STUDY STATEMENTS

1980-81

NORTHERN FOREST RESEARCH CENTRE

CANADIAN FORESTRY SERVICE

APRIL 1980

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1980 - 81

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: January 22, 1980

1. Project: Fire management systems and guidelines.

2. Title: Fire retardant and airtanker evaluations and application.

3. New: Cont.: X 4. No.: NOR-5-037

5. Study Leader: R. G. Newstead

6. Key Words: Airtankers, helitankers, retardants, aerial suppression, airtanker accuracy, effectiveness, drop patterns, static testing, tank and gating systems, simulation models, wildfires.

7. Location of Work: Throughout region.

8. Problem:

This operational research study is oriented towards the immediate needs and requests of client agencies, namely Provincial and Territorial Forest Services. The intent is to improve aerial suppression methods by optimizing the use and effectiveness of available airtankers, helitankers and retardants. Results from this study complement those of NOR-128, 131 and 130. Benefits accruing will include reductions in fire suppression costs, and areas burned as well as limiting damage to the forest resource by enhancing operational effectiveness in the control of wildfires by fire control agencies.

Through continuous cooperative effort and liaison with client agencies, the probability of application of study results will be high in the long run, although technological and financial considerations may somewhat affect the degree of utilization in the short run.

Results from this study will see almost immediate use because they will be aligned with present client policies, needs and objectives. Past experience supports this assessment.

Methods:

The methods associated with this study involve the use of a wide variety of fixed and rotary-wing airtankers normally employed in

fire suppression operations within the region. Similarly there are a variety of fire retardants, both long-term and short-term which form an integral part of this study. Retardant drop pattern tests, airtanker effectiveness evaluations, and fire retardant mixing, quality control and effectiveness investigations all involve closely integrated field and laboratory study procedures. Air drop grids are established and calibrated to determine drop patterns under controlled conditions and may involve the preparation and supervision of contractual arrangements. Airtanker and helicopter retardant delivery systems are evaluated under controlled test conditions on the air drop grid and on wildfire operations. Retardant mixing and application criteria are observed and evaluated in the combustion laboratory and during field operations for both existing and new retardant products. Much related data is accumulated and disseminated through cooperation with other fire operations and research agencies and through communication with client agencies.

9. Study Objectives:

1. To measure and evaluate the drop characteristics of various airtanker/fire retardant combinations, including helitankers.

2. To evaluate fire retardants and determine the optimum application required to slow and/or stop fires burning in different fuels under varying burning conditions.

3. To observe and evaluate the effectiveness of airtankers and helitankers and other fireline construction resources during fire suppression operations.

4. To evaluate new retardant mixing systems and their role on wildfire operations.

5. To analyze and disseminate information concerning resource use optimization to fire management agencies through technical assistance, consultation, and training.

10. Resources:

a. Starting date: 1968
b. Estimated year of completion: 1978 Revised: 1981
c. Estimated total Prof. man-years required: 0.5
d. Essential new major equipment items for 1980-81 with costs: Four (4) pressure sensitive transducers and digital output recorder - estimated total cost - $6,000.00
e. Essential new major equipment items beyond 1980 with costs: Nil
f. 1980-81 man-years

Prof.	0.5	(R. G. Newstead)
Supp.	1.0	(R. J. Lieskovsky)
Casual	-	
Total	1.5	

11. Progress to Date:

Fire retardants and other water modifying additives are in common use throughout the northern region. Investigations concerning retardant properties and quality control, airtanker delivery systems, retardant mixing and storage facilities, pilot accuracy and airtanker and helitanker drop patterns have resulted in more effective aerial fire control by user agencies.

Evaluation of on-site effectiveness of selected fire retardants on wildfires and prescribed fires has led to a better understanding of their role in fire control operations. Laboratory analyses and field trials concerning the chemical, physical and rheological properties of retardants and water thickening compounds and associated mixing equipment have provided necessary technical information to manufacturers and users alike. The results of these tests have enabled these organizations to make qualified decisions on the development and utilization of several commercial products. Guidelines on the selection and application of fire retardant and suppression compounds are being drafted in an effort to enhance this process.

The liaison and development functions of this study have effectively transferred technological achievements to regional, national and international forest fire research and suppression organizations.

Progress in the development of a computerized airtanker allocation model, the synthesis of ten years of airtanker drop pattern data, and three years of airtanker performance data is reported in the fire management systems Study NOR-5-174.

12. Goals for 1979-80:

1. Continue experimental burns at the Slave Lake black spruce plots as weather, logistics and Alberta Forest Service support permit. The effects of various durations of drying time on retardant effectiveness will be the primary variable under investigation. Up to six plots could be involved during this phase of the study.

2. Provide technical assistance to regional fire control agencies, specifically:

   a) Respond to a request from the Department of Northern Saskatchewan concerning factors affecting quality control, mixing and application of long-term retardants.

   b) At the request of the NWL & F Service, evaluate the Avalon Aviation on-board injection system proposed for use with Chemonics Ind. water thickening polymer.

c) In conjunction with the AFS, conduct static drop tests on the delivery systems of modified PBY and B-26 airtankers soon to be introduced to Alberta.

d) Provide additional training and consultation as requested.

3. Conduct retardant drop tests with Chemonics Ind. short-term liquid polymer water thickening compound with the B-26 airtanker to compensate for unsatisfactory results obtained in the 1978 Alberta tests.

4. Pending the availability of equipment development and technical assistance, complete construction and calibration of a retardant spray apparatus. Conduct initial tests on coating and penetration effects of different retardant rheological properties.

5. Prepare draft of development criteria and selection guidelines for short-term retardant products.

6. Complete final thesis manuscript and convocate from U of A masters program.

7. Review pre-1977 retardant drop test results and retardant chemicals summary sheet, convert all values to metric (SI) equivalents and prepare same for release and/or publication.

8. Publish:

Hodgson, M. J. and R. G. Newstead. 1978. "Wildfire and Airtanker Allocation," Annals, Ass'n of American Geographers (in review).

Goals Added:

9. Evaluate physical and rheological attributes of a synthetic liquid polymer water thickening compound as submitted for analysis by the Sanitek Corporation, Los Angeles, California.

