S T U D Y S T A T E M E N T S

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NORTHERN FOREST RESEARCH CENTRE

CANADIAN FORESTRY SERVICE

MAY, 1977

NOR-5-037

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1977 - 78

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 7, 1977

1. Project: Reduction of losses by improved fire suppression methods.

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 ia 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 using retardants 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: 1980
c. Estimated total Prof. man-years required: 4.0
d. Essential new major equipment items for 1977-78 with costs: Nil
e. Essential new major equipment items beyond 1978 with costs: Nil
f. 1977-78 man-years

Prof.	1.0	(Newstead)
Supp.	1.0	(Lieskovsky)
Casual	0.3	
Total	2.3	

11. Progress to Date:

Within the study the use of fire retardants, long-term in particular, has been promoted to regional fire control agencies and, due in part to that liaison development and service activity, fire retardants are now in common use with concomitant improvement in air drop effectiveness.

Air drop patterns have been delineated for most airtankers and helitankers in use in the region in aid of improved aerial suppression throughout the region. Portable ground mixing units and retardant mixing systems within aircraft have been developed and are being utilized to good effect by fire control agencies. Work continues in assessing new retardants and mixing systems.

Aerial fire suppression research has evolved into a two-pronged approach within the Northern region. The first involves on-site evaluation of fire retardants and airtanker effectiveness on wildfires. The second is concerned with simulation of this theme, using parameters determined through static testing of tank and gating characteristics and utilization of available retardant delivery and fuel related models.

Airtanker accuracy has been investigated under simulated bombing conditions, however results achieved suggested that economically constrained sampling methods used were inadequate and statistically unrealiable. Numerous variables within the experiment could not be accounted for in the analysis of results.

Studies of mixing and storage of long-term fire retardants in Alberta have demonstrated that continuous quality control in the preparation and storage of these commercial products is of utmost importance in maintaining their viability during relatively short and uncertain periods of demand.

A preliminary draft of specifications for long-term fire retardants remains subject to continuing revision in order to incorporate user suggestions, up-dated technical information and potential corrosive and environmental damage.

12. Goals for 1976-77:

1. Continue to assess on-site effectiveness through experimentation and on-site evaluation through the cooperation of the Alberta Forest Service, North West Lands & Forest Service and other agencies as well as N.F.R.C. resources.

2. Provide technical assistance to regional government and industrial agencies. Specifically:

    1. Evaluation of the Alberta Forest Service in-line powdered retardant mixer re: mixing capabilities, advantages and disadvantages over an alternate eductor mixer.

    2. Further evaluation of Monsanto Canada Ltd. new long-term retardant Phos-Chek XB regarding ability to meet certain retardant specifications mainly, salt content, viscosity, storage and efficient mixing.

    3. Preliminary screening of a new long-term liquid retardant submitted by ERCO Industries Ltd., Toronto, Ontario. Mainly, to compare through laboratory testing various properties of this new retardant with other long-term retardants presently on the market.

    4. Evaluation of the new Fire-Trol 931 liquid concentrate (retardant) blending and thickening system in the Slave Lake forest region.

    5. Training and consultation as requested.

3. Lead further investigation towards an improved understanding of airtanker delivery systems through static testing. As in the past this type of undertaking is costly and cannot be continued without the full moral and financial support of both the cooperating agency and the owner-operators of the airtankers. Financial support by the Alberta Forest Service and Airspray (1967) Ltd. is anticipated with regard to the rental of a recording oscilloscope, aircraft fuel supplies plus pilot and engineer participation if N.F.R.C. resources are not available.

4. Evaluate by way of simulation modelling C.E. Hardy's contract report on the relationship between fuel type classification, retardant penetration characteristics and tank and gating systems.

5. Study leader to complete course work at U. of A. - masters program. Masters thesis will consider the development of a simple resource allocation model for use with initial attack airtankers under various demand criteria in Alberta.

6. Complete constuction of Fire Lab retardant spray apparatus.

7. Time and opportunity permitting appraise the effectiveness of various fire retardants and monitoring techniques on prescribed burns in the Slave Lake Forest region.

8. No publications foreseen in 1976-77.

13. Accomplishments in 1976-77:

1. The period from mid-May to mid-June was set aside for the purpose of working towards the goal of assessing on-site effectiveness of fire retardants. However, very low fire incidence during that period in the designated forest (Slave Lake) prevented data collection under wildfire conditions. Low fire hazard during the period from mid-July to mid-August precluded similar observations under experimental fire conditions in the Slave Lake forest.

