyses.

Reported by:

0 Unknown
1 Lookout
2 Patrol Aircraft
3 Non-patrol Aircraft
4 Ground Patrol or Other Forestry Personnel
5 Forest Industries
6 Other Industries or Construction
7 Railroad
8 General Public
9 Miscellaneous Known

This should be expanded to include space for the specific source (i.e., lookout name). A 3-column subfield would be needed for this purpose.

Species: This code varied for each province. See the provincial listings immediately after this section for a detailed listing. This should be changed so that one code is used for all of Canada. The last two digits of the species code listed by Simard (1970), pages 19 and 20 could be used. In addition there should be three 2-column fields to allow for various mixtures.

Size Class:

0 Unknown
1 Slash
2 Cutover - No Slash
3 Reproduction
4 Young Growth
5 Pulpwood, Poletimber
6 Saw Timber
7 Merchantable and Cutover

8 Merchantable and Young Growth
9 Cutover and Young Growth

This should be greatly changed. Only five classes are needed: Unknown; cutover, slash; reproduction and young growth; pulpwood; and merchantable. The area burned in each class should be recoded and converted to percentage of the total area burned. Five 3-column fields would be adequate in the final format.

Fuel Type:

0 Unknown
1 Litter and Duff
2 Recent Burn*
3 Grass
4 Brush
5 Slash
6 Snag
7 Windfall
8 Lichen or Moss
9 Miscellaneous Known

*Coded as Duff for New Brunswick.

The only change suggested for fuel type would be the addition of two 1-column fields for combinations of material.

Slope:

0 Unknown
1 Upslope
2 Downslope
3 Level
4 Rolling, sloping
5 Steep or precipitous

For Alberta and B.C.:

0 Unknown
1 Level
2 Sloping or variable
3-9 % slope divided by 10 (i.e., 56% = 5)

A second 2-column field should be added to list the actual percent slope as the above general information is of only limited usefulness.

Exposure:

0 Unknown
1 Level
2 North (1)*
3 Northeast
4 East (2)*
5 Southeast
6 South (3)*
7 Southwest
8 West (4)*
9 Northwest

*New Brunswick Codes.

Elevation in thousands of feet:

0 Unknown
1 0 - 999 ft
2 1,000 - 1,999 ft
3-8 as above
9 8,000 ft plus

Aircraft Used:

0 Unknown
1 Airtankers
2 Transportation
3 Scouting
4 1 & 2
5 2 & 3
7 1, 2 & 3
8 Aircraft Used but Use Unknown
9 Aircraft Not Used

Fire Type:

0 Unknown
1 Ground
2 Surface
3 Torching Out
4 Crowning
5 Burning Building, Vehicle or Aircraft
6 Ground and Surface

Type of Aircraft Used:

0 Unknown
1 Fixed-wing
2 Helicopter
3 1 & 2
4 Beaver
5 Canso
6 TBM
7 Miscellaneous Known

This field could be deleted for future work.

Non-wildfire:

0 Wildfire
1 Training Fire
2 Prescribed Fire

Map Number: The number of the map board on which the fire is located. There are from 1 to 5 map boards for each province. Inclusion of this number facilitates back checking. This code could be deleted for future work.

Island Fires:

0 Not On An Island
1 Unknown
2 Inhabited Island
3 Uninhabited Island
4 Large Island (more than 2 square miles)

The main purpose of this code is to preclude the fire growth model from generating excessively large fires on islands.

Outside Protected Area:

0 Inside Protected Area Boundary
1 Outside Protected Area Boundary

Card (File) Number:

1 Card (File) No. 1
2 Card (File) No. 2

Longitude and Latitude: Recorded to the nearest minute.

Nearest Ground Station Number: See provincial codes (number of initial attack station, if given).

Near Road: 0 Unknown
1 Within Half a Mile of a Road
2 More Than Half a Mile from a Road

This code could be deleted for future work.

Distance to Lake: Distance to the nearest 10th of a mile from the fire to the closest lake which is 1.5 or more miles long. This code could also be deleted for future work.

Nearest Airport Number: See provincial codes.

Nearest Seaplane Base Number: See provincial codes.

Forest or Region Number: See provincial codes.

Ranger District Number: See provincial codes.

Nearest Weather Station Number: See Simard (1972) for a complete list of weather station numbers.

Cost and Damage: Recorded to the nearest dollar. Both of these fields should be expanded considerably. Costs should be stratified as follows: wages and salaries; supplies and provisions; transportation; equipment rental; miscellaneous; equipment lost; and total cost. Six column fields are adequate for all but total cost which should be 7 columns. Damage should include both value and volume data. Value data which should be included are: value of sawtimber; pulpwood; non-forest losses; and property damage as well as total loss. Six column fields are adequate for all but total damage which should be 7 columns. Volume should include both sawtimber and pulpwood. Six column fields are adequate. Volume and value of salvageable sawtimber and pulpwood should also be included. These should also be six column fields.

Insufficient data: 0 All Data are Known
1 Location is Approximate
2 Detection Time (and/or date) is Approximate
3 No Action Taken
4 1 & 2
5 1 & 3
6 2 & 3
7 1, 2 & 3
8 Partial Action Taken (either the initial attack crew withdrew or several weeks elapsed before a crew was dispatched, or both)

Weather Data: A detailed description of the weather data was given by Simard (1972). No changes are proposed.

Since the airtanker project did not require detailed suppression data, none was recorded. For more general applications a suppression section should be included as follows:

Travel to Fire: Miles travelled by: air, vehicle, boat, walking, other. This should be recorded to the nearest mile for all but walking which should be to the nearest 10th. Three columns are needed for air, four for walking and two for the other categories.

Perimeter Held and Type of Construction: Recorded in feet by: hand, bulldozers or plows, pumps or ground tankers, airtankers, backfiring, other, and total. Also an entry for total perimeter lost should be included. Six column fields are adequate.

Equipment Used: Number of pieces of equipment by: bulldozers and plows, pumps and ground tankers, aircraft, two columns each.

Manpower: Number of men plus supervisors - four columns, and total man hours - six columns.

Tactics:
0 Unknown
1 Direct Attack
2 Indirect Attack
3 1 & 2

Table III-1. PERCENTAGE OF SPACE DEVOTED TO EACH TYPE OF INFORMATION.

	Present Data Set		Proposed Data Set	
	Cols.	Percent	Cols.	Percent
Statistical	34	.18	36	.09
Suppression	74	.38	169	.43
Cost	13	.07	43	.11
Damage	12	.06	67	.17
Conditions	51	.26	72	.18
Administrative	10	.05	10	.02
Totals	194	1.00	397	1.00

Comparison of Table 1 with III-1 discloses that from the research point-of-view, suppression data and conditions in the fire area receive greater emphasis than the average fire report. Emphasis on damage is about the same while emphasis on statistical, cost and administrative data drop significantly. This is not surprising since two of the main purposes for which fire report forms are designed are statistical analysis and cost accounting. In addition, an operational fire control agency has administrative considerations which do not concern the researcher.

The total length of the format recommended for future work (397 columns) is consistent with record lengths currently used by provinces which employ computer processing techniques (range 240 to 400 columns). The amount of data available through the above format is greater than for any single currently available record however, as each of the currently used reports contain some information not required from the research point-of-view.

APPENDIX IV

SPECIFIC CODES

ALBERTA

REGIONS AND DISTRICTS:

Region 1 Crowsnest Forest (DC)

District	1	DC 1
	2	DC 2
	3	DC 3
	4	DC 4
	5	DC 5

Region 2 Bow River Forest (DB)

District	1	DB 1
	2	DB 2
	3	DB 3
	4	DB 4
	5	DB 5
	6	DB 6
	7	DB 7
	8	DB 8

Region 3 Rocky-Clearwater Forest (DR)

District	1	DR 1
	2	DR 2
	3	DR 3
	4	DR 4
	5	DR 5
	6	DR 6
	7	DR 7
	8	DR 8

Region 4 Edson Forest (DE)

District	1	DE 1
	2	DE 2
	3	DE 3
	4	DE 4

Region 5 Whitecourt Forest (DW)

District	1	DW 1
	2	DW 2
	3	DW 3
	4	DW 4
	5	DW 5
	6	DW 6

Region 6 Lac la Biche Forest (DL)

District	1	DL 1
	2	DL 2
	3	DL 3
	4	DL 4
	5	DL 5
	6	DND Weapons Range

Region 7 Slave Lake Forest (DS)

District	1	DS 1
	2	DS 2
	3	DS 3
	4	DS 4
	5	DS 5
	6	DS 6
	7	DS 7

Region 8 Grande Prairie Forest (DG)

District	1	DG 1
	2	DG 2
	3	DG 3
	4	DG 4
	5	DG 5

REGIONS AND DISTRICTS: (Cont.)

Region 9 Athabasca Forest (DA)

District	1	DA 1
	2	DA 2
	3	DA 3
	4	DA 4
	5	DA 5

Region 10 Peace River Forest (DP)

1	DP 1
2	DP 2
3	DP 3
4	DP 4
5	DP 5
6	DP 6
7	DP 7

Region 11 Wood Buffalo Nat. Park

District 1

Region 12 Footner Lake Forest (DF)

District	1	DF 1
	2	DF 3
	3	DF 5
	4	DF 6
	5	DF 7

Region 13 Out of Fire Prot. Boundary

District 1

GROUND STATIONS:

		Long.	Lat.
1	Lynx Creek	11425	4928
2	Coleman	11430	4938
3	Livingstone	11424	4952
4	Willow Creek	11422	5014
5	Skyline	11400	4952
6	Porcupine	11408	4958
7	Highwood	11438	5023
8	Sheep	11439	5039
9	Kovach	11507	5055
10	Elbow	11442	5054
11	Pigeon Mountain	11446	5103
12	Ghost	11457	5119
13	Red Deer	11515	5139
14	James River	11500	5153
15	Clearwater	11509	5159
16	Strachan	11507	5215

		Long.	Lat.
17	Upper Saskatchewan	11627	5209
18	Key	11457	5223
19	Shunda	11544	5229
20	Nordegg	11604	5229
21	Alder Flats	11456	5255
22	Robb	11658	5314
23	Entrance	11743	5322
24	Hilton	11736	5324
25	Rock Lake	11815	5328
26	Moberly	11801	5334
27	Hay River	11743	5337
28	Medicine Lodge	11700	5333
29	Cabin Creek	11823	5346
30	Grande Cache	11906	5352
31	Muskeg	11839	5356
32	Lodgepole	11518	5306

GROUND STATIONS: (Cont.)