10. Attend and/or serve on the following:

- Coast Fire Control Course sponsored by the Canadian Forestry Association, at Abbotsford, B. C., April 2 - 6, 1979.

- Fire retardant workshop sponsored by Chemonics Industries (Canada) Ltd. at Kamloops, B. C., April 17 - 20, 1979.

- National Air Attack workshop sponsored by the Canadian Committee on Forest Fire Control at Ottawa, November 5 - 9, 1979.

- AFS Forest Protection Officers annual meeting at Devon, Alberta, December 12 - 13, 1979.

11. Meet with B. C. Forest Service air attack and operations research personnel regarding co-operative research programs in these fields.

12. Publish:

    Lane, E. D. and R. G. Newstead. 1980. "Three-Dimensional Computer Mapping of Lakes". The Progressive Fish Culturist. Vol. 42 #1, 2, or 3.

13. Accomplishments in 1979-80:

    1. Owing to inclement weather and an abnormally high water table in the vicinity of the Slave Lake black spruce experimental burn plots, prescription minima could not be met and none of the six plots could be treated or burned.

    2. Provided technical assistance as follows:

        a) Assisted Department of Northern Saskatchewan personnel in evaluating and monitoring modified retardant mixing and loading facilities at the Prince Albert and La Ronge tanker bases. These trials resulted in improved retardant quality and flow control throughout the DNS tanker base network.

        b) Evaluated two existing on-board injection systems in conjunction with Poly-trol 200, a liquid polymer water thickening compound marketed by Chemonics Ind. (Canada) Ltd. These tests were conducted at Red Deer and Yellowknife in co-operation with Avalon Aviation Ltd. and the NWL & F Service with the Field conversion Canso. Similar tests were also conducted at Slave Lake, Alberta, in co-operation with the Flying Fireman Ltd. and the Alberta Forest Service with the Fairey conversion Canso. Subsequent file reports indicate that to date neither system affords uniform or consistent mixture quality during water skooping and pick-up.

        c) Static tests were not conducted with AFS contracted B-26 and Super PBY Canso airtankers since proposed modifications were not forthcoming.

        d) Provided additional training and consultation as follows:

            (i) Reviewed and reported on loading and venting characteristics of DNS Tracker airtankers. This assessment could result in system modifications designed to increase tank, gating, and venting efficiency.

            (ii) Prepared comments on the pros and cons of continued use of water thickening compounds with skimmer

aircraft in northwestern Ontario. In light of existing mixing equipment and product limitations, the abundance of available water and present water-bombing techniques, the cost-effectiveness of water thickners is questionable in this region of Ontario.

(iii) Presented a lecture to graduating students at the Hinton Forest Technology School on the subject of aerial fire suppression research.

(iv) Participated in the Saskatchewan Department of Tourism and Renewable Resources annual spring fire control meeting at Meadow Lake and presented a talk on aerial attack systems.

3. The B-26 airtanker drop tests were repeated with Poly-trol 200 as scheduled; however, a combination of airtanker malfunction and poor pilot accuracy are likely to invalidate the data collected.

4. Basic construction of the retardant spray apparatus and combustion table is well underway and will be completed upon acquisition of suitable transducers and readout equipment.

5. A preliminary draft of development and selection guidelines for water thickening compounds was submitted to and approved in principle by the CCFFC training subcommittee members in attendance at the national air attack workshop. Baseline rheological information is pending from the Kelco Corporation in San Diego, California, and additional product drying rates under investigation at the PNFI are required prior to preparation of a more comprehensive publication.

6. A completed first draft of thesis manuscript has been reviewed by graduate advisory committee. A revised draft is well underway in anticipation of an early spring oral exam and subsequent convocation.

7. Good progress is being made in revising the retardant chemicals summary for publication. Similarly the past 10 years of airtanker drop patterns are under analysis, having been coded and submitted to the NFRC computer for various determinations. CALCOMP plotting will follow shortly.

8. Publications:

Hodgson, M. J. and R. G. Newstead. 1978. "Wildfire and Airtanker Allocation," Annals, Ass'n of American Geographers (in review).

This article is still in the review stage, having undergone additional revisions.

Accomplishments Added:

9. The physical and rheological properties of a synthetic liquid polymer under development by the Sanitek Corporation of Los Angeles, California, were assessed under lab conditions. Based upon preliminary results, this product is at present unsuitable for use as a water thickener in Canadian skimmer operations.

10. Attended and/or served on the following:

    - Coast Fire Control Course, Abbotsford, B. C.

    - Fire retardant workshop, Kamloops, B. C. (R. J. Lieskovsky - attendee).

    - National Air Attack Workshop, Ottawa, Ontario.

    - AFS Forest Protection Officers Meeting, Devon, Alberta.

11. Research technician Lieskovsky visited air attack personnel and airtanker bases in central B. C. and Victoria to discuss the possibilities of future co-operative research projects with the B. C. Forest Service. A meeting with B.C.F.S. operations research personnel was also held in Edmonton to further consider the role of NFRC fire management systems studies in B.C.F.S. fire operations planning.

12. Publications:

    Lane, E. D. and R. G. Newstead. 1980. "Three-Dimensional Computer Mapping of Lakes". The Progressive Fish Culturist. Vol. 42 #1, 2 or 3 (in press).

14. Goals for 1980-81:

    1. Complete thesis manuscript and convocate from U of A masters program.

    2. Complete guidelines for development and selection of water thickening compounds, and publish same.

    3. Complete revision of fire retardant chemicals summary, and publish same as a Forest Management Note.

    4. Complete construction and calibration of fire retardant spray apparatus pending receipt of capital equipment requirements.

    5. In co-operation with the AFS, conduct prescribed burns at Slave Lake black spruce plots in a continuing effort to assess the relative effectiveness of various fire retardants over time - as permitted by a predefined weather prescription.

6. In co-operation with the B.C.F.S., conduct static and drop tests with the recently modified Tracker Firecat aerial tanker, at Abbotsford, B. C.

7. Provide technical assistance, training, and technology transfer to regional and other national and international fire control agencies and industrial organizations as requested.

8. Assess future intentions of present study format, make recommendations regarding future objectives, and accordingly modify or terminate study as appropriate.