2. Provided technical assistance to regional government and industrial agencies as follows:

    1. The Alberta Forest Service in-line eductor mixer saw limited use during the past fire season and N.F.R.C. participation was not requested during the brief period that it was in operation. However, two days were spent in assessing the fluidizing characteristics of the dry retardant powder assigned to these eductor bases at Calgary and Lethbridge. This was accomplished in the company of A.F.S. personnel.

    2. This product was not used in the Northern region during the past fire season, therefore no further assessment was conducted.

    3. Preliminary screening of a new long-term liquid concentrate retardant, as submitted by Enco Industries, has been completed and a written statement of our observations and recommendations was forwarded to the company. In its present formulation, it was noted that the product submitted would not meet the basic requirements of a long-term retardant as exhibited by existing commercial products.

    4. A first stage evaluation of the Fire-Trol 931 liquid concentrate blending and thickening system was completed at Slave Lake. A file report outlining observed deficiencies of the system has been prepared, and a copy forwarded to the Alberta Forest Service. It was concluded that this equipment is not yet capable of maintaining consistent quality control of the mixed and thickened retardant.

    5. Study leader spent five days in northern Manitoba reviewing the present fire control program and organization of that region, in terms of the needs for potential research undertaking. Two days were spent with D.N.S. personnel in Prince Albert, Saskatchewan discussing the province's present and future aerial fire control program. The possibilities of conducting operational research programs in Saskatchewan were discussed also.

3. Static airtanker tests were conducted at Slave Lake during August with the PBY-5A Canso. An oscilloscope and camera were rented by the Alberta Forest Service for these tests while N.F.R.C. monitoring equipment was used. Because inaccurate results were achieved during these tests with a modified flow gauge, a new gauge was designed and tested prior to repeating the tests at the Flying Fireman Ltd. headquarters in Sidney, B.C. in November, using the recording oscilloscope recently acquired by the N.F.R.C. All flow data now appear to be in order and will be processed by computer at the Northern Forest Fire Laboratory in Missoula, Montana towards the end of the present fiscal year.

4. Simulation modelling of retardant penetration and crown retention characteristics in boreal fuels could not be undertaken because of deficiencies in the computer model being developed at the Northern Forest Fire Laboratory in Missoula. The Hardy contract report on this subject is under review in terms of following through with an interim approach to the problem of rating airtanker effectiveness in relation to various fuel types.

5. Study leader finalized course work towards completion of a masters program at the U. of A. In conjunction with this program a contract was let to Dr. M.J. Hodgson of the U. of A. to develop a computer routine for a simple resource allocation model. As a result a computerized heuristic algorithm will be employed extensively in the preparation of the thesis. A draft copy of an initial thesis chapter has been prepared and has been used as the basis for two conference papers. These papers consider optimal airtanker allocation in Alberta (see publications).

6. Construction of the combustion laboratory retardant spray apparatus has once again been delayed owing to higher priority design and fabrication of static testing equipment.

7. As reported in accomplisment (1) this goal was not achieved because of unfavorable burning conditions at the Slave Lake burns site of the proposed experimental burns.

8. Publications:

1. Hodgson, M.J. and R.G. Newstead. 1977. Location-allocation procedures and forest fire suppression. Paper submitted to Pacific Regional Science Conference, Vancouver, B.C.

2. Hodgson, M.J. and R.G. Newstead. 1977. Variability in the location of Alberta forest fires: A suppression strategy. Paper submitted to annual meeting, Canadian Association of Geographers, Regina, Saskatchewan.

9. Accomplishment added: An extensive air drop testing program was undertaken at Slave Lake when low fire incidence and unfavorable conditions precluded accomplishment of anticipated goals (1) and (7). Drop patterns for the PBY-5A Canso (Fairey conversion) were completed for Fire-Trol 100 long-term retardant and Tenogum water thickening agent. One water drop was also recorded and several drops with test mixtures of Fire-Trol 931 were also conducted.

10. Accomplishment added: Three 800-gallon salvo drops of various concentrations of Tenogum mixtures were completed, along with calibration of the Tenogum injection system on board the Canso. The results of these tests were significant in that they suggested that the benefit/cost ratio of Tenogum may well be less than expected. This information coupled with further laboratory testing has been sent to several Canadian fire control agencies. The study leader attended the Canadian Committee on Forest Fire Control meeting in Ottawa in January at the request of the Department of Northern Saskatchewan to present this same information to other users of the product. These observations will appear in a forthcoming Forestry Report.