		Long.	Lat.
33	Cold Creek	11535	5336
34	Blue Ridge	11527	5408
35	Fort Assiniboine	11447	5420
36	Fox Creek	11649	5424
37	Swan Hills	11524	5443
38	Lacorui	11046	5427
39	Beaver Lake	11153	5446
40	Wandering River	11232	5512
41	Calling Lake	11311	5512
42	Conklin	11505	5538
43	Smith	11403	5509
44	Sunset	11651	5459
45	Kinuso	11527	5520
46	High Prairie	11631	5526
47	Salt Prairie	11604	5538
48	Wabasca	11349	5557
49	South Wapiti	11912	5455
50	Valley View	11717	5504
51	Debolt	11802	5513
52	Fish Creek	11713	5517
53	Spirit River	11850	5547
54	Grovedale	11853	5501
55	Anzac	11102	5627
56	Fort MacKay	11138	5711
57	Embarras	11120	5812
58	Fort Chipewyan	11109	5843
59	McLennan	11653	5543
60	Three Creeks	11700	5623
61	Hines Creek	11837	5615
62	Worsley	11908	5631
63	Dixonville	11740	5632
64	Manning	11737	5655
65	Keg River	11737	5745
66	Little Red River	11445	5824
67	Fort Vermilion	11600	5823
68	North Vermilion	11602	5825
69	High Level	11707	5831
70	Hay Lakes	11844	5850
71	Upper Hay	11741	5901
72	Upper Steen River	11708	5938
73	Castle	11421	4923
74	Slave Lake	11446	5517
75	McMurray	11121	5643
76	Fort Smith	11152	6000

AIRPORTS:

		Long.	Lat.	Length
1	Cowley	11405	4938	6800'
2	Livingstone	11426	5003	3200'
3	Ghost	11501	5123	3000'
4	Red Deer	11514	5139	2400'
5	Jumping Pound	11442	5102	3200'
6	Rocky Mountain House	11455	5225	4900'
7	Clearwater	11514	5159	3000'
8	Upper Saskatchewan	11627	5210	2400'
9	Thunderlake	11642	5251	3000'
10	Alder Flats	11510	5253	2400'
11	Shunda	11545	5230	3300'
12	Edson	11627	5335	3000'
13	Elk River	11611	5254	2800'
14	Steeper	11707	5308	2900'
15	Mayberne	11646	5352	3000'
16	Entrance	11742	5323	3500'
17	Eaglesnest	11835	5332	3000'
18	Grande Cache	11906	5353	3600'
19	Cote Creek	11939	5351	2900'
20	Big Berland	11820	5345	4000'

AIRPORTS: (Cont.)

		Long.	Lat.	Length
21	Wildhay	11734	5352	2700'
22	Grande Prairie	11853	5511	6500'
23	Sherman Meadows	11950	5417	2600'
24	Smoky City	11835	5445	3000'
25	Kakwa	11859	5425	2700'
26	Valleyview Forestry	11720	5502	2400'
27	Whitecourt	11539	5408	3200'
28	Lodgepole	11508	5306	3000'
29	Swan Hill	11529	5446	4200'
30	Judy Creek	11537	5431	4000'
31	Fox Creek	11646	5423	4600'
32	Goose River	11619	5444	2500'
33	Simonette	11743	5425	3000'
34	Berland Tower	11724	5406	2700'
35	Najack	11534	5336	2400'
36	Slave Lake	11447	5518	3500'
37	Athabasca	11317	5444	2000'
38	Bitumount	11138	5722	4400'
39	Bonnyville	11044	5416	2240'
40	Cadotte	11618	5627	3200'
41	Calgary	11401	5106	12675'
42	Calling Lake	11311	5514	2100'
43	Chipewyan Lake	11330	5655	2700'
44	Cooking Lake	11308	5326	2500'
45	Edmonton Int.	11335	5319	11000'
46	Embarras	11123	5812	4400'
47	Fairview	11826	5605	4000'
48	Footner Lake	11710	5837	5000'
49	Forestry F-L	11838	5910	3000'
50	Forestry Westzama	11942	5835	1900'
51	Fort Chipewyan Public	11107	5846	5000'
52	Fort Macleod	11325	4942	3000'
53	Fort Vermilion	11556	5824	3000'
54	Graham Lake	11433	5630	2200'
55	Habay	11843	5850	2200'
56	High Level	11707	5830	3379'
57	Innisfail	11402	5205	3025'
58	Jauvier	11045	5555	2600'
59	Lac la Biche	11201	5446	4300'
60	Lethbridge	11248	4938	6500'
61	Manning	11738	5657	4000'
62	North Vermilion	11606	5824	2500'
63	Peace River	11726	5614	4999'
64	Rainbow Lake	11924	5830	4850'
65	Redearth	11507	5637	3900'
66	Spirit River	11850	5547	3000'
67	Stettler	11245	5219	2100'
68	Vermilion	11050	5321	3000'
69	Wabasca	11349	5558	3800'
70	Worsley	11905	5631	3300'
71	Camrose	11249	5302	2500'
72	Brooks	11155	5038	3000'
73	Hanna	11154	5138	2000'

SEAPLANE BASES:

		Long.	Lat.	Length
1	Athabasca	11321	5444	2 mi.
2	Bassett Lake	11830	5819	1.5 mi.
3	Bearspaw Dam	11419	5108	4 mi.
4	Bistcho Lake	11831	5942	10 mi.
5	Brooks	11156	5029	8 mi.
6	Calling Lake	11314	5515	
7	Caribou	11605	5904	2 mi.
8	Cold Lake	11010	5428	15 mi.
9	Cooking Lake	11308	5326	3 mi.
10	Desmarais	11347	5556	7 mi.

SEAPLANE BASES: (Cont.)

		Long.	Lat.	Length
11	Egg Lake	11124	5605	2 mi.
12	Embarras	11124	5812	3 mi.
13	Eva Lake	11514	5855	2 mi.
14	Footner Lake	11710	5837	2 mi.
15	Fort Chipewyan	11109	5842	3 mi.
16	Fort Fitzgerald	11136	5951	2 mi.
17	Fort McKay	11137	5711	

		Long.	Lat.	Length
18	Fort McMurray	11132	5644	2 mi.
19	Fort Vermilion	11558	5824	RIVER
20	Lac la Biche	11159	5446	7 mi.
21	Mitsue Lake	11436	5515	1.5 mi.
22	Peace River	11719	5614	2 mi.
23	Wentzell Lake	11430	5859	3 mi.

SPECIES:

1 Spruce (SW, SB)
2 Pine (P, PL)
3 Deciduous (A, BW)
4 Muskeg
5 Dog
6 Brush
7 Grass
8 Recent Burns
9 Clear Cut
10 Others

BRITISH COLUMBIA

REGIONS AND DISTRICTS:

Region 1 (Nelson)

District	1 to 22	1 to 22
	23	Glacier Nat. Park
	24	Yoho Nat. Park
	25	Kootenay Nat. Park

Region 2 (Kamloops)

District	1 to 21	1 to 21
	22	Wells Gray Prov. Park
	23 to 24	23 to 24

Region 3 (Vancouver)

District	1 to 28	1 to 28

(No District Nos. 13, 18, 20, 22)

Region 4 (Prince Rupert)

District	2 to 17	2 to 17

(No District Nos. 8, 10, 15)

Region 5 Prince (George)

District	1 to 19	1 to 19
	20	Mount Robson Prov. Park

GROUND STATIONS:

		Long.	Lat.
1	Invermere	11602	5031
2	Fernie	11503	4931
3	Golden	11658	5118
4	Cranbrook	11545	4932
5	Creston	11632	4905
6	Kaslo	11655	4955
7	Lardeau	11658	5008
8	Nelson	11718	4927
9	New Denver	11721	5001
10	Nakusp	11748	5015
11	Castlegar	11741	4919
12	Grand Forks	11827	4902
13	Kettle Valley	11857	4904
14	Canal Flat	11549	5009
15	Mica Creek	11832	5159
16	Fauquier	11803	4952
17	Elko	11506	4919
18	Spillimacheen	11623	5055
19	Cranbrook	11546	4929
20	Beaverdell	11905	4926
21	Salmo	11717	4911
22	Revelstoke	11812	5059
23	Lumby	11857	5015
24	Birch Island	11952	5137
25	Barriere	12006	5110
26	Kamloops	12022	5038
27	Chase	11941	5048
28	Salmon Arm	11920	5042

GROUND STATIONS: (Cont.)