9. Publish articles in forthcoming Forestry Report as follows:

   "Interim results of retardant effectiveness on two prescribed burns in black spruce".

   "Liquid polymer water thickener - a review of test results to date".

10. Prepare a slide-tape presentation on the role of airtankers and fire retardants in wildfire control.

15. Publications:

Reports and articles published prior to 1978-79

21 in total

1978-79

Hodgson, M. J. and R. G. Newstead. 1978a. "A model for allocating airtanker groups to airbases," Proceedings of the Fifth Pacific Regional Science Conference, Vancouver, B. C.

1979-80

Lane, E. D. and R. G. Newstead. 1980. "Three-Dimensional Computer Mapping of Lakes". The Progressive Fish Culturist. Vol. 42 #1, 2, or 3 (in press).

16. Signatures:

Investigator

Program Manager

Director G. T. Silver

NOR-5-086

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1980-81

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: January 22, 1980

1. Project: Fire management systems and guidelines.

2. Title: Fire behavior in boreal forest fuels.

3. New: Cont.: X 4. No.: NOR-5-086

5. Study Leader: Z. Chrosciewicz

6. Key Words: Canadian Forest Fire Weather Index, fire behavior, fire effects, danger rating.

7. Location of Work: Various areas within the western and northern region.

8. Problem:

Intensive fire control management requires improved methods of assessing and forecasting fire danger for all major fuel types over a wide range of weather and site conditions. Although such methods would not prevent fires from occurring, they would undoubtedly result in substantial reduction of losses through better planning and implementation of various fire control measures all the way from preventation to suppression.

A good start in the development of such methods was made with the publication of the new Canadian Forest Fire Weather Index tables in 1970. The main index as well as the component codes are designed to summarize and rate the important weather variables that affect the ignition and spread of forest fires. The entire system provides means for daily rating of fire danger across the country. However, as the system uses primarily weather-dependent scales, it does not provide means for rating fire behavior in specific fuels.

The second phase, then, would be the development of fire spread and intensity tables for important fuel types by major sites and climates within the Region. Studies of moisture relationships in different fuels will help to determine the degrees of deviation from the standard curves as originally used in working out the Fire Weather Index. Experimental ground burns and observations of natural crown fires will provide data on fire behavior over a wide range of weather and site conditions for each of the fuels. The resulting tables will

then relate some of the main characteristics of ground and crown fires to the Fire Weather Index and its component codes. This in turn will provide means for a more precise rating and forecasting of fire danger and fire effects for major fuel types within the Region.

9. Study Objectives:

1. To develop fire spread and intensity tables for major fuel complexes.

2. To assess fire effects in terms of fuel reduction and plant succession over a range of burning conditions.

3. To establish guidelines for rational uses of fire in manipulation of various fuel combinations.

4. To assist fire control agencies in application of the resulting tables and guidelines.

10. Resources:

a. Starting date: 1970
b. Estimated year of completion: 1983
c. Estimated total Prof. man-years required: 8.0
d. Essential new major equipment items for 1980-81 with costs: Nil
e. Essential new major equipment items beyond 1981 with costs: Nil
f. 1980-81 man-years

Prof.	0.9	(Chrosciewicz)
Supp.	-	
Casual	-	
Total	0.9	

11. Progress to Date:

The new Canadian Fire Weather Index was introduced to the Region in 1970 through a series of training sessions for the user agencies. Since then, fire behavior and fire effects were studied by means of experimental burning on a number of cutover sites and in uncut stands. Varying in area from 0.16 to 33.35 ha, the tests included 2 burns of black spruce slash, plus 17 burns of jack pine slash in Manitoba, 31 burns of jack pine slash in Saskatchewan, and 22 burns of lodgepole pine slash plus 2 burns of undisturbed black spruce in Alberta. Results are being published as they become available.

While this work was nearing completion, variations in moisture content and heat content of green conifer foliage (jack pine, black spruce, white spruce and balsam fir) were studied in Alberta to determine their seasonal lows (moisture) and highs (heat) that may contribute substantially to the incidence and the spread of crown fires. The foliage data, along with the associated weather information, are now being prepared for publication.

To study further fire behavior under undisturbed forest canopies, a series of 0.09-ha experimental plots were established in each of four mature stands in Alberta (jack pine, black spruce, white spruce-aspen, and aspen). In preparation for the burning tests, inventories of dead fuels and live vegetation were recently completed on 16 jack pine plots. Burning and fire behavior studies were carried out on 12 of the plots in 1978 and 1979.

Associated studies in the major forest cover types of Alberta are aimed at fuel appraisal for improved fire behavior predictions at the operational level.

12. Goals for 1979-80:

1. Publication of reports on (1) "Jack pine and other forest regeneration following postcut burning and seeding treatments in central Saskatchewan," and (2) "Foliar moisture variations in major conifers of central Alberta".

2. Preparation of a report on "Foliar calorific variations in major conifers of central Alberta".

3. Experimental burning and fire behavior studies on the remaining jack pine plots in central Alberta.

4. Based on current work in jack pine, completion of data processing on total biomass, weather, fuel moisture, fire behavior, fire effects, and fuel depletion.

5. Development of fuel and fire behavior relationships over a range of weather conditions for use in the "decision-aid models" (NOR-5-174).

6. Regeneration surveys of postburn plantations and seeded areas in central Saskatchewan.

7. Continuation of providing consultative services as required.

Goals Added:

8. Freeze-drying foliar samples of major conifers in central Alberta.

9. Field review of "Fire Hazard Ratings" for forest ecosystems in central Saskatchewan.

10. Critical review of manuscripts by other scientists prior to publication.

11. Preparation of an invited report on "Some practical methods for securing adequate postcut forest reproduction in Canada".

12. Preparation of several illustrated lectures with topics ranging from fire behavior and fire use to forest regeneration.

13. Attendance at various meetings as needs arise.

14. Participation in a University of Alberta Graduate Committee as an outside member.

15. Participation in an Ontario coroner's inquest as an expert witness re. controlled burning.

13. Accomplishments in 1979-80:

1. The manuscript of a report on "Jack pine and other forest regeneration following postcut burning and seeding treatments in central Saskatchewan" is completed and ready for internal review. All figures, tables and other supporting material for a report on "Foliar moisture variations in major conifers of central Alberta" are now in their final format, and the manuscript will be completed in about two months.