11. Accomplishment added: Two new flow gauges were designed and fabricated. These were tested under lab and field conditions as a part of the static testing program (goal 3). The hydrostatic pressure gauge was tested and rejected because of its inaccuracy and emphasis was shifted to a more reliable resistance wire gauge capable of accurately recording changing water depth in an airtanker delivery system, upon evacuation.

12. Accomplishment added: Excellent cooperation by Alberta Forest Service bird-dog officers resulted in the accumulation of valuable information on airtanker operations and effectiveness through the completion of N.F.R.C. designed air observer forms.

13. Accomplishment added: At the request of the Yukon Lands and Forest Service, a detailed examination of retardant samples revealed that the reasons for deterioration of mixed Phos-Chek retardant held in prolonged storage, resulted from bacterial degradation coupled with poor quality control at the time of mixing.

14. Goals for 1977-78:

1. Continue to assess on-site effectiveness of fire retardants through experimental and wildfire evaluation. Cooperation of the Alberta Forest Service and other interested regional agencies is anticipated.

2. Provide technical assistance to regional government and industrial agencies involved in fire control. Specifically:

    1. Continued evaluation of modified prototype Fire-Trol 931 blending and thickening system at the Slave Lake tanker base.

    2. Participate in the inaugurations of the Fire-Trol 931 retardant base operation at Meadow Lake, Saskatchewan. In concert with Department of Northern Saskatchewan staff quality control techniques will be demonstrated and applied to the introduction of this retardant mixing equipment upon its arrival at the Meadow Lake base.

    3. Training and consultation as requested.

3. Complete field evaluation of Tenogum in an effort to further quantify the effects of various concentrations on drop pattern configuration. Also, the influence of winds and drop height on thickened water drops versus plain water drops will be determined for the PBY-5A Canso (Lieskovsky).

4. Conduct static tests on Field Aviation conversions of the PBY-5A Canso. These tests depend to a large degree upon the willingness of owner-operators to cooperate with aircraft availability and may be conducted in Saskatchewan, Alberta or the N.W.T., wherever desired cooperation and ease of performance permit.

5. Complete masters thesis at the University of Alberta.

6. Complete construction of retardant spray apparatus for use in the combustion laboratory (Lieskovsky).

7. Publish article on Tenogum in forthcoming issue of Forestry Report.

8. Let contract to modify an existing location-allocation model to account for short-term variability of optimal location of forest fire suppression resources.

15. Publications:

Up to 1976-77

Grigel, J.E. 1969. Preliminary evaluation of TX-350 - A new long-term retardant. For. Br., Dep. Fish. For. Internal Rep. A-20.

Grigel, J.E. 1969. Evaluation of the nitrogen injection system of mixing Gelgard fire retardant in the PBY Canso water bomber. For. Br., Dep. Fish. For. Internal Rep. A-21.

Grigel, J.E. 1969. An injector system for mixing Gelgard fire retardant on land based airtanker operations. For. Br., Dep. Fish. For. Internal Rep. A-22.

Grigel, J.E. 1970. The use of airtankers for fire suppression in Canada. Can. For. Serv., Dep. Fish. For. Internal Rep. A-33.

Grigel, J.E. 1970. Fire retardants and their use in Western Canada. Can. For. Serv., Dep. Fish. For. Inf. Rep. A-X-38.

Lieskovsky, R.J. 1971. Drop pattern for Twin Otter Membrane Tank system. Can. For. Serv., Dep. Environ. Internal Rep. NOR-2.

Grigel, J.E. 1971. Air drop tests with Fire-Trol 100 and Phos-Chek 205 fire retardants. Can. For. Serv., Dep. Environ. Inf. Rep. NOR-X-8.

Grigel, J.E. and R.J. Lieskovsky. 1972. A comparison of the B-26 and Thrush Commander airtankers. Can. For. Serv., Dep. Environ. Inf. Rep. NOR-X-17. (Replaces unpublished Internal Rep. NOR-6).

Bradford, Samuel A. 1973. Corrosion of metals in fire retardants. Can. For. Serv., Dep. Environ. Inf. Rep. NOR-X-66.

Lieskovsky, R.J., R. Kruger, and R.G. Newstead. 1974. Problems in mixing and storage of long-term retardants in Alberta. Can. For. Serv., Dep. Environ. Inf. Rep. NOR-X-94. (Replaces File Rep. NOR-Y-68).