		Long.	Lat.
29	Sicamous	11857	5049
30	Lillooet	12157	5042
31	Vernon	11915	5016
32	Penticton	11934	4928
33	Princeton	12031	4928
34	Clinton	12135	5107
35	Williams Lake	12211	5208
36	Alexis Creek	12316	5205
37	Kelowna	11927	4954
38	Ashcroft	12116	5043
39	Merritt	12048	5006
40	Blue River	11916	5206
41	Enderby	11910	5032
42	Tatla Lake	12436	5153
43	100 Mile (N)	12115	5140
44	Horsefly	12125	5220
45	100 Mile (S)	12114	5138
46	Cultus Lake	12157	4905
47	Hope	12125	4922
48	Harrison Lake	12145	4818
49	Mission	12220	4909
50	Port Moody	12251	4916
51	Squamish	12308	4942
52	Sechelt	12344	4929
53	Pender Harbour	12358	4938
54	Powell River	12430	4952
55	Lund	12444	4959
56	Campbell River (S)	12516	5000
57	Sayward	12555	5021
58	Port McNeil (S)	12704	5032
59	Oirt McNeil (N)	12704	5034
60	Port Hardy	12730	5043
61	Campbell River (N)	12516	5002
62	Lower Post	12829	5956
63	Parksville	12421	4919
64	Duncan	12343	4847
65	Langford	12332	4828
66	Lake Cowichan	12402	4849
67	Port Alberni	12448	4915
68	Tofino	12553	4908
69	Pemberton	12249	5019
70	Gold River	12604	4946
71	Queen Charlotte City	13204	5316
72	Prince Rupert	13019	5416
73	Terrace	12835	5432
74	Kitwanga	12805	5508
75	Hazelton	12739	5515
76	Smithers	12710	5446
77	Houston	12639	5423
78	Burns Lake	12547	5414
79	Bella Coola	12645	5221
80	South Bank	12548	5401
81	Kitimat	12843	5359
82	Stewart	12957	5557
83	McBride	12012	5317
84	Valemount	11916	5249
85	Prince George	12242	5354
86	Prince George	12245	5356
87	Fort St. James	12414	5426
88	Quesnel	12227	5258
89	Dawson Creek	12015	5545
90	Aleza Lake	12203	5406
91	Vanderhoof	12403	5358
92	Fort St. John	12051	5617
93	Fort Fraser	12432	5403
94	Summit Lake	12237	5417
95	Fort Nelson	12240	5848
96	Prince George	12246	5351
97	Hixon	12234	5326
98	Quesnel	12226	5256
99	Quesnel	12225	5256
100	Chetwynd	12138	5541
101	Mackenzie	12306	5519

COMBINATION AIRPORTS AND SEAPLANE BASES:

No.	Name	Long.	Lat.	Length Airport	Length Seaplane	No.	Name	Long.	Lat.	Length Airport	Length Seaplane
1	Kaslo	11659	4956		9900'	13	Prince George	12241	5353	6400'	2 mi.
2	Nelson	11718	4929	2300'	4 mi.	14	Marilla	12548	5341	2000'	
3	Courtenay	12459	4941	2000'		15	Dawson Creek	12011	5544	5000'	5000'
4	Kamloops	12025	5043	5500'	10 mi.	16	Telegraph Creek	13111	5754	2600'	2 mi.
5	Vernon	11920	5015	2530'		17	Stewart	12959	5556	5600'	3 mi.
6	Slocan Lake	11728	5005	1650'		18	Fort Nelson	12235	5850	6400'	1.5 mi.
7	Canim Lake	12037	5153	3850'	3 mi.	19	Dease	13002	5828	3000'	5.4 mi.
8	Chilco Lake	12408	5137	2500'		20	Muncho Lake	12546	5900		8 mi.
9	Bella Coola	12636	5223	4000'	8 mi.	21	Watson Lake (Yukon)	12849	6007	5500'	4 mi.
10	Anahim Lake	12519	5231	1600'	2 mi.	22	Atlin	13340	5935	3600'	8 mi.
11	Quesnel	12231	5302	5500'	2 mi.	23	Puntzi Mtn.	12410	5207		
12	Nulki Lake	12409	5355	2000'		24	Sidney	12330	4840		

AIRPORTS:

No.	Name	Long.	Lat.	Length	No.	Name	Long.	Lat.	Length
25	Cranbrook	11547	4936	6000'	43	Valemount	11913	5250	3000'
26	Grasmere	11510	4908	1500'	44	Hope Slide	12115	4918	1500'
27	Fairmount Springs	11553	5019	2200'	45	Princeton	12031	4928	5660'
28	Golden	11658	5119	2400'	46	Merrit	12045	5007	2000'
29	Sullioan River	11759	5157	2200'	47	Juliet (Station)	12101	4945	2350'
30	Boat Encampment	11825	5208		48	Bar Q Ranch	12116	5040	
31	Revelstoke	11811	5058	4500'	49	Lillooet	12155	5041	2000'
32	Mabel Lake	11844	5037	2000'	50	100 Mile House	12118	5138	2100'
33	Salmo	11716	4910	3200'	51	Horsefly	12124	5222	1850'
34	Trail	11736	4904	4700'	52	Stokke Creek	12202	4943	
35	Grand Forks	11828	4902	2800'	53	Braloine	12247	5047	
36	Seymour Arm	11858	5115		54	Dog Creek	12215	5138	6360'
37	Westbridge	11858	4910	1800'	55	Williams Lake	12203	5211	7000'
38	Penticton	11936	4928	6000'	56	Fishem Lake	12339	5113	
39	Kelowna	11923	4958	5350'	57	Big Creek	12303	5144	2600'
40	East Barriere Lake	11952	5115		58	Tatlayoko Lake	12424	5139	
41	Vavenby	11944	5135	2900'	59	Southgate	12450	5057	
42	Blue River	11919	5206	3000'	60	Nimpo Lake	12512	5219	4100'

AIRPORTS: (Cont.)

		Long.	Lat.	Length
61	Phillips Ranch	12503	5255	1500'
62	Port Alberni	12449	4914	2150'
63	Tofino	12546	4905	5000'
64	Woss	12636	5012	3300'
65	Port Hardy	12722	5041	5000'
66	Eutsuk Lake	12649	5318	
67	Tatelkuz Lake	12444	5318	
68	Fraser Lake	12450	5403	
69	St. James	12403	5425	
70	Burns Lake	12555	5420	1500'
71	Smithers	12711	5449	5000'
72	Kispiox	12744	5528	1530'
73	Germansen Landing	12441	5544	1500'
74	Moose Valley	12642	5644	
75	Liard River	12622	5931	6000'
76	Smith River	12626	5954	5000'
77	Daughney	13055	5828	
78	Jakut Village	12958	5750	
79	Burrage River	13012	5718	
80	Snippaker Creek	13046	5635	
81	Woodcock	12815	5504	5200'
82	Digby Island (Prince Rupert)	13027	5417	6000'

		Long.	Lat.	Length
83	Sandspit	13149	5315	5120'
84	Kitimat	12841	5403	
85	South Bentinck Arm	12640	5200	
86	Tulsequash	13336	5839	
87	Trophet River	12247	5758	6000'
88	Co-Beatton	12110	5752	
89	Beatton River	12123	5723	
90	Port Washington	12319	4849	
91	Fort St. John	12044	5617	6900'
92	Hudson Hope	12159	5602	5200'
93	Chetwynd	12128	5541	2600'
94	Lemoray	12230	5531	3500'
95	Cattermole	12312	5520	
96	Sukunka River	12157	5508	
97	Stony Lake	12034	5447	
98	Simmons	12238	5423	
99	Brown Lake	12125	5314	
100	McBride	12010	5319	3000'
101	Crescent Spur	12039	5334	2500'
102	Chilliwack	12157	4909	3210'
103	Pitt Meadows	12242	4913	2500'

SEAPLANE BASES:

		Long.	Lat.	Length
25	Gold River	12607	4941	10 mi.
26	Port Alberni	12449	4914	4 mi.
27	Sullivan Bay	12650	5053	5 mi.
28	Duncanby Landing	12739	5124	
29	Invermere	11603	5031	4 mi.
30	Bonaparte Lake	12031	5115	10 mi.
31	South Bentinck Arm	12640	5200	3 mi.
32	Shearwater	12805	5209	12 mi.

		Long.	Lat.	Length
33	Jedway	13115	5218	
34	Tasu	13206	5245	5 mi.
35	Juskatla	13218	5337	4 mi.
36	Silver City	12929	5528	3 mi.
37	Topley Landing	12608	5448	
38	Takla Landing	12559	5530	4.5 mi.
39	Butedale (Lake)	12840	5308	
40	Moyie Lake	11550	4922	3 mi.

SPECIES:

1 B
2 BH
3 BS
4 C
5 CF
6 CH
7 DeC
8 F
9 FC
10 FDeC
11 FH
12 FL
13 FPI
14 FPy
15 FS
16 H
17 HB
18 HC
19 HDeC
20 HF
21 HS
22 L
23 LF
24 PL
25 PLDeC
26 PLF
27 PLS
28 Pw
29 Py
30 S
31 SB
32 SDeC
33 SF
34 SH
35 SPI
99 Other

MANITOBA

REGIONS AND DISTRICTS:

Region 1 Southern

District	1	Spragve
	2	Hadashville Braintree
	3	Piney
	4	Marchand
	5	Dawson
	6	Whitemouth
	7	Netley
	8	Steinbach
	9	Delta
	10	Pembina
	11	Whiteshell Prov. Park

Region 2 Western

District	1	Killarney
	2	Brandon
	3	Virden
	4	Neepawa
	5	Roblin
	6	Dauphin
	7	Grandview
	8	Garland
	9	Winnipegos Is
	10	Minitonas
	11	Swan River
	12	Birch River
	13	Mafeking
	14	Riding Mtn. Nat. Park

Region 3 Eastern

District	1	Grand Rapids
	2	Lac Du Bonnet
	3	Gypsumville
	4	Ashern
	5	Hodgson
	6	Oak Point
	7	Riverton
	8	Bissett
	9	Pine Falls
	10	Lake Winnipeg East

Region 4 Northern

District	1	Thompson
	2	Gods Narrows
	3	Island Lake
	4	Norway House
	5	Wabowden
	6	Cranberry Portage
	7	The Pas
	8	Channing
	9	Snow Lake
	10	Sherridow
	11	Cormorant
	12	Lynn Lake
	13	Ilford

GROUND STATIONS:

		Long.	Lat.
1	Sprague	9539	4904
2	Hadashville	9553	4941
3	Piney	9559	4905
4	Marchand	9624	4926

GROUND STATIONS: (Cont.)