2. Additional data for a report on "Foliar calorific variations in major conifers of central Alberta" are now available from a series of 1979 freeze-drying tests (see item 8), and the final manuscript will be prepared during the next fiscal year.

3. Experimental burning, fire behavior studies, plus detailed preburn and postburn fuel assessments were completed on a total of 12 jack pine plots in central Alberta. The burns now cover the intended range of weather conditions up to the outset of sustained crown fire and, therefore, no further tests in this pine type will be required.

4. Field data on total biomass, weather, fuel moisture, fire effects and, to some degree, fuel depletion were processed as they became available. However, additional computer time, and particularly the reinstatement of lost technical support, will be required to complete the analyses.

5. Delineation of the relationships between fuels, fire behavior and weather had to be postponed until the basic analyses are completed (see item 4).

6. Large-scale postburn jack pine plantations and seeded areas were surveyed in central Saskatchewan at the stand age of about 8 years. In terms of pine re-establishment and its stocking, the treatments were highly successful, very much so after planting and, to a somewhat lesser degree, after seeding. Generally, spring treatments produced better results than autumn treatments, and the rates of height growth varied with site quality.

7. Consultative services were provided to senior forestry officials from Ontario, Manitoba, Saskatchewan, Alberta, British Columbia, Yukon, Alaska, Arizona, and three Scandinavian countries, namely Norway, Sweden and Finland.

Accomplishments Added:

8. Freeze-drying of some 480 foliar samples from central Alberta was done (a) to provide explanation for the existing foliar moisture variations (see item 1), and (b) to secure better controls for the existing foliar calorific variations (see item 2).

9. The "Fire Hazard Ratings" that were previously formulated for some 23 forest ecosystems in central Saskatchewan were progressively field adjusted after viewing and discussing examples of each of the systems. Among participants in this task were provincial forest officials and fire researchers from the Northern Forest Research Centre.

10. Manuscripts for publication by the following authors were critically reviewed: P. L. Fuglem (M. Sc. thesis), H. Zalasky (two reports), I. K. Edwards and L. M. Carlson (one report), plus J. H. Cayford and D. J. McRae (one report).

11. A report entitled "Some practical methods for securing adequate postcut forest reproduction in Canada" was prepared and presented during the International Workshop on Forest Regeneration at High Latitudes, Fairbanks, Alaska (November 13 - 15, 1979). This report is now in press.

12. Several illustrated lectures, or talks, were prepared and given as follows:

    (a) "Fire dynamics and effects within a jack pine stand in central Alberta" by Z. Chrosciewicz, Northern Forest Research Centre, Edmonton, Alberta (August 2, 1979).

    (b) "Examples of experimental burning for fire-behavior studies in semimature jack pine stands of varying density" by Z. Chrosciewicz, Northern Forest Research Centre, Edmonton, Alberta (September 27, 1979).

    (c) "Case studies of successful postcut jack pine and black spruce reproduction following burning, both with and without supplementary treatments" by Z. Chrosciewicz, Northern Forest Research Centre, Edmonton, Alberta (September 27, 1979).

    (d) "Controlled burning for postcut conifer reproduction in central and midwestern Canada" by Z. Chrosciewicz, Bureau of Land Management, Fairbanks, Alaska (November 14, 1979).

13. Attendance at meetings included:

    (a) Central Region Fire Weather Committee, Winnipeg, Manitoba (December 11, 1979).

(b) Briefings re. research program and future needs with officials from the Saskatchewan and Alberta Forest Services, Prince Albert, Saskatchewan (August 30, 1979) and Edmonton, Alberta (January 18, 1980), respectively.

14. Jointly with other members of the University of Alberta Graduate Committee, consultative, supervisory and examining functions were performed over a period of two years for a M. Sc. student candidate.

15. On invitation from the Regional Coroner for northwestern Ontario, "expert witness" services were provided during an inquest in Geraldton, Ontario.

14. Goals for 1980-81:

1. Summarization of updated information on the "Fire Hazard Ratings" for all 23 forest ecosystems in the Mixedwood Section B.18e of central Saskatchewan.

2. Submission for publication of reports on (1) "Jack pine and other forest regeneration following postcut burning and seeding treatments in central Saskatchewan," (2) "Foliar moisture variations in major conifers of central Alberta," (3) "Foliar calorific variations in major conifers of central Alberta," and (4) "Failures and successes in jack pine regeneration following postcut burning and seeding treatments in southeastern Manitoba.

3. Continuation of data analysis leading to the determination of basic relationships between fuels, fire behavior and weather for semimature jack pine stands in central Alberta.

4. Continuation of providing consultative services as required.

15. Publications:

1978-79

Chrosciewicz, Z. 1978. Slash and duff reduction by burning on clear-cut jack pine sites in southeastern Manitoba. Environ. Can., Can. For. Serv., North. For. Res. Cent. Inf. Rep. NOR-X-199. 11 p.

Chrosciewicz, Z. 1978. Slash and duff reduction by burning on clear-cut jack pine sites in central Saskatchewan. Environ. Can., Can. For. Serv., North. For. Res. Cent. Inf. Rep. NOR-X-200. 12 p.

Chrosciewicz, Z. 1978. Large-scale operational burns for slash disposal and conifer reproduction in central Saskatchewan. Environ. Can., Can. For. Serv., North. For. Res. Cent. Inf. Rep. NOR-X-201. 11 p.

Chrosciewicz, Z. 1978. Silvicultural uses of fire in midwestern Canada. Pages 37-46 *in*: Fire ecology in resource management. Workshop proceedings. Environ. Can., Can. For. Serv., North. For. Res. Cent. Inf. Rep. NOR-X-210.

1979-80

Chrosciewicz, Z. 1980. Some practical methods for securing adequate postcut forest reproduction in Canada. *In*: Proceeding of the international workshop on forest regeneration at high latitudes. Univ. Alaska (in press).