Grigel, J.E., R.J. Lieskovsky, and R.G. Newstead. 1974. Air drop tests with helitankers. Can. For. Serv., Dep. Environ. Inf. Rep. NOR-X-77.

Grigel, J.E. 1974. Role of the helitanker in forest fire control. Can. For. Serv., Dep. Environ. Inf. Rep. NOR-X-123.

Grigel, J.E., R.G. Newstead, and R.J. Lieskovsky. 1975. A review of retardant delivery systems used in fixed-wing airtankers. Can. For. Serv., Dep. Environ. Inf. Rep. NOR-X-134.

In addition the following contributions have been prepared for:

Forestry Report Vol. 1, No. 1
- Short and long-term fire retardants.
- The B-26 airtanker.

Forestry Report Vol. 2, No. 1
- Portable helitanker retardant systems for the Yukon.
- B-26 airtanker air drop tests with liquid concentrate.
- PBY Canso air drop tests with Gelgard retardant.

- Sikorsky S58T drop tests with Phos-Chek retardant.
- Modification of chemical injection system in the PBY Canso airtanker.
- Airtanker simulation model.

Forestry Report Vol. 3, No. 1
- Recent airtanker drop tests.
- Quality control - a must.

Forestry Report Vol. 4, No. 4. 1975
- Determining airtanker accuracy or How to make nobody happy

Hardy, C.E. (contract report) 1975
- Operational assessment of the effectiveness of aerially applied fire retardants under wildfire operations (file report plus copy submitted to cooperative contractor A.F.S.).

16. Signatures:

Investigator

Program Manager

Director G.T. Silver

NOR-5-128

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1977 - 78

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 7, 1977

1. Project: Reduction of losses by improved fire suppression methods.

2. Title: Assessment and development of fireline systems.

3. New: Cont.: X 4. No.: NOR-5-128

5. Study Leader: D. Quintilio

6. Key Words: fuel types, fire behavior, bulldozers, airtankers, handcrews.

7. Location of Work: Region wide.

8. Problem:

The greatest percentage of the suppression budget is usually allocated to aircraft, bulldozers, and handcrews employed to build firelines. To maximize the effect of each suppression dollar by planning for optimum resource allocation, agencies require fundamental knowledge of production rates and effectiveness of the above techniques. To date little information exists describing line building capabilities of fireline systems, hence efficiency is much below acceptable levels. Along with assessing existing fireline systems the study will develop new techniques and concepts with modern capabilities.

This work will create a data bank of productivity rates for existing and potential fireline systems, which will eventually be used for optimum allocation models. Preliminary information from this study and NOR 037 and NOR 131 has already been incorporated into an initial attack simulation model (NOR 130).

Methods:

1. Ground attack systems

Major fuel types are stratified according to resistance to control.

A time and motion study has been designed to document productivity of bulldozers and handcrews.

The use of explosives will be developed for fireline use and effectiveness, cost and productivity will be compared to handline work.

2. Air attack systems

Available drop patterns of airtankers and helicopters will be reviewed to determine fireline construction rates under ideal conditions.

Wildfires will be assessed to determine deviation of fireline construction rates under operational conditions, i.e., drop accuracy, drop height and speed, actual load carried.

An aerial ignition device for backfiring and burnout will be developed and tested utilizing methods pioneered in Australia.

An aerial marking device for relocating reported fires by initial attack crews will be developed utilizing the low frequency transmitter principle of wildfire tracking systems.

9. Study Objectives:

1. To provide accurate productivity rates of bulldozers, handcrews, and airtankers for fireline building in regional fuel types.

2. To promote and extend research results to client agencies as required.

10. Resources:

a. Starting date: 1972
b. Estimated year of completion: 1978
c. Estimated total Prof. man-years required: 3.5
d. Essential new major equipment items for 1977-78 with costs: Nil
e. Essential new major equipment items beyond 1978 with costs: Nil
f. 1977-78 man-years

Prof.	0.3 (Quintilio)
Supp.	0.4 (Maffey)
Casual	0.3
Total	1.0

11. Progress to Date:

The study was introduced to the Alberta Forest Service and cooperative guidelines were formed to facilitate the initial summer's work. A standardized format was prepared for the data collection pertaining to ground attack systems. This was reviewed by AFS field personnel and finalized for use during 1972. CFS personnel manned spring fires in the Whitecourt and Slave Lake Forest Districts and the format was improved based on field experience. Four hundred field forms were distributed to selected AFS districts for 1973 use.