		Long.	Lat.
5	Richer	9628	4940
6	Whitemouth	9559	4956
7	Netley	9657	5022
8	Steinback	9641	4932
9	Portage la Prairie	9817	4959
10	Killarney	9939	4911
11	Brandon	9957	4950
12	Virden	10056	4950
13	Neepawa	9928	5014
14	Roblin	10120	5113
15	Dauphin	10002	5109
16	Grandview	10042	5111
17	Garland	10028	5139
18	Winnipegosis	9957	5139
19	Manitonas	10104	5205
20	Swan River	10115	5206
21	Birch River	10106	5223
22	Mafeking	10106	5241
23	Grand Rapids	9917	5310
24	Lac du Bonnet	9603	5016
25	Gypsumville	9838	5146
26	Ashern	9820	5111
27	Hodgson	9735	5113
28	Oak Point	9801	5030
29	Riverton	9700	5100
30	Bissett	9543	5102
31	Pine Falls	9613	5035
32	Thompson	9751	5545
33	Gods Narrows	9429	5433
34	Island Lake	9446	5358
35	Norway House	9751	5359
36	Wabowden	9838	5455
37	Cranberry Portage	10123	5435
38	The Pas	10114	5349
39	Channing	10149	5445
40	Snow Lake	10001	5453
41	Lynn Lake	10104	5651

AIRPORTS:

		Long.	Lat.	Length
1	Brandon	9757	4955	5700'
2	Dauphin	10003	5106	5000'
3	Killarney	9941	4909	2164'
4	Neepawa	9930	5014	2750'
5	Netley	9659	5022	5290'
6	Portage la Prairie	9818	4959	2800'
7	St. Andrews	9702	5004	3000'
8	Selkirk	9652	5010	2000'
9	Swan River	10115	5207	3800'
10	Virden	10055	4953	3500'
11	Winnipeg Int.	9714	4954	11000'
12	Flin Flon	10141	5441	5000'
13	The Pas	10106	5358	6325'
14	Thompson	9752	5548	5400'
15	Churchill	9404	5845	9200'
16	Gillam	9442	5622	5000'
17	Lynn Lake	10104	5652	5000'

SEAPLANE BASES:

		Long.	Lat.	Length
1	Barrens River	9701	5221	1.5 mi.
2	Gimli	9658	5036	1.5 mi.
3	Lac du Bonnet	9603	5016	3.5 mi.
4	Little Grand Rapids	9528	5203	2 mi.
5	Negginan	9717	5300	
6	River Crest	9703	5000	2 mi.
7	Riverton	9700	5100	1.5 mi.
8	Beaver Hill Lake	9451	5421	5 mi.
9	Channing	10150	5445	1.5 mi.
10	Cross Lake	9747	5437	1 mi.
11	Gods River	9405	5450	2.2 mi.
12	Grace Lake	10112	5349	2.5 mi.
13	Island Lake	9441	5352	1.5 mi.
14	Nelson House	9852	5547	
15	Norway House	9750	5359	2 mi.
16	Oxford House	9517	5457	3 mi.
17	Red Sucker Lake	9335	5409	
18	Sherridon	10107	5507	5 mi.
19	Thompson	9750	5545	1.5 mi.
20	Wabowden	9837	5455	1 mi.
21	Brochet	10140	5753	2.5 mi.
22	Churchill	9403	5842	1 mi.
23	Ilford	9538	5604	2.2 mi.
24	Lynn Lake	10101	5649	2.5 mi.
25	South Indian Lake	9857	5647	2 mi.

SPECIES:

Same codes as for Ontario.

NEW BRUNSWICK

REGIONS AND DISTRICTS:

Region 1 (1)

District 1 to 12 1 to 12

Region 2 (2)

District 1 1
3 to 11 3 to 11

Region 3 (3)

District 1 to 10 1 to 10

Region 4 (4)

District 1 to 8 1 to 8

Region 5 (5)

District 1 to 5 1 to 5

NOTE: A year after data processing was complete, New Brunswick was reorganized into 7 regions.

GROUND STATIONS:

		Long.	Lat.
1	Kedgwick River	6729	4740
2	St. Quentin	6724	4731
3	Kedgwick	6721	4739
4	Glenwood	6701	4751
5	St. Arthur	6646	4754
6	Balmoral	6626	4758
7	Campbellton	6629	4741
8	Nash Creek	6605	4755
9	Petit Rocher	6543	4748
10	Bathurst	6540	4737
11		6517	4741
12	Bertrand	6504	4745
13	Pointe Canot	6441	4750
14	Tracadie	6455	4731
15	Allardville	6529	4729
16	St. Laurent	6507	4714
17		6524	4715
18		6551	4710
19	Riley Rock	6713	4710
20		6732	4708

		Long.	Lat.
21	St. André Madawaska	6746	4706
22	St. Leonard	6755	4710
23	Montage de la Croix	6802	4721
24	Edmundston	6808	4724
25	Plourd	6821	4728
26	Baker Brook	6831	4719
27	Connors	6850	4713
28	Perth	6742	4644
29	Plaster Rock	6724	4654
30	Juniper	6713	4633
31	Doaktown	6609	4633
32	Sunny Corner	6549	4657
33	Renous	6548	4649
34	Blackville	6550	4644
35		6525	4655
36	Rogersville	6525	4644
37	St. Louis de Kent	6458	4628
38	Harcourt	6515	4628
39	Buctouche	6443	4628
40	Port Elgin	6405	4603

GROUND STATIONS: (Cont.)

		Long.	Lat.
41	Moncton	6448	4605
42	East Canaan	6522	4605
43	Chipman	6553	4611
44	Minto	6605	4605
45	Boiestown	6625	4628
46	Stanley	6644	4617
47	Gordonsville	6730	4629
48	Canterbury	6728	4553
49	McAdam	6723	4535
50	Lake George	6702	4551
51	Fredericton	6639	4557
52	Tracy	6642	4541
53	Coles Island	6547	4555
54	Hampton	6550	4532
55	Sussex	6531	4543
56	Petitcodiac	6511	4556
57	Hillsborough	6439	4556
58	Loch Lomond	6552	4520
59		6613	4515
60	Welsford	6621	4527
61	St. George	6649	4508
62	Lawrence Station	6713	4526
63	Oak Bay	6712	4514
64	Castalia	6645	4444
65	Miramichi	6510	4702
66	Bransfield	6454	4705
67	Newcastle	6534	4700
68	Fundy National Park		
69	Camp Gagetown		

AIRPORTS:

		Long.	Lat.	Length
1	Hornes Gulch	6744	4749	
2	Grog Brook	6707	4748	
3	MacFarlane	6820	4735	
4	Budworm City	6637	4732	
5	Rose Hill	6543	4735	
6	Nictau	6708	4714	
7	Sevogle	6610	4712	
8	Tabu	6526	4720	
9	Renous	6634	4657	
10	Taxis	6632	4627	
11	Kesnac	6708	4605	
12	Boston Brook	6738	4727	
13	Charlo	6622	4758	4000'
14	Bathurst	6542	4740	4000'
15	Edmundston	6828	4729	4200'
16	Grand Falls	6742	4704	2600'
17	Woodstock	6732	4609	2000'
18	Juniper	6710	4634	
19	Dunphy	6553	4639	
20	Chipman	6553	4609	
21	St. Stephen	6715	4513	3000'
22	Trout Brook	6527	4628	
23	Buctouche	6442	4632	3000'
24	Chatham	6527	4701	10000'
25	Moncton	6441	4607	8000'
26	St. John	6553	4519	7000'
27	Fredericton	6637	4557	6000'
28	Pennfield	6642	4512	5010'
29	Scoudouc	6434	4610	

SEAPLANE BASES:

There are no liscensed seaplane bases in New Brunswick.

SPECIES:

1 Non Forest
2 Swamp or Bog
3 Grass or Range
4 More than 75% Pure Softwood
5 50-75% Pure Softwood
6 Mixtures with Hardwood Species Common
7 Pure Softwood and Pure Hardwood Types Mixed
8 Intermixed Softwood and Hardwood Species
9 Mixtures with Softwood Species Common
10 50-75% Pure Hardwood

NEWFOUNDLAND AND LABRADOR

REGIONS AND DISTRICTS:

Region 1 South East Newfoundland

District
1 Avelon East
2 Avelon West
3 Burin
4 Clarenville
5 Port Rexton

Region 2 Central Newfoundland

District
1 Bay D'Espoir
2 Gambo
3 Lewisporte
4 Botwood
5 Springdale

Region 3 Western Newfoundland

District
1 St. Georges
2 Corner Brook
3 Bonne Bay
4 Port Saunders
5 St. Antony

Region 4 Labrador

District
1 Labrador

GROUND STATIONS:

		Long.	Lat.
1	Cape Broyle	5257	4706
2	Lawrence Pond	5253	4728
3		5320	4714
4	Whitbourne	5332	4728
5	Winteland	5518	4709
6	Clarenville	5358	4810
7	Port Rexton	5320	4823
8	Head Bay D'Espoir	5545	4756
9		5400	4829
10	Gambo	5414	4846
11	Gander	5431	4853
12	Glen Wood	5452	4900
13	Lewisporte	5504	4915
14	Botwood	5521	4909
15	Grand Falls	5540	4856
16	Badger	5602	4859
17	Millertown	5633	4849
18	South Brook	5606	4925
19	Robinson's	5848	4815
20	Skallop Cove	5832	4825
21	Corner Brook	5757	4857
22	Wild Cove Pond	5823	4903
23	Midland	5743	4900
24	Junction Brook	5725	4912
25	Sop's Arm	5653	4947
26	Woody Point	5756	4930
27	Port Saunders	5717	5039
28	Roddickton	5608	5053
29	Goose Bay	6025	5321
30	Churchill Falls	6406	5333
31	Labrador City	6653	5256
32	Cartwright	5701	5343

AIRPORTS:

		Long.	Lat.	Length			Long.	Lat.	Length
1	Deer Lake	5724	4913	5000'	5	Torbay	5245	4737	8500'
2	Gander Int.	5434	4857	8900'	6	Churchill Falls	6407	5334	5500'
3	St. Anthony	5549	5129	3000'	7	North West River	6009	5332	2500'
4	Stephenville	5833	4832	10000'	8	Wabush	6652	5255	6000'

SEAPLANES BASES:

		Long.	Lat.	Length			Long.	Lat.	Length
1	Baie Verte	5611	4957	3 mi.	3	South Brook	5738	4901	8 mi.
2	Gander	5433	4856	4000'	4	Goose Bay	6024	5322	1.6 mi.