16. Signatures:

Investigator

Program Manager

Director G. T. Silver

NOR-5-130

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1980 - 81

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: January 22, 1980

1. Project: Fire management systems and guidelines.

2. Title: Initial attack strategy and resources in fire suppression operations.

3. New: Cont.: X 4. No.: NOR-5-130

5. Study Leader: Vacant

6. Key Words: Detection, fire behavior, airtankers, simulation modelling, handcrews, helicopters.

7. Location of Work: Northern Forest Research Centre.

8. Problem:

Fire control agencies serviced by the Northern Forest Research Laboratory in Edmonton spend between 10 and 15 millions of dollars annually on fire suppression. At least an equal amount is lost in the form of damage to various resources. In the past, fire control expenditures have been justified on the basis that fire damage must be reduced "at all cost." In the future, fire protection agencies will see greater competition for the fire control dollar.

In the defence of future budget requests fire protection agencies must place a greater emphasis on planning, including resource valuation. Suppression strategy and allocation must then be geared more closely to existing resource values and fire behavior to obtain maximum value of fire control dollar. The fire manager urgently requires guidelines specifically derived for the initial attack stage since benefits are maximized when the fire is controlled in its early growth stage.

The Alberta Forest Service is cooperating in the development of an initial attack simulation model for Whitecourt Forest District. It is designed to provide a relative assessment of initial attack systems and if the model proves satisfactory, it will be introduced as an operational decision-making aid.

9. Study Objectives:

1. To develop a simulation model for assessing initial attack systems over a range of burning conditions.

2. To provide guidelines for suppression strategy and optimum combinations of men and equipment to achieve successful initial attack.

3. To promote and extend research results to client agencies through lectures and training sessions.

10. Resources:

a. Starting date: 1972
b. Estimated year of completion: 1973 Revised: 1978
c. Estimated total Prof. man-years required: 3.4
d. Essential new major equipment items for 1979-80 with costs: Nil
e. Essential new major equipment items beyond 1980 with costs: Nil
f. 1979-80 man-years

Prof.	0.0
Supp.	0.0
Casual	-
Total	0.0

11. Progress to Date:

An inter-agency study group was formed to develop a simulation model for three initial attack methods, i.e. helicopters, air-tankers, and ground crews. Important variables were documented and ten years of fire and weather data transferred to IBM-360 tapes.

Model development was completed and preliminary runs made for ground and aerial systems. At the request of the Alberta Forest Service, the model was expanded to include: (1) a B-26 airtanker, (2) both land-based and amphibious PBY Canso's and (3) a 204B helicopter W/235 gal. bucket.

A statistical analysis of 2000 individual AFS forest fire reports and 35 000 fire weather observations has been completed. Results indicate that the Fire Weather Index and components accurately reflect key aspects of fire behavior and fire-fighting difficulty, particularly during the early or initial attack phase.

The growth model has been re-designed and dispatch logic for simultaneous operation of helitankers and handcrews is complete.

12. Goals for 1979-80:

1. Continue membership on the following committees:

a) Western Fire Weather Committee.

b) Central Fire Weather Committee.

c) AES/CFS Development Committee.

d) Regional Fire Research Committee.

e) Intermountain Fire Research Council.

f) Fire Danger Rating Working Group.

2. Continue joint AFS/CFS fire behavior/retardant evaluation study in Slave Lake Forest.

3. Report contract results.

ENFOR - Sampling forest floor fuels.
ASPEN - Fuel loading in regional aspen stands.

13. Accomplishments in 1979-80:

1. Continued membership on the following committees:

a) Western Fire Weather Committee - no meeting.

b) Central Fire Weather Committee - attended by Z. Chrosciewicz.

c) AES/CFS Development Committee - did not meet.

d) Regional Fire Research Committee - did not meet.

e) Intermountain Fire Research Council - attended by D. Quintilio as member of Steering Committee.

f) Fire Danger Rating Working Group - attended by D. Quintilio.

2. Project was continued but no burns were conducted in summer of 1979 owing to unsuitable burning conditions. Future burning to be covered under NOR-5-037.

3. Data analysis continued and a draft report has been completed (ENFOR). No progress was made on the aspen fuel loading data owing to resignation of study leader in October, 1979.

14. Goals for 1980-81:

1. Terminate study - unfinished goals transferred to NOR-5-174.

15. Publications:

1978-79

Nil

1979-80

Nil

16. Signatures:

Investigator

Program Manager

Director G. T. Silver

NOR-5-131

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1980 - 81

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: January 22, 1980

1. Project: Fire management systems and guidelines.

2. Title: Evaluation and planning of fire detection, surveillance and communications systems and methods.

3. New: Cont.: X 4. No.: NOR-5-131

5. Study Leader: C. J. Ogilvie

6. Key Words: Aerial patrols, lookouts, forestry communications, weather data collection, storm tracking, wildfire smoke emission, wildfire mapping, remote sensing.

7. Location of Work: Alberta, National Parks, Yukon and Northwest Territories, Saskatchewan, Manitoba

8. Problem:

The study consists of an analysis of fire records as well as of on-site evaluations of existing wildfire detection - mapping and communication systems.

Research is done on factors influencing the performance and efficiency of such systems.

The results of the study will enable user agencies to increase the efficiency of their fire surveillance systems thereby reducing total fire losses and minimizing fire suppression costs.

Since some of the user agencies in the region are, at this time, not operating a fully developed fire surveillance system, the study is bound to meet with a certain measure of success.

Much of the results achieved in this study so far are already being implemented, and the prospects of further findings being put to practical use are excellent since most phases of the study are based upon user requests.

The following general course of action is being followed:

1. Discussion with respective user agencies to define and outline the problems to be solved.

2. On-site evaluations of existing installation and systems as well as analysis of available data.

3. Formulation of objectives and arbitrary financial constraints to be considered with designing the new system.

4. Design of new systems or modifications of existing systems in order to achieve optimal returns under given local conditions and accepted constraints.

5. Assistance to user agency during implementation as well as research through short-term projects solving day-to-day problems that have a bearing on systems design and operation.

9. Study Objectives:

1. Develop plans for wildfire surveillance and communications systems for the Northwest Territories, and other clients, on request.