The bulldozer fireline assessment format was introduced to provincial agencies during the annual Fire Plans Course at Hinton, May 19, 1973. Two hundred forms were distributed to sector and cat boss personnel and a field exercise was conducted on the school forest. Fourteen fires were subsequently monitored by the Alberta Forest Service and data for 29 miles of fireline construction were received at N.F.R.C.

N.F.R.C. personnel collected data on wildfires in Alberta and N.W.T. and 78 miles of bulldozer and 5 miles of handline observation are documented.

12. Goals for 1976-77:

1. Monitor selected wildfires throughout the region as a means of building data banks for airtanker, bulldozer and handcrew productivity rates.

2. Publish the following:

Quintilio, D. 1976. Fire control application of bulldozers. Inf. Rep.

Murphy, P.J. and D. Quintilio. 1976. Handcrew fireline production rates in Alberta fuel types. Inf. Rep.

Quintilio, D., G.R. Fahnestock, and D.E. Dubé. 1976. The Darwin Lake project, a cooperative study of fire behavior. Inf. Rep. 174.

3. Goal added: Continue liaison assignments as requested.

4. Goal added: Participate in cooperative fire research projects.

5. Goal added: Re-inventory Slave Lake aspen plots.

13. Accomplishments in 1976-77:

1. No appropriate wildfires.

2. Quintilio, D., G.R. Fahnestock and D.E. Dubé. 1977. Fire behavior in upland jack pine - The Darwin Lake project. Dep. of Environ., Can. For. Serv., North. For. Res. Cent. Inf. Rep. NOR-X-174.

Murphy, P.J. and D. Quintilio. 1977. Handcrew fireline production rates in Alberta fuel types. Inf. Rep. NOR-X- (In review).

Quintilio, D. 1977. Fire control application of bulldozers. Inf. Rep. NOR-X- (First draft).

3. Participated in a joint AES/CFS training session in Inuvik, N.W.T. Presented FWI and fire behavior lectures.

   Participated in a familiarization trip to Manitoba forest districts.

4. Participated in planning of the Slave Lake black spruce burns and implementation of the Jasper National Park burn.

5. Conducted a mortality inventory of Slave Lake aspen burns and supervised contract KL015-76-0224 for data compilation and summary.

14. Goals for 1977-78:

1. Monitor selected wildfires throughout the region as a means of building data banks for airtanker, bulldozer and handcrew productivity rates.

2. Complete reports as listed:

   Quintilio, D., G.R. Fahnestock and D.E. Dubé. 1977. Fire behavior in upland jack pine - The Darwin Lake Project. Dept. of Environ., Can. For. Serv., North. For. Res. Cent. Inf. Rep.

   Murphy, P.J. and D. Quintilio. 1977. Handcrew fireline production rates in Alberta fuel types. Inf. Rep. NOR-X-

   Quintilio, D. 1977. Fire control application of bulldozers. Inf. Rep. NOR-X-

   Quintilio, D. and R.L. Ponto. 1977. Spring burns in a 50-yr-old aspen stand. Inf. Rep. NOR-X-

15. Publications:

Up to 1976-77

Lait, G.R. and W.C. Taylor. 1973. Backfiring and burnout techniques used in the Yukon. Can. For. Serv., North. For. Res. Cent., Edmonton, Alberta. Inf. Rep. NOR-X-43.

Ponto, R.L. and G.M. Lynch. 1973. Use of electronic markers to relocate small forest fires. Can. For. Serv., North. For. Res. Cent., Edmonton, Alberta. Inf. Rep. NOR-X-61.

Ponto, R.L., D. Quintilio, P. Bihuniak, and G.R. Lait. 1974. An incendiary priming and release mechanism for backfiring from aircraft. Can. For. Serv., North. For. Res. Cent., Edmonton, Alberta. Inf. Rep. NOR-X-75.

Dubé, D.E. 1973. Fire control methods in the black spruce-Labrador tea-Cladonia fuel complex. North. For. Res. Cent., Edmonton, Alberta. File Report.

Ponto, R.L. 1974. Electronic fire marker being tested in Canada. USDA Forest Serv., Fire Management 35(2):15.

Kiil, A.D. and D. Quintilio. 1975. A resume of current forest fire research in Canada. File Report.