SPECIES:

1	Barren, Brush, Marsh, Grassland	12	Hard Maple
4	White Pine	13	Yellow Birch
5	Red Pine	14	White Birch
6	Jack Pine	15	Poplar
7	Spruce	16	Other Hardwoods, Trembling Aspen, Ash
8	Balsam Fir	17	Conifer
9	Hemlock	18	Deciduous
10	Other Conifers, Cedar, Tamarak, Juniper	19	Oak
11	Mixed Wood		

NOVA SCOTIA

REGIONS AND DISTRICTS:

Region	1	(Sub 5)	Region	7	(Sub 3)
Region	2	(Sub 6)	Region	8	(Sub 1)
Region	3	(Sub 4)	Region	9	(Sub 1)
Region	4	(Sub 3)	Region	10	(Sub 7)
Region	5	(Sub 2)	Region	11	(Sub 7)
Region	6	(Sub 2)			

There were no districts for Nova Scotia.

GROUND STATIONS:

		Long.	Lat.			Long.	Lat.
1	Chester Grant	6419	4437	12	Musquodoboit Harbour	6309	4447
2	Bridgewater	6439	4424	13	Middle Musquodoboit	6309	4503
3	McGowan Lake	6504	4426	14	Truro	6319	4522
4	Minton	6445	4404	15	Chignecto	6427	4536
5	Shelburne	6519	4345	16	MacLellan Brook	6236	4533
6	Kemptville	6550	4403	17	Upper Manchester	6131	4527
7	Hillgrove	6548	4431	18	Baddeck	6046	4605
8	Lawrence Town	6510	4453	19	Coxheath	6015	4606
9	Stanley	6355	4508	20	North East Margaree	6101	4620
10	Lewis Lake	6351	4441	21	Big Lease	6046	4623
11	Lake William	6335	4446	22	Lake George	6441	4454

AIRPORTS:

		Long.	Lat.	Length			Long.	Lat.	Length
1	Indian Fields	6528	4403		4	Middle Field	6551	4414	
2	Waterville	6439	4503	2300'	5	Stanley	6356	4506	3000'
3	Hillgrove	6549	4433		6	Shubenacadie	6324	4506	1800'

AIRPORTS: (Cont.)

		Long.	Lat.	Length			Long.	Lat.	Length
7	Debert	6328	4525	5000'	14	Margaree	6100	4620	2000'
8	Chignecto Sanctuhry	6426	4535		15	Yarmouth Airport	6605	4350	6000'
9	Plymouth	6240	4532		16	Greenwood Base	6455	4459	8000'
10	Hopewell	6243	4528	2000'	17	Sheerwater Base	6331	4438	7000'
11	Edden Barrens	6215	4521		18	Halifax Int. Airport	6331	4453	8800'
12	Purl Brook	6202	4534		19	Trenton Airport	6237	4537	3100'
13	Marianna	6049	4613		20	Sydney Airport	6000	4610	7070'

SEAPLANE BASES:

1	Dauphinee	6406	4439	1.5 mi.	2	Waverley	6336	4447	1.7 mi.

SPECIES:

1	Softwood	5	Barren
2	Hardwood	6	Agricultural
3	Mixedwood	7	Unknown
4	Cutover	8	Grass

ONTARIO

REGIONS AND DISTRICTS:

Region 1 (Chapleau)

- District 1 Biscotasing
- 2 Chapleau
- 3 Foleyet

Region 2 (Cochrane)

- District 1 Cochrane
- 2 Timmins
- 3 Wade Lake

Region 3 (Fort Frances)

- District 1 Fort Frances
- 2 Atikokan

Region 4 (Geraldton)

- District 1 Geraldton
- 2 Longlac
- 3 MacDiarmid
- 4 Nakina
- 5 Terrace Bay

Region 5 (Kapuskasing)

- District 1 Hearst
- 2 Hornepayne
- 3 Kapuskasing

Region 6 (Kemptville)

- District 1 Lanark

Region 7 (Kenora)

- District 1 Dryden
- 2 Kenora

Region 8 (Lake Huron)

- District 1 Bruce
- 2 Out of Fire Protected Boundry

Region 9 (Lake Simcoe)

- District 1 Severn

Region 10 (Lindsay)

- District 1 Gooderham
- 2 Minden
- 3 Out of Fire Protected Boundry

Region 11 (North Bay)

- District 1 North Bay
- 2 Timagami

Region 12 (Parry Sound)

- District 1 Bracebridge
- 2 Parry Sound
- 3 Powassan

Region 13 (Pembroke)

- District 1 Pembroke
- 2 Stonecliffe
- 3 Whitney

Region 14 (Port Arthur)

- District 1 Armstrong
- 2 Port Arthur
- 3 Shebandowan

REGIONS AND DISTRICTS: (Cont.)

Region 15 (Sault Ste. Marie)

District 1 Blind River
2 Kirkwood
3 Sault Ste. Marie

Region 16 (Sioux Lookout)

District 1 Ignace
2 Pickle Lake
3 Red Lake
4 Sioux Lookout

Region 17 (Sudbury)

District 1 Espanola
2 Skead
3 Sudbury
4 Gogama
5 Out of Fire Protected Boundry

Region 18 (Swastika)

District 1 Elk Lake
2 Matheson
3 Swastika

Region 19 (Tweed)

District 1 Bancroft
2 Dacre
3 Tweed
4 Out of Fire Protected Boundry

Region 20 (White River)

District 1 Wawa
2 White River

Region 21 (Out of Fire Protected Boundry)

District 1 Out of Fire Protected Boundry

GROUND STATIONS:

		Long.	Lat.
1	Biscotasing	8207	4718
2	Sultan	8247	4736
3	Chapleau	8324	4750
4	Missanabie	8406	4820
5	Wrong Lake	8322	4821
6	Joleyet	8226	4805
7	Elsas	8255	4832
8	Opishing	8151	4814
9	Cochrane	8102	4904
10	Smooth Rock	8137	4917
11	Moosonee	8040	5118
12	Timmins	8120	4830
13	Cattle Lake	8054	4835
14	Wade Lake	8034	4903
15	Eades	7952	4858
16	Nellie Lake	8047	4846
17	Fort Frances	9323	4837
18	Rainy River	9433	4844
19	Nym Lake	9128	4842
20	Geraldton	8659	4944
21	Longlac	8624	4927
22	Hillsport	8534	4927
23	MacDiarmid	8808	4927
24	Nakina	8643	5011
25	Pays Plat	8733	4853
26	Marathon	8623	4844

GROUND STATIONS: (Cont.)

No.	Station	Long.	Lat.
27	Killala Lake	8631	4908
28	Terrace Bay	8706	4847
29	Hearst	8340	4942
30	Rogers	8409	4958
31	Hornepayne	8448	4914
32	Oba	8407	4904
33	Kapuskasing	8226	4925
34	Lanark	7623	4502
35	Limerick	7539	4453
36	Larose	7509	4525
37	National Capital	7543	4525
38	Dryden	9248	4948
39	Vermillion Bay	9323	4952
40	Cedar Lake	9312	5008
41	Kenora	9426	4947
42	Sioux Narrows	9406	4924
43	Nester Falls	9355	4906
44	Minaki	9440	5000
45	Owen Sound	8056	4434
46	Miller Lake	8132	4504
47	Severn Falls	7936	4453
48	Gooderham	7824	4454
49	Adsley	7806	4445
50	Minden	7844	4456
51	Haliburton	7830	4503
52	Burnt River	7843	4441
53	North Bay	7928	4620
54	Marten River	7949	4644
55	Haddo	8019	4614
56	Kelvin	7850	4616
57	Jield	8003	4632
58	Timagami	7947	4704
59	Atchford	7947	4720
60	Bear Island	8005	4659
61	Lady Evelyn	8015	4723
62	Brace Bridge	7919	4502
63	Dorset	7854	4514
64	Parry Sound	8003	4521
65	Byng Inlet	8033	4545
66	Powassan	7921	4605
67	Loring	8000	4553
68	Pembroke	7708	4549
69	Achray	7745	4552
70	Round Lake	7734	4539
71	Stonecliffer	7754	4612
72	Kiosk	7853	4606
73	Whitney	7815	4529
74	West Gate	7851	4520
75	Armstrong	8902	5020
76	Black Sturgeon	8854	4921
77	Port Arthur	8912	4827
78	Nipigon	8816	4902
79	Sibley	8844	4827
80	Shebandowan	9001	4837
81	Upsala	9030	4903
82	Saganaga	9052	4815
83	Blind River	8259	4612
84	Peshu Lake	8316	4653
85	Mount Lake	8243	4638
86	Elliot Lake	8238	4624
87	Kirkwood	8330	4620
88	Sault Ste. Marie	8420	4632
89	Pancake Bay	8542	4658
90	Ranger Lake	8337	4652
91	Ignace	9140	4926
92	Pickle Lake	9010	5130
93	Red Lake	9340	5059
94	Ear Falls	9314	5040
95	Sioux Lookout	9154	5007
96	Espanola	8146	4615
97	Massey	8206	4613
98	Skead	8045	4640
99	Sudbury	8101	4630
100	Stinson	8043	4631
101	Windy Lake	8128	4637
102	Jamot	8035	4607

GROUND STATIONS: (Cont.)