2. Identify the most advantageous detection medium (alternative) for given conditions.

3. Define and identify factors influencing the design of wildfire detection and communication systems.

4. Develop effective wildfire mapping and surveillance techniques.

10. Resources:

a. Starting date: 1971
b. Estimated year of completion: 1983
c. Estimated total Prof. man-years required: Nil
d. Essential new major equipment items for 1980-81 with costs: Nil
e. Essential new major equipment items beyond 1981 with costs: Nil
f. 1980-81 man-years

Prof.	0.0	(Vacant)
Supp.	0.8	(C. Ogilvie)
Casual	-	
Total	0.8	

11. Progress to Date:

Reports on communications and fire detection plans have been prepared for the Yukon, N.W.T. and Wood Buffalo National Park. These regions are all making use of their respective reports.

The "Barnes Airborne Fire Spotter" was tested and found to be unreliable under actual field conditions.

Experiments started in 1974 have resulted in the widespread use across Canada of the AGA 750 infra-red scanner for detecting

holdover fires. NFRC's Sony vidicon was successfully adapted to record the thermovision imagery. A power pack was constructed at NFRC to be used to run the AGA, the vidicon and other instruments.

A simple sighting device to aid air observers in estimating distances on the ground was designed and built.

A device known as a "scan extender" that will allow the AGA 750 thermovision to be used for systematic searches of large areas from a fixed wing aircraft has been developed and tested to a limited degree. A "scan extender" is presently being utilized in fire detection programs in Alberta and Saskatchewan.

The field work for a detection system evaluation in Saskatchewan has been completed. This included taking panoramic photographs, making a sketch of the seen area, and making notes on the safety and efficiency of each of 75 Saskatchewan towers, 7 interacting Manitoba towers and 6 Prince Albert National Park towers.

Data compilation related to the Saskatchewan detection system evaluation is completed. This includes profiles, photographs and seen-area maps for 88 towers.

12. Goals for 1979-80:

1. Process field information on 48 lookout sites collected in Saskatchewan and Manitoba as follows:

    a) Process and interpret remaining 12 sets of panoramic photographs.

    b) Compile seen area maps for each of 38 remaining lookouts based on panoramic photographs, field sketches and profiles.

    c) Construct a composite seen area map of the province.

    d) Compile all information, prepare a final report, and submit with all maps to the client agency.

2. Do the seen area mapping for 6 towers in Prince Albert National Park using the same methods used in Saskatchewan and submit a report to the Parks people.

3. Complete construction and test in co-operation with the Alberta Forest Service an improved version of the AGA scan extender and:

    a) Demonstrate as requested to fire control personnel in Saskatchewan.

    b) Prepare report on construction and use of scan extender.

4. Participate in fuel inventory studies that will provide background for fire prediction models.

5. Continue to appraise Lightning Location and Protection System for regional agencies.

13. Accomplishments in 1979-80:

1. Using standardized CFS procedures, completed field work and data collection on 48 lookout sites in Saskatchewan including 7 interacting Manitoba towers as follows:

   a) Processed and interpreted remaining 12 sets of panoramic photographs.

   b) Compiled seen-area maps for each of 38 remaining lookouts based on panoramic photographs, field sketches and profiles.

   c) Constructed a composite seen-area map of Saskatchewan fixed detection network.

   d) Prepared a partial draft report to be submitted to the client agency when completed.

2. Completed the seen-area maps for 6 towers in Prince Albert National Park. Final reporting on how these towers and the Saskatchewan towers interact along with a composite visible-area map to follow.

3. Continued development of the AGA scan extender by constructing a model that is designed for use outside the aircraft. One version of this new design was mounted on an Alberta Forest Service Cessna 337. Another scan extender was built and, in co-operation with the Department of Northern Saskatchewan, was adapted for helicopter use by mounting it where the cargo hook is normally located on a Bell 206. A first draft report on the construction and use of the scan extender was prepared for publication in Forestry Report.

4. Participated in fuel inventory studies in Wood Buffalo National Park in conjunction with NOR-5-168.

5. Continued to appraise Lightning Location and Protection system for regional agencies by assimilating background information and technical knowledge to prepare a framework for field evaluation of operational units.

14. Goals for 1980-81:

1. Finish report on Saskatchewan detection system and submit it along with the maps and photographs to the Department

of Northern Saskatchewan, and assist in the implementation of the recommendations made in the report.

2. Complete work for Prince Albert National Park.

   a) Prepare composite visible-area map.

   b) Submit a report along with maps and photographs to Prince Albert National Park.

3. Begin a co-operative study with the Department of Northern Saskatchewan to investigate the feasibility of using the AGA scan extender in conjunction with their Lightning Location and Protection System to locate incipient lightning fires. In addition, localized fuel and weather data will be gathered at lightning fire locations discovered. This source of specific information is expected to support assessment of the correlation between lightning fire incidence and fuel and weather parameters.

4. Monitor effectiveness and level of use by Alberta Forest Service of the AGA scan extender and provide technical assistance upon request.

5. Develop a user manual for the operational use of the AGA thermovision and scan extender as applied to forest fire detection.

6. Provide liaison and technical services among client agencies making use of the Lightning Location and Protection System.

15. Publications:

1978-79

Niederleitner, J. 1978. Got a fire mapping job? Photography with infra-red film may be your best bet. Forest Fire News 1978.

1979-80

Nil.

16. Signatures:

Investigator

Program Manager

Director G. T. Silver

NOR-5-168

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1980-81

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: January 22, 1980

1. Project: Fire management systems and guidelines.

2. Title: Evaluation of the role of fire in forest and intermingled vegetation in the Prairie Provinces, Rocky Mountains and far north.

3. New: Cont.: X 4. No.: NOR-5-168

5. Study Leader: D. E. Dubé

6. Key Words: Fire ecology, fire history, fire cycle, fire type, fire climax, fire scar rating.

7. Location of Work: Region Wide.

8. Problem:

Within broad climatic limitations, fire has been the most important single, natural influence on vegetation throughout the region for about the past 10,000 years. Areal and temporal patterns of burning have varied along with fire intensity. Fire has played a significant role in influencing the physical-chemical environment; in regulating dry-matter accumulation; in controlling plant species and communities, in determining wildlife habitat patterns and populations; in controlling forest insects, parasites, fungi, etc.; in controlling major ecosystem processes and characteristics such as nutrient cycles and energy flow, succession, diversity, productivity and stability. The "natural" fire regime has been obscured by man's intervention and the long-term consequences of fire suppression are now becoming clear.