1976-77

Nil

16. Signatures:

Investigator

Program Manager

Director G.T. Silver

NOR-5-130

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1977 - 78

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 7, 1977

1. Project: Reduction of losses by improved fire suppression methods.

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

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

5. Study Leader: D. Quintilio, D. Kiil

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

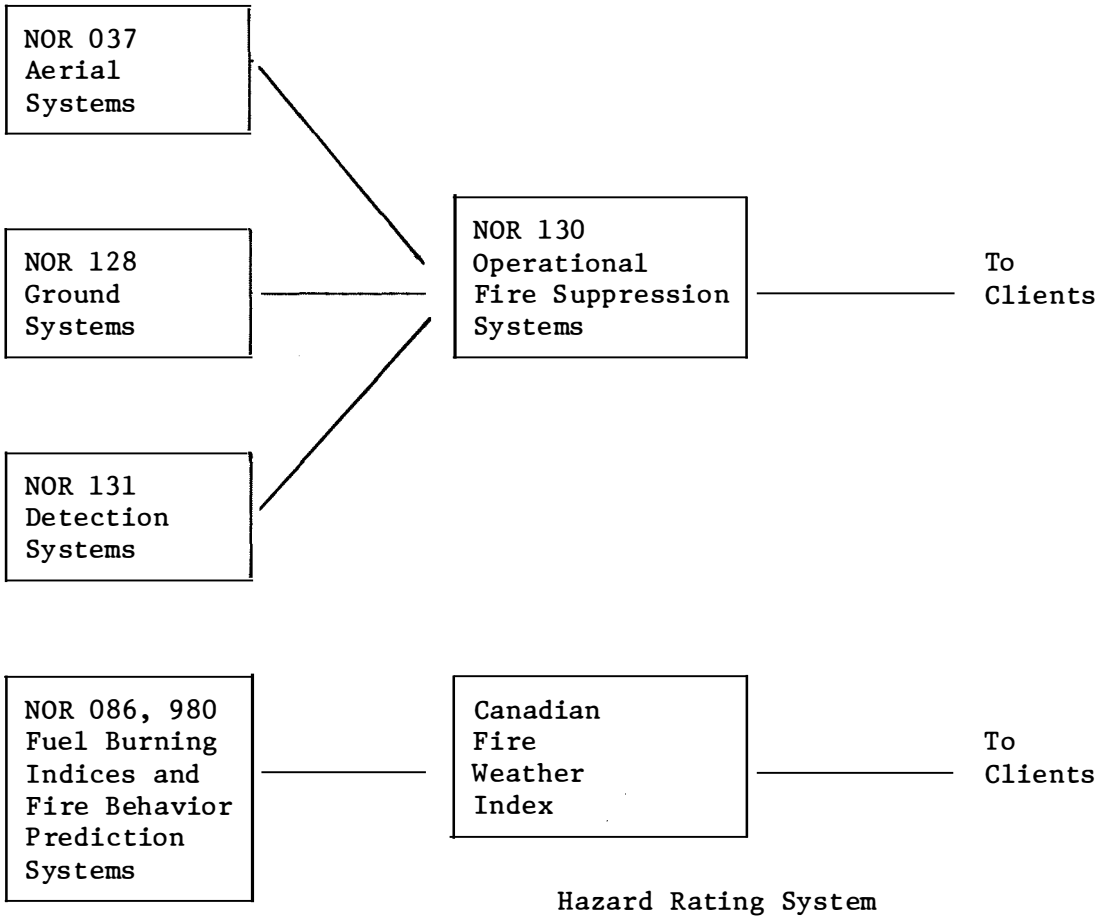
7. Location of Work: Northern Forest Research Centre.

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.



Hazard Rating System

Methods

- Review agency operations to delineate and define the problem, and to select a prototype forest district.
- Construct a study team of Alberta Forest Service field personnel, Alberta Forest Service headquarters personnel, Canadian Forestry Service personnel, and systems analyst consultant.
- Conduct weekly meetings to determine the variables for a simulation model.
- Sort and transfer 10-fire and weather data to IBM-360 tape.
- Compile line building capability of the initial attack systems.
- Design flow chart for the intial attack model.
- Program and run the model.
- Analyze results and present guidelines.

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 1977-78 with costs: Nil
e. Essential new major equipment items beyond 1978 with costs: Nil
f. 1977-78 man-years

Prof.	0.7	(Quintilio)
	0.9	(Kiil)
	1.6	
Supp.	0.6	(Maffey)
Casual	0.0	
Total	2.2	

11. Progress to Date:

An inter-agency study group was formed to develop a simulation model for three initial attack methods, i.e. helicopters, airtankers, 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.