		Long.	Lat.
103	Penage	8121	4617
104	Gogama	8144	4742
105	Ronda	8112	4737
106	Elk Lake	8021	4744
107	Gowganda	8046	4741
108	Matachewan	8037	4758
109	Matheson	8028	4833
110	Swastika	8006	4807
111	Larder Lake	7944	4806
112	Englehart	7952	4750
113	Englehart Mu	7952	4750
114	Bancroft	7752	4503
115	Gilmour	7736	4450
116	Dacre	7659	4522
117	Pleuna	7659	4458
118	Palmer Rapids	7731	4519
119	Tweed	7719	4429
120	White Lake	7629	4522
121	Wawa	8449	4801
122	Franz	8425	4828
123	Red Rock	8457	4742
124	Agawa Bay	8436	4720
125	White River	8516	4535
126	Manitouwadge	8546	4908
127	White Lake	8545	4838

AIRPORTS:

		Long.	Lat.	Length
1	Armstrong	8854	5017	3790'
2	Arnprior	7622	4525	2765'
3	Bonnechere	7736	4540	6600'
4	Camp Petawawa	7718	4555	2025'
5	Earlton	7951	4742	6000'
6	Gore Bay	8234	4553	6000'
7	Kapuskasing	8228	4925	3740'
8	Kenora	9422	4948	4000'
9	Lakehead	8919	4822	6200'
10	Muskoka	7918	4458	6000'
11	North Bay	7925	4622	10000'
12	Sault Ste. Marie	8430	4629	6000'
13	Sioux Lookout	9154	5007	2800'
14	Sudbury	8048	4637	6600'
15	Timmins	8122	4834	5700'
16	Wiarton	8106	4445	6009'
17	Atikokan	9131	4849	3000'
18	Azilda	8109	4638	
19	Bancroft	7753	4504	2400'
20	Blind River	8250	4611	
21	Bracebridge	7926	4505	
22	Cobden	7650	4536	2300'
23	Donald	7831	4458	
24	Douglas	7650	4530	
25	Dryden	9256	4946	3000'
26	Eagle River	9308	4945	2200'
27	Emsdale	7921	4533	2500'
28	Fort Frances	9327	4839	2200'
29	Foxborough	7725	4417	
30	Graham	9035	4916	5950'
31	Griffith Island	8059	4450	
32	Hearst	8340	4940	3000'
33	Ignace	9146	4931	2300'
34	Sellicoe	8735	4940	3000'
35	Lake of Two Rivers	7830	4534	2400'
36	Moosewee	8027	5128	3000'

AIRPORTS: (Cont.)

		Long.	Lat.	Length
37	Nakina	8642	5011	4000'
38	Owen Sound	8058	4437	2400'
39	Barrie	7944	4424	
40	Parry Sound	7958	4523	2500'
41	Pembroke	7715	4552	4250'
42	Bigwin Island	7901	4515	2200'
43	Brantford	8021	4308	4000'
44	South River	7920	4549	2975'
45	Vermillion Bay	9326	4953	3300'
46	Brockville	7545	4438	2716'
47	Bobcaygeon	7832	4433	
48	Collingwood	8010	4427	3300'
49	Goderich	8142	4346	3800'
50	Haliburton	7828	4508	1500'
51	Kirkland Lake	7954	4813	
52	Marathon	8622	4845	4500'
53	Red Lake	9349	5104	4000'
54	Wawa	8447	4758	4600'
55	Hamilton	7956	4310	6000'
56	Hanover	8104	4410	2000'
57	Kingston	7636	4413	2946'
58	Lindsay	7847	4422	1800'
59	Listowel	8100	4342	2600'
60	London	8109	4302	6000'
61	Morrisburg	7705	4457	1500'
62	Cornwall	7447	4508	2400'
63	Nixon	8024	4251	2050'
64	Orangeville	8001	4354	1900'
65	Oshawa	7854	4356	3476'
66	Ottawa Int. Airport	7540	4519	10000'
67	Pendleton	7506	4529	2650'
68	Peterborough	7821	4414	5000'
69	Picton	7709	4359	2580'
70	Port Elgin	8125	4425	3000'
71	St. Catharines	7910	4311	5000'
72	Sarnia	8218	4300	4000'
73	Smith Falls	7556	4457	3150'
74	Stratford	8102	4319	2000'
75	Tobermory	8138	4514	3400'
76	Toronto Int.	7938	4341	11050'
77	Waterloo-Wellington	8023	4327	4100'
78	Windsor	8258	4216	7900'
79	Wingham	8120	4354	3000'
80	Chatham	8205	4218	3600'

SEAPLANE BASES:

		Long.	Lat.	Length
1	Kenora	9429	4945	2 mi.
2	Fort Frances	9321	4837	2 mi.
3	Sioux Lookout	9155	5005	3 mi.
4	Red Lake	9350	5102	5 mi.
5	Pickle Crow	9011	5128	2.1 mi.
6	Armstrong	8903	5015	3 mi.
7	Port Arthur	8910	4827	2 mi.
8	Crystal Lake	9116	4843	3 mi.
9	Geralton	8655	4942	2 mi.
10	Pays Plat	8734	4853	Unlimited
11	Hearst	8402	4945	1 mi.
12	White River	8514	4839	1.5 mi.
13	Chapleau	8324	4751	1.3 mi.
14	Kapuskasing	8209	4924	3 mi.
15	Timmins (South Porcupine)	8112	4829	2 mi.
16	Swastika (Kirkland Lk.)	8013	4806	3.5 mi.
17	Gogama	8142	4741	2 mi.
18	Sault Ste. Marie	8419	4630	3.5 mi.
19	Blind River (Algoma)	8250	4611	4 mi.
20	Sudbury	8059	4628	1.5 mi.

SEAPLANE BASES: (Cont.)

		Long.	Lat.	Length			Long.	Lat.	Length
21	Timagami	7950	4703	2 mi.	24	Tweed	7718	4429	
22	Parry Sound	8002	4920	2 mi.	25	Toronto	7924	4338	1.7 mi.
23	Pembroke	7708	4550						

SPECIES:

1 Non Forest, Dump
2 Swamp, Bog, Muskeg
3 Grass or Range
4 White Pine
5 Red Pine
6 Jack Pine
7 Spruce
8 Balsam Fir
9 Hemlock
10 Other Conifers, Cedar, Tamarack, Juniper
11 Mixed Wood
12 Hard Maple
13 Yellow Birch
14 White Birch
15 Poplar
16 Other Hardwoods, Trembling Aspen, Ash
17 Conifer
18 Deciduous
19 Oak

QUEBEC

REGIONS (SOCIETES DE CONSERVATION):

Région 1 (Gaspésie)

Région 2 (Sud du Québec)

Région 3 (Québec - Mauricie)

Région 4 (Côte-Nord)

Région 5 (Saguenay-Lac St. Jean)

Région 6 (Outaouais)

Région 7 (Nord-Ouest)

*District information was not available at this time due to organizational changes within the province

GROUND STATIONS:

		Long.	Lat.
1	Cowansville	7245	4512
2	Bromptonville	7156	4528
3	Ville-St-Georges	7041	4607
4	Plessisville	7147	4613
5		7027	4702
6		7314	4628
7	Hervey-Jonction	7228	4651
8		7304	4658
9	Lac-Édouard	7217	4739
10	Clermont	7013	4741
11		7306	4803
12		7424	4856
13	Sanmaur	7348	4753
14	Ta Tuque	7247	4726
15	St-Michel-des-Saints	7355	4640
16		7141	4652
17	Québec	7114	4651
18	Lévis	7110	4648
19	St-Jovite	7436	4607
20	Hull	7545	4526
21	Wakefield	7555	4538
22	Maniwaki	7558	4622
23	Fort-Coulonge	7644	4550
24		7703	4726
25		7438	4755
26	Kipawa	7900	4647
27	Noranda	7902	4814
28	Senneterre	7715	4823
29	Ferland	7051	4811
30	Matagami	7738	4944
31	Chicoutimi	7104	4825
32		7025	4824
33		7100	4834
34	Roberval	7213	4830
35	Dolbeau	7214	4852
36	Girardville	7233	4901
37	Ailleboust	7317	4859
38		7407	4926
39	Chibougamau	7421	4953
40		7102	4902
41	Chute-des-Passes	7116	4953
42		7307	5057

<u>GROUND STATIONS: (Cont.)</u>

		Long.	Lat.
43	Labrieville	6933	4918
44	Les Escoumins	6925	4821
45	Rivière-Bersimis	6842	4855
46	Forestville	6904	4845
47	Micoua	6845	4942
48		6850	4957
49	St-Jean - Port-Joli	7016	4713
50	St-Pacôme	6956	4724
51	Cabano	6853	4740
52		6929	4756
53	Matapedia	6656	4758
54		6827	4811
55	St-Eleuthère	6918	4729
56	Rimouski	6831	4827
57	Causapscal	6714	4821
58	Amqui	6726	4828
59	Carleton	6608	4812
60	New Carlisle	6520	4801
61	Grand Cascapedia	6554	4815
62	Chandler	6441	4821
63	Gaspé	6428	4850
64		6500	4912
65	Mont-Louis	6544	4914
66	Cap-Chat	6641	4905
67	Matane	6731	4851
68	Baie-Comeau	6809	4914
69	Rivière Pentecôte	6711	4947
70	Port-Cartier	6652	5002
71	Moisie	6606	5011
72	Clarke City	6639	5012
73	Rivière-au-Tonnerre	6447	5017
74	Havre-St-Pierre	6338	5015
75	Gagnon	6810	5154
76		6730	5239
77	Murdochville	6530	4858