Resource management problems are developing which require an understanding of the historical role of fire, the effects of fire on a variety of landscapes, the alternatives available to resource managers and approaches required to implement alternatives.

9. Study Objectives:

1. To develop and implement fire management programs in designated National Parks.

2. To define the needs and priorities of client agencies in the area of fire impact assessments.

3. To describe and elucidate the natural role of fire.

10. Resources:

a. Starting date: 1974
b. Estimated year of completion: 1984
c. Estimated total Prof. man-years required: 10
d. Essential new major equipment items for 1980-81 with costs: Nil
e. Essential new major equipment items beyond 1980 with costs: Nil
f. 1980-81 man-years

Prof.	0.5	(D. Dubé)
Supp.	0.5	(M. A. Walters)
Casual	-	
Total	1.0	

11. Progress to Date:

Programs in National Parks aimed at integrating fire management into resource management plans are nearing completion.

12. Goals for 1979-80:

1. Publish as Information Report "Early plant succession following wildfire, Kootenay National Park".

2. Submit operational fire management plan for Nahanni National Park.

3. Complete field work and analysis of data for operational fire management plan for Wood Buffalo National Park.

4. Provide consultation and advice for fire management planning in Western and Prairie National Parks.

5. Prepare paper for "Fire in Northern Circumpolar Ecosystems: A Workshop".

6. Participate in training sessions of client agencies and meetings relevant to study content.

13. Accomplishments in 1979-80:

1. Information Report, "Early plant succession following wildfire in Kootenay National Park" is in review process.

2. Operational fire management plan for Nahanni National Park to be completed by February 15, 1980.

3. Field work completed and data has been analyzed for operational fire management plan for Wood Buffalo National Park.

4. Prescribed burning was conducted in Elk Island National Park in May, 1979 and a finished report presented to the Park titled "Prescribed burning in Elk Island National Park".

5. Completed and presented, at the Fire in Northern Circumpolar Ecosystems Conference, a paper titled, "Fire in Wilderness Areas, Parks and other Nature Reserves".

6. Participated in training sessions of client agencies and meetings relevant to study content including the following:

   a) March 5, 1979 - Fire ecology lecture at Hinton Forest Technology School.

   b) March 15, 1979 - Meeting with Alberta Forest Service to discuss program.

   c) March 20, 1979 - Meeting with Northwest Lands and Forest to discuss program.

   d) April 18, 1979 - Meeting in Fort McMurray with A.F.S./ W.B.N.P. to discuss study proposal.

   e) April 30, 1979 - Meeting with Park personnel from Elk Island National Park to discuss prescribed burn.

   f) May 2, 1979 - Lecture at Westlock High School on fire ecology.

   g) May 28, 1979 - Discussion of fire modelling programs with Gradient Modelling Ltd.

   h) June 22, 1979 - Meeting with M. Alexander, GLFRC, to finalize New Brunswick symposium paper.

   i) September 27, 1979 - Presentation to delegation from People's Republic of China.

   j) October 22 - 26, 1979 - Attended "Fire in Northern Circumpolar Ecosystems Symposium," in Fredericton, New Brunswick.

   k) October 29 - November 1, 1979 - Attended Intermountain Fire Research Council Meeting in Missoula, Montana.

   l) November 27, 1979 - Presented Parks work to EMS/Parks Canada meeting.

   m) December 12 - 13, 1979 - Attended Alberta Forest Service, Fire Control Meeting in Devon, Alberta.

   n) January 4, 1980 - Meeting with A.F.S./U.A./F&W to discuss prescribed burning for Bighorn Sheep range improvement.

14. Goals for 1980-81:

1. Publish as Information Report: "Early plant succession following wildfire, Kootenay National Park".

2. Publish in Forestry Report: "Prescribed burning in Elk Island National Park".

3. Publish paper: "Fire management in Wilderness Areas, Parks and other Nature Reserves," *in* Fire in Northern Circumpolar Ecosystems Proceedings, University of New Brunswick.

4. Complete and submit fire management study for Nahanni National Park.

5. Complete and submit fire management study for Wood Buffalo National Park.

6. Provide advice and consultation for fire management planning in Western and Prairie National Parks.

7. Participate in training sessions of client agencies and meetings relevant to study content.

15. Publications:

1978-79

Dubé, D. E. 1978. (Compiler). Fire ecology in resource management. Workshop Proceedings. Northern Forest Research Centre. Information Report NOR-X-210.

Dubé, D. E. 1978. Prescribed fire on Henry House Prairie, Jasper National Park. Fire Ecology in Resource Management, Workshop Proceedings. Information Report NOR-X-210. pp. 20-22.

Dubé, D. E. 1978. Guidelines and operational plan for prescribed burning in Elk Island National Park. File Report. North. For. Res. Cent., 7 pages. Study #168.

Dubé, D. E. 1978. Considerations in the use of prescribed burning. *In*: Fire and Range Management Workshop, Regina, Saskatchewan. pp. 29-31.

1979-80

Dubé, D. E. 1979. Fire Management in National Parks. *In*: Proceedings of the International Fire Management Workshop. pp. 78-79. Information Rept. NOR-X-215. Compiled by Quintilio, D., NFRC, CFS. Edmonton, Alberta.

Dubé, D. E. 1979. Prescribed burning in Elk Island National Park. File Report. NFRC. CFS. Edmonton, Alberta. Study #168.

16. Signatures:

Investigator

Program Manager

Director G. T. Silver

NOR-5-174

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1980 - 81

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: January 22, 1980

1. Project: Fire management systems and guidelines.

2. Title: Decision-aid models for use in fire management.

3. New: Cont.: X No.: NOR-5-174

5. Study Leader: D. Dubé, R. G. Newstead, Z. Chrosciewicz

6. Key Words: Fire behavior, fuels, fireline production fire statistics, fire effects, decision models, fire management, computer systems.