Final results of the first generation simulation runs were presented to the Alberta Forest Service, Protection Branch, on January 6, 1976, at NFRC.

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.

12. Goals for 1976-77:

1. Update 1972-73 input parameters with current information and conduct second generation runs. (Quintilio)

2. Re-design the program to allow suppression techniques, i.e., handcrews and airtankers, to operate simultaneously on individual fires. (Quintilio)

3. Coordinate workshop sessions necessary to update model. (Quintilio)

4. Continue FWI Task Force and liaison assignments as required. (Quintilio)

5. Publish report:

   Quintilio, D. and W.A. Anderson. 1976. Simulation study of three initial attack systems--a progress report. Inf. Rep.

6. Prepare draft problem analysis to identify and evaluate new research and technology transfer needs and requirements in support of fire management activities, including fire impact on environment, cost/benefit concerns, improved statistical base for management, and guidelines for implementation. (Kiil)

7. Continue serving on the following committees: (Kiil)

   1. Western Fire Weather Committee
   2. Central Fire Weather Committee
   3. Forest Committee of the National Fire Protection Association
   4. Metric Sub-committee of the Canadian Committee on Forest Fire Control
   5. Development Committee - AFS/CFS Policy on Meteorological Services for Fire Control
   6. Regional Fire Research Committee.

8. Prepare the following reports:

   Performance of the Fire Weather Index in relation to fire activity in Alberta (Kiil, Miyagawa, Quintilio). Inf. Rep.

   The forest fuel complex in four forest types in Alberta (Kiil). Inf. Rep.

9. Coordinate proposed fire behavior/retardant evaluation program in Slave Lake Forest. (Kiil)

10. Goal added: As member of a DOE in-house task force on federal financial assistance for forest protection, provide updated statistics for task force report. (Kiil)

11. Goal added: Serve as CFS representative on a CCFFC-appointed working group on fire-damage appraisal in Canada. (Kiil)

12. Goal added: To coordinate the regional forest fire research program. (Kiil)

13. Goal added: To initiate plans for a CFS-sponsored international symposium on fire behavior, effects and management implications in black spruce, to be convened in Edmonton in the fall of 1978. (Kiil)

13. Accomplishments in 1976-77:

1. Handcrew and airtanker productivity data were reviewed with the Alberta Forest Service. A second generation run is complete for handcrews and airtankers will be re-run following completion of the Slave Lake retardant effectiveness study.

2. The growth model has been re-designed and dispatch logic for simultaneous operation of helitankers and handcrews is complete. A computer program is in preparation to account for the changes.

3. Four workshop sessions were scheduled and conducted to develop the logic required for combining resources on individual fires.

4. Participated in the national FWI Task Force meeting, April 13-15, at NFRC. Finalized outline for User's Manual. Supervised contracts KL015-6-0206 and KL015-6-0279. (Kiil & Quintilio)

5. Completed.

6. A problem analysis was initiated to identify and to evaluate new research and technology transfer needs in support of fire management activities carried out by the regional agencies. The current research and development program, aimed at satisfying the short-term needs of federal, provincial and industrial fire management agencies, has resulted in a relatively high level of implementation of research findings and continued support of joint cost-sharing programs. Recommendations are made to guide the future development of the regional fire research program.

7. Kiil continued to serve on the following committees:

    1. Western Fire Weather Committee - attended first annual meeting in Edmonton and outline progress in fire weather and fire behavior research.

2. Central Fire Weather Committee - attended first annual meeting in Winnipeg.

3. Forest Committee of the National Forest Protection Association - Attended the annual meeting of this Committee in Houston, Texas and presented a progress report on fire research in the CFS.

4. Metric Sub-committee of the Canadian Committee of Forest Fire Control - attended a meeting of this committee in Winnipeg, to discuss conversion to metric system by provincial fire control agencies.

5. Development Committee - AFS/CFS Policy on Meteorological Services for Fire Control - attended first annual meeting of Development Committee in Toronto to discuss implementation of DOE policy relating to meteorological services in fire control. Also prepared a brief statement of services needed by provincial fire management agencies, including recommendations for improved level of service as required by individual agencies.

6. Regional Fire Research Committee - acted as chairman at the annual meeting of this Committee in Edmonton to review research accomplishments and to identify new research needs and requirements in the region.