<u>AIRPORTS (Licensed):</u>

		Long.	Lat.	Length
1	Amos Municipal	7814	4834	3050'
2	Asbestos	7159	4548	3000'
3	Beloeil	7314	4535	2400'
4	Charlevoix	7014	4736	4500'
5	Bromont	7245	4517	4000'
6	Cranson Lake	7659	4549	2600'
7	Joliette	7330	4603	3000'
8	Lachute	7422	4538	4200'
9	Lambton	7106	4550	2350'
10	Montmagny	7030	4700	1500'
11	Oriskany	7339	4729	4500'
12	Quevillon	7701	4902	4000'
13	Rouyn	7850	4813	5600'
14	St-Jean-Chrysostome	7109	4641	3000'
15	St-Jovite	7435	4609	3250'
16	St-Louis-de-France	7238	4626	2000'
17	Senneterre	7711	4820	5000'
18	Fort George	7900	5349	4000'
19	Alma	7139	4831	4300'
20	Forestville	6906	4844	6000'
21	Manicouagan	6850	5039	5500'
22	Baie-Comeau	6812	4908	6000'
23	Gagnon	6808	5157	5280'
24	Harrington Harbour	5938	5028	2000'
25	Havre-St-Pierre	6335	5015	4000'
26	Lourdes-du-Blanc Sablon	5711	5127	3400'
27	Natashquan	6148	5011	4000'
28	Rivière-au-Tonnerre	6445	5017	4000'
29	St-Augustin	5114	5841	2000'
30	Sept-Iles	6616	5013	6572'
31	Fort-Chimo	6826	5806	6000'
32	Schefferville	6649	5448	4600'
33	Gaspé	6429	4846	4000'
34	Matane	6733	4851	3500'
35	Mont-Joli	6812	4836	6000'
36	New Richmond	6554	4811	3000'

AIRPORTS (Licensed) (Cont.):

		Long.	Lat.	Length
37	Port-Menier	6417	4950	4000'
38	Riviére-du-Loup	6935	4746	6000'
39	Ste-Anne-des-Monts	6632	4907	4600'
40	House Harbour	6147	4725	3725'

SEA PLANE BASES (Licensed):

		Long.	Lat.	Length
1	Amos	7807	4830	1.5 MI.
2	Brompton Lake	7209	4527	7 MI.
3	Cranson Lake	7659	4549	2 MI.
4	Drummondville	7223	4551	1.5 MI.
5	Hull	7542	4526	2 MI.
6	La Sarre	7917	4848	2.25MI.
7	Lac-a-Beauce	7246	4719	3 MI.
8	Lac Achigan	7359	4556	3 MI.
9	Lac-a-la-Tortue	7237	4637	2.3 MI.
10	Lac-des-Ecorces	7525	4633	1.6 MI.
11	Lac des Oblats	7601	4620	2 MI.
12	Lac des Loups	7632	4703	1.8 MI.
13	Lac Kipawa	7858	4647	6 MI.
14	Lac St-Louis	7348	4633	1.7 MI.
15	Lac Simon	7505	4559	3 MI.
16	Lake Dufault	7901	4817	1.5 MI.
17	Ste-Anne-de-Bellevue	7356	4524	2 MI.
18	Ste-Anne-du-Lac	7519	4653	4 MI.
19	Sand Bay	7634	4532	2 MI.
20	Senneterre	7714	4824	3 MI.
21	Eastmain	7830	5215	4 MI.
22	Fort-George	7900	5350	2 MI.
23	Fort-Rupert	7845	5129	2 MI.
24	Matagami	7738	4944	4.5 MI.
25	Nouveau-Comptoir	7848	5300	1.1 MI.
26	Poste-de-la-Baleine	7745	5517	3 MI.
27	Roberval	7213	4832	
28	Dolbeau	7212	4852	1.5 MI.
29	Gilman Lake	7421	4955	1.3 MI.
30	Lac Sébastien	7108	4839	2 MI.
31	Baie-Comeau	6822	4913	3 MI.
32	Blanc Sablon	5711	5128	1.6 MI.
33	Harrington Harbour	5928	5030	2 MI.
34	Havre-St-Pierre	6333	5016	.8 MI.
35	Kegaska	6116	5011	1.8 MI.
36	La Tabatière	5859	5050	.9 MI.
37	Rapids Lake	6625	5018	3 MI.
38	Baie-Johan-Beetz	6248	5019	.9 MI.
39	Aguanish	6205	5013	1.03MI.
40	Fort-Chimo	6827	5808	2 MI.
41	Squaw Lake	6649	5450	2 MI.
42	Estcourt	6914	4728	7 MI.
43	Inoucdjouac	7809	5827	1 MI.
44	Povungnituk	7716	6002	1 MI.
45	Val-D'or	7747	4807	1.5 MI.
46	St-Jovite	7435	4610	1.25MI.
47	Québec	7112	4649	
48	Rimouski	6831	4828	
49	Gagnon	6810	5158	1.5 MI.

SPECIES :

1 Non-forest, dump
2 Swamp, bog, muskeg
3 Grass or range
4 More than 75% pure softwood
5 50-75% pure softwood
6 Mixtures with hardwood species common
7 Pure softwood and pure hardwood types mixed
8 Intermixed softwood and hardwood species
9 Mixtures with softwood species common
10 50-75% pure hardwood

SASKATCHEWAN

REGIONS AND DISTRICTS:

Region 1 (1400)

District	2	1401
	3	1402
	4	1403
	5	1404
	6	1405
	7	1406
	8	1407
	9	1408
	10	1409
	11	1410
	12	1411
	13	1412

Region 3 (1300)

District	1	1301
	2	1302
	3	1303
	4	1304
	5	1305
	6	1306
	7	1307
	8	1308

Region 2 (1200)

District	2	1201	
	3	1202	
	4	1203	
	5	1204	
	6	1205	
	7	1206	
	8	1207	
	9	1208	
	10	1209	
	11	1210	Prince Albert Nat. Park
	12	1211	
	13	1212	
	14	1213	
	15	1214	
	16	1215	
	17	1216	
	18	1217	

GROUND STATIONS:

		Long.	Lat.			Long.	Lat.
1	Pelly	10159	5152	8	Melfort	10436	5252
2	Sturgis	10236	5158	9	Spiritwood	10732	5322
3	Somme	10300	5235	10	Glaslyn	10819	5322
4	Loiselle Creek	10221	5248	11	St. Walburg	10911	5338
5	Armit	10150	5250	12	Loon Lake	10911	5402
6	Veillardville	10227	5253	13	Big River	10701	5351
7	Burntout Brook	10326	5257	14	Emma Lake	10521	5334

GROUND STATIONS: (Cont.)

		Long.	Lat.
15	Candle Lake	10519	5346
16	Smeaton	10453	5330
17	Arborfield	10339	5307
18	Montreal Lake	10543	5404
19	Molanosa	10534	5429
20	Doré Lake	10726	5440
21	Green Lake	10748	5418
22	Dorintosh	10836	5421
23	Buffalo Narrows	10830	5552
24	La Ronge	10517	5507
25	Pelican Narrows	10255	5510
26	Flin Flon	10155	5448
27	Kinoosac	10202	5704
28	La Loche	10927	5630
29	Uranium City	10837	5934
30	Meadow Lake	10823	5339
31	Ile à la Crosse	10750	5522
32	Prince Albert	10540	5314
33	Nipawin	10401	5322
34	Cumberland House	10218	5356
35	Stony Rapids	10553	5916

AIRPORTS:

		Long.	Lat.	Length
1	Biggar	10759	5203	2500'
2	Buffalo Narrows	10829	5551	3300'
3	Candle Lake	10515	5346	1640'
4	Canora	10227	5138	2800'
5	Carrot River	10333	5317	3000'
6	Colonsay	10554	5159	1755'
7	Cudworth	10544	5229	1350'
8	Doré Lake	10726	5437	1565'
9	Flin Flon (Man.)	10141	5441	5000'
10	Foam Lake	10327	5139	2100'
11	Hudson Bay	10223	5251	1200'
12	Ile à la Crosse	10754	5527	2800'
13	Island Falls	10252	5533	1000'
14	Kelvington	10331	5208	1932'
15	La Loche	10926	5629	2600'
16	La Ronge	10520	5505	4100'
17	Leoville	10733	5339	1861'
18	Lloydminister	10959	5318	3500'
19	Loon Lake	10909	5402	2000'
20	Yorkton	10228	5116	4800'
21	Maidstone	10919	5306	3100'
22	Meadow Lake	10824	5408	3200'
23	Melfort	10824	5408	3200'
24	Molanosa	10532	5429	1600'
25	North Battleford	10815	5246	5000'
26	Paradise Hill	10927	5332	1500'
27	Pelican Narrows	10256	5510	1100'
28	Pinehouse Lake	10636	5531	3300'
29	Prince Albert	10541	5313	5000'
30	No Airprot at Peter Pond			
31	Rose Valley	10348	5218	2640'
32	Saskatoon	10641	5210	8300'
33	Shellbrook	10622	5312	2000'
34	Smeaton	10452	5329	1500'
35	Tanley Mission	10434	5526	1175'
36	Stony Rapids	10550	5915	3680'
37	Uranium City	10829	5934	5000'
38	Wollaston Lake	10312	5807	4150'

SEAPLANE BASES:

		Long.	Lat.	Length
1	Pelican Narrows	10256	5510	2 mi.
2	Peter Pond	10858	5556	
3	Amisk	10205	5439	3 mi.
4	Doré Lake	10715	5442	
5	Fond-du-Lac	10710	5919	2 mi.
6	Green Lake	10748	5416	22 mi.
7	Ile à la Crosse	10754	5527	3 mi.
8	Islandfalls	10219	5531	5 mi.
9	Kinoosac	10202	5705	
10	La Ronge	10517	5506	2 mi.
11	Nipawin	10401	5324	1 mi.
12	Otter Lake	10446	5536	3 mi.
13	Pinehouse	10634	5532	
14	Saleski Lake	10925	5629	2 mi.
15	Southend	10313	5620	
16	Stony Rapids	10550	5916	1.5 mi.
17	Uranium City	10836	5934	1.5 mi.
18	Waskesiu Lake	10605	5355	3 mi.
19	Wollaston Lake	10310	5807	3 mi.