7. Location of Work: Regional.

8. Problem:

The economic impact of forest fires in Canada is significant; in this region alone 2,000 fires burn 0.6 million ha annually and associated fire-fighting costs total $20 million. The protection role of regional fire management agencies is complicated by the extreme variability of the occurrence and behavior of wildland fires. The traditional solution to the wildfire problem is similar in all parts of Canada where climate and fuel situations support wildfire conflagrations. Seasonal suppression forces are annually hired by each fire management organization to meet the demands of an "average" fire-season. The fire management resource demand, however, varies considerably over relatively short time spans and is largely unpredictable.

During low and moderate hazards the often excessive expenditure is difficult to justify and there is a tendency to "overkill" many fires. During very serious fire situations, resources are inadequate and the whole fire management process becomes less efficient. This dilemma will exist in Canada until the information required to accurately predict the demand function over time and space becomes available in a systemized form. The requirement of all fire management agencies, then, is decision-aids geared to providing an improved response to individual fire situations. These decision-aids (models) would integrate data on fuel inventory, fire behavior, fire effects and fireline production and much of this information is currently being generated at the NFRC.

Historically the fire research group at the NFRC has focused its resources on the short-term needs of fire management agencies. This effort has contributed to (1) a strong client-research relationship and a credible advisory program, and (2) accessibility to agency data in all operational areas. Output has been service-directed in response to immediate needs, and given the experience of the fire group, this information flow can continue, albeit with a reduced manpower commitment. This new thrust in the area of systematized data processing will add a new dimension to the fire program.

9. Study Objectives:

1. To identify the key factors relating to the occurrence, behavior, and effect of wildfires to the cost-effectiveness of fire control decisions.

2. To build, test, and operate relevant decision-aid models designed to assist fire management agencies in optimizing the allocation and use of available resources during demanding or multiple fire occurrence situations.

10. Resources:

a. Starting date: 1978
b. Estimated year of completion: 1985
c. Estimated total Prof. man-years required: 10
d. Essential new major equipment items for 1980-81 with costs: Nil
e. Essential new major equipment items beyond 1981 with costs: $3,000.00 (computer terminal similar to LANPAR Scope Mod. 100)
f. 1980-81 man-years

Prof.	1.0	(Vacant)
	0.5	(R. G. Newstead)
	0.5	(D. Dubé)
	0.1	(Z. Chrosciewicz)
Supp.	1.0	(M. Maffey)
	0.2	(C. Ogilvie)
	0.5	(M. Walters)
Total	3.8	

11. Progress to Date:

As is common with any new research undertaking, the initial phase is concerned with gathering the resource and data bases upon which a comprehensive program can be developed. During the two years since its inception, this study has acquired much of the necessary data management hardware and software in the form of the mini-computing system and programs now established at the NFRC. Systems analysis, computing and other related support staff functions have also become available to this study. Data files have been created using regional fire and weather statistics. Pertinent simulation modelling routines have been brought on stream and "regionalization" and modification of these are underway. Contracts have also been

let to various specialists to introduce specific aspects of fire modelling to the program, e.g. instructional seminars, fuels inventory requirements and gradient modelling (FORPLAN), etc.

12. Goals for 1979-80:

1. Continue to collate and classify existing relevant data from regional inventories, i.e. biophysical, biogeoclimatic, AFS Phase III.

2. In cooperation with the AFS and NWLF, designate operational test areas to utilize remote sensing technology for fuel inventory processing. Introduce concepts of fire behavior prediction in relation to fuel inventories through discussion with regional agencies.

3. Continue validation of airtanker resource model.

4. Modify the interactive Whitecourt elliptical fire growth model.

13. Accomplishments in 1979-80:

1. A preliminary inquiry was undertaken to determine the feasibility of using existing biophysical, biogeoclimatic, and forest inventories as means of identifying, and quantifying fuel measurements. Correlations among various inventory and presently quantifiable fuel parameters will determine whether or not these data bases can be used to advantage on a broader regional scale.

2. In co-operation with the NWL&F Service, a contract was let to conduct a fuels appraisal survey in the Fort Smith district. Raw data from this inventory is on file at the NFRC. Initial data compilation by Timmerlin Woodland Services Limited, the survey contractor, is in progress. Compilation of the data collected from the aerial photography and line-intersect surveys conducted in northeastern Alberta in co-operation with the AFS is also underway. This goal was achieved in conjunction with Study NOR-22-142.

3. To date there has been no attempt to modify or validate the airtanker allocation model. Only following completion of the affiliated masters program can this model be introduced to the AFS for validation and/or operationalization.

4. The Whitecourt interactive elliptical fire growth model is presently undergoing modification and refinement of its performance abilities is expected. This model was further demonstrated to AFS fire control personnel as a decision-making aid.

14. Goals for 1980-81:

1. Refine, calibrate and field test the elliptical fire growth model. In conjunction with two AFS remote computer terminals located in separate forest protection jurisdictions, interactive model performance will be assessed relative to actual fire growth circumstances.

2. Continue synthesis of regional fuels data base and assess feasibility of integrating fuels data from other inventory and survey criteria (e.g. AFS Phase III, biophysical, biogeoclimatic). These data should provide the framework for the future development of a regional fire behavior model.

3. Analyze and synthesize relevant fire line production data (e.g. airtankers, dozers, and hand lines). These data can then be used in fire behavior modelling where fire containment parameters are required.

4. Assess the feasibility of conducting a fire history and fire effects study in the Swan Hills region of the Slave Lake Forest.

5. Collate 1979 fire statistics from Department of Northern Saskatchewan records. Transfer previous four years' statistics from FFRI computer files to NFRC files. These data can be used in conjunction with study NOR-5-131 goals concerning lightning fire detection and related measurement of fuels and weather parameters in northern Saskatchewan.

6. Complete analysis and compilation of accumulated fixed-wing airtanker drop pattern information initiated under Study NOR-5-037, and publish same.

7. Analyze airtanker effectiveness data collected by AFS aerial observers during the past four-year survey period.

15. Publications:

Nil.

16. Signatures:

Study Leader

Program Manager

Study Leader

Director G. T. Silver

Study Leader