8. Reports:

Kiil, A.D., R.S. Miyagawa and D. Quintilio. 1977. The calibration and performance of the Fire Weather Index in Alberta. Inf. Rep. NOR-X-173 (Final editing).

Kiil, A.D. 1977. The fuel complex in four forest types in Alberta. (First draft).

9. Coordinated the development and field implementation of a joint AFS/CFS fire behavior/retardant evaluation program in the Slave Lake Forest.

10. On special assignment in Ottawa, completed an updating of statistics for a DOE in-house task force report on federal assistance in forest protection.

11. Participated in national workshop session in Toronto to identify and discuss needs and opportunities for research on fire damage appraisal.

12. Coordinated regional fire research program. Visited the Northern Fire Research Laboratory in Missoula and the Interagency Fire Centre in Boise to keep abreast of research and operational programs at these centres. Established and maintained contact with numerous fire control agencies in Canada and the U.S. involving exchange of information, development of joint projects and relevant research activities. Carried out administrative and supervisory duties as required. Participated in a week-long field trip to Manitoba to obtain first-hand knowledge of fire control operations and research opportunities in that province.

13. Obtained approval in principle to proceed with plans for an international symposium on fire behavior and effects in black spruce. Contacted numerous individuals and agencies and received replies largely in favour of the proposed symposium.

14. Goals for 1977-78:

1. Continue running the simulation model for new airtankers and helitankers as requested (Quintilio).

2. Initiate a new integrated work program using simulation modelling as a tool for comparing the magnitude of differences between fire management alternatives. Develop study methodology and organization. Continue and expand work to develop fire spread and impact models for major vegetation types in the region. Initiate modelling work to simulate airdrop penetration through regional fuel types and expand work on fireline construction predictor. (Members of fire research group).

3. Continue to serve on the following committees and task force groups (Kiil).

    1. Western Fire Weather Committee
    2. Central Fire Weather Committee
    3. Forest Committee - NFPA
    4. Development Committee - AFS/CFS
    5. Regional Fire Research Committee
    6. CFS in-house task force on Federal Assistance to Forest Protection.

4. Firm up plans for a CFS-sponsored international symposium on fire behavior and effects in black spruce, including fire management implications, to be held in Edmonton in late 1978 (Kiil).

5. Coordinate and participate in a joint AFS/CFS fire behavior/retardant evaluation study in the Slave Lake Forest in spring, 1977 (Kiil and Quintilio).

6. Coordinate the Fire Research Program at NFRC (Kiil).

15. Publications:

Up to 1976-77

Quintilio, D. 1975. Simulation of three initial attack systems. For. Rep. Vol. 4, No. 4.

1976-77

Quintilio, D. and A.W. Anderson. 1976. Simulation study of initial attack fire operations in the Whitecourt Forest, Alberta. Dept. of Environ., Can. For. Serv., North. For. Res. Cent., Inf. Rep. NOR-X-166.

Kiil, A.D., R.S. Miyagawa and D. Quintilio. 1977. Calibration and performance of the Fire Weather Index in Alberta. Dept. of Environ., Can. For. Serv., North. For. Res. Cent., Inf. Rep. NOR-X-173.

16. Signatures:

Investigator

Program Manager

Investigator

Director G.T. Silver

NOR-5-131

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1977 - 78

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 7, 1977

1. Project: Reduction of losses by improved fire suppression methods.

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: J. Niederleitner

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 loses 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:
c. Estimated total Prof. man-years required:
d. Essential new major equipment items for 1977-78 with costs: Nil
e. Essential new major equipment items beyond 1977 with costs: Nil
f. 1977-78 man-years

Prof.	0.0	
Supp.	2.0	(Niederleitner, Ogilvie)
Casual	0.0	
Total	2.0	

11. Progress to Date:

1. Yukon Territory - Inspected in the field, mapped and evaluated the existing detection and communication system of the Yukon Territory. Based on extensive field surveys designed and submitted to the Yukon Lands and Forest Service a proposed wildfire detection and

communications plan. The plan included details of area coverage, location and function of each existing and proposed lookout or communication site, within the system as well as details and plans describing type and quantity of equipment, installations and personnel needed.

Manning and operating rules, objectives to aim for and budgetory estimates were also provided. Most of our recommendations have been implemented.

2. Similar plans with less emphasis on the communications aspect were prepared for the Northwest Territories and the Wood Buffalo National Park. Both agencies have made considerable progress in implementing our recommendations.

3. Experimented with the AGA Thermovision 680 and 750 infrared