SPECIES:

1 Non Forest, Dump
2 Swamp, Bog, Muskeg
3 Grass or Range
4 White Pine
5 Red Pine
6 Jack Pine
7 Spruce
8 Balsam Fir
9 Hemlock
10 Other Conifer, Cedar, Tamarack, Juniper
11 Mixed Wood
12 Hard Maple
13 Yellow Birch
14 White Birch
15 Poplar
16 Other Hardwoods, Trembling Aspen, Ash
17 Conifer
18 Deciduous
19 Oak

YUKON AND NORTHWEST TERRITORIES

REGIONS AND DISTRICTS:

Region 1 Yukon

District

1	Watson Lake
2	Teslin
3	Tagish
4	Laberge
5	Haine Junction
6	Ross River
7	Carmacks
8	Beaver Creek
9	Mayo
10	Dawson
11	Old Crow

Region 2 Inuvik Forest

Region 3 Norman Wells Forest

Region 4 Fort Simpson Forest

Region 5 Ft. Liard Forest

Region 6 Yellowknife Forest

Region 7 Hay River Forest

Region 8 Ft. Smith Forest

Region 9 Caribou Range Forest

Region 10 Keewatin Forest

Region 11 Wood Buffalo National Park

GROUND STATIONS:

		Long.	Lat.
1	Forestry Lake	10528	6055
2	Porter Lake	10759	6141
3	Snowdrift	11040	6224
4	Fort Resolution	11342	6113
5	Fort Providence	11735	6122
6	Rae	11558	6249
7	Lac la Martre	11720	6310
8	Wrigly	12333	6317
9	Fort Norman	12534	6456
10	Fort Good Hope	12845	6615
11	Arctic Red River	13341	6729
12	Fort McPherson	13450	6728
13	Aklavik	13501	6815
14	Watson Lake	12842	6004
15	Teslin	13244	6010

		Long.	Lat.
16	MacRae	13510	6041
17	Haines	13731	6045
18	Beaver Creek	14055	6225
19	Carmacks	13616	6205
20	Ross	13308	6212
21	Dawson	13925	6403
22	Mayo	13554	6336
23	Fort Smith	11152	6000
24	Fort Liard	12329	6012
25	Nahanni Butte	12325	6102
26	Fort Simpson	12123	6152
27	Yellowknife	11421	6227
28	Inuvik	13343	6821
29	Hay River	11543	6051

AIRPORTS:

		Long.	Lat.	Length
1	Fort Resolution	11333	6109	4150'
2	Hay River	11552	6049	6000'
3	Yellowknife	11427	6226	7500'
4	Port Radium	11757	6607	
5	Fort Simpson	12120	6145	6000'
6	Wrigley	12328	6315	4220'
7	Norman Wells	12644	6518	6000'
*9	Inuvik	13329	6818	6000'
10	Fort Smith	11158	6001	7020'
11	Pine Point	11422	6051	4500'
12	Fort Providence	11736	6119	
13	Sawmill Bay	11855	6544	6700'
14	Fort Norman	12534	6455	3000'
28	Carmacks	13618	6206	2650'
29	Braeburn	13546	6129	3000'
30	Ross River	13226	6158	3600'
31	Squanga Lake	13329	6029	6000'
32	Pine Lake	13056	6006	6000'
33	Carcross	13442	6011	2800'
34	Collision Air Strip	13924	6406	
35	Faro	13400	6230	
36	Old Crow	13959	6736	

* 8 was not coded.

		Long.	Lat.	Length
15	Fort Good Hope	12836	6615	3000'
16	Dawson City	13905	6403	4000'
17	Mayo	13552	6337	3540'
18	Whitehorse	13504	6043	7200'
19	Watson Lake	12849	6007	5500'
20	Teslin	13245	6010	5500'
21	Aishihik	13729	6139	
22	Snag	14024	6222	
23	Burwash	13903	6122	6000'
24	Haines Junction	13733	6047	
25	Clinton	14044	6428	4200'
26	McQuesten	13724	6333	
27	Minto	13651	6235	
37	Cantung	12800	6200	
38	Bennett Field	12438	6502	5000'
39	Discovery	11354	6511	3000'
40	Fort Simpson Island	12122	6152	3000'
41	Tundra	11109	6404	3500'
42	Komakuk Beach	14011	6936	3500'
43	Mile 924	13511	6049	3000'
44	Mile 1167	14032	6159	1600'
45	Shingle Point	13714	6856	3785'

SEAPLANE BASES:

		Long.	Lat.	Length
1	Hay River	11546	6051	1 mi.
2	Yellowknife	11421	6226	3 mi.
3	Inuvik (Long Lake)	13331	6818	1.5 mi.
4	Aklavik	13500	6814	2.8 mi.
5	Arctic Red River	13345	6727	2.2 mi.
6	Cameron Bay	11752	6604	9900 '
7	Coppermine	11505	6750	1 mi.
8	Ferguson Lake	9651	6252	2 mi.
9	Fort Franklin	12325	6511	1.2 mi.
10	Fort Good Hope	12839	6616	2.2 mi.

		Long.	Lat.	Length
18	Norman Wells	12642	6512	1 mi.
19	Port Radium	11802	6605	3.5 mi.
20	Providence	11740	6121	2 mi.
21	Reindeer Station	13408	6842	2 mi.
22	Rocher River	11245	6124	2 mi.
23	Sawmill Bay	11855	6544	2.5 mi.
24	Wrigley	12336	6315	3.8 mi.
25	Carcross	13442	6011	2 mi.
26	Dawson	13926	6404	2.8 mi.
27	Mayo	13554	6335	1 mi.

SEAPLANE BASES (Cont.)

		Long.	Lat.	Length
11	Fort Liard	12328	6015	4 mi.
12	Fort McPherson	13453	6727	3 mi.
13	Fort Norman	12535	6454	1.5 mi.
14	Fort Rae	11604	6249	1.5 mi.
15	Fort Reliance	10910	6242	6.4 mi.
16	Fort Resolution	11341	6110	3 mi.
17	Fort Simpson	12122	6152	6.4 mi.

		Long.	Lat.	Length
28	Old Crow	13951	6734	
29	Teslin	13243	6010	9 mi.
30	Watson Lake	12848	6007	4 mi.
31	Whitehorse	13503	6042	1 mi.
32	Ross River	13231	6156	1 mi.
33	Herschel Is.	13855	6935	1.7 mi.

SPECIES:

0 Unknown
1 Non-Forest
2 Barren
3 Muskeg, Swamp or Bog
4 Grass
5 Deciduous (Larch, Tamarak, Softwood)
6 Conifer
7 Mixed
8 Black Spruce
9 White Spruce
10 Jack Pine
11 Poplar
12 Birch
13 Willow
14 Spruce

APPENDIX V

LIST OF VARIABLES USED IN THE GROUND SUPPRESSION SIMULATION

Variable	Definition	Measurement
1. AC	area at the time of control	acres
2. AD	area at detection	acres
3. ADMC	adjusted duff moisture code for the day (mid-afternoon)	
4. AF	area when the fire is declared out	acres
5. AFFT	average firefighting time for the nearest ground station (does not include night-time hours)	hours
6. AG	total free burning area growth	acres
7. ARLC	average rate of line construction for the nearest ground station	feet/hour
8. ARMU	average rate of mop-up for the nearest ground station	acres/hour
9. AS	area at the start of suppression	acres
10. ATC	average time to control for the nearest ground station	hours
11. ATMU	average time for mop-up and patrol for the nearest ground station	hours
12. C	total suppression cost	dollars
13. DC	drought code for the day (mid-afternoon)	
14. E(prefix)	used to denote an estimated or calculated variable - absence of the E indicates an observed variable	
15. ETC1	preliminary estimate of TC	hours
16. FRS	free burning forward rate of spread	feet/hour
17. FWI	fire weather index for the day (mid-afternoon)	
18. GR	free burning to suppression growth ratio (RPG/RPGS)	
19. PC	perimeter at the time of control	feet
20. PD	perimeter at detection	feet
21. PF	final perimeter when fire is declared out	feet
22. PGF	total free burning perimeter growth	feet
23. PGS	total perimeter growth during the suppression period	feet
24. PS	perimeter at the start of suppression	feet
25. RAG	free burning rate of area growth	acres/hour
26. RLC	rate of line construction	feet/hour
27. RMU	rate of mop-up and patrol	acres/hour
28. RPG	free burning rate of perimeter growth	feet/hour
29. RPGS	rate of perimeter growth during the suppression period	feet/hour
30. SFWI	fire weather index at the time of detection	
31. SSI	initial spread index at the time of detection	
32. ST	total time between detection and the start of suppression	hours
33. SXSI	grass spread index at the time of detection	
34. TC	time to control the fire	hours
35. TFS	total forward spread between detection and the start of suppression	acres/hour
36. TMU	time for mop-up and patrol	hours
37. TT	travel time	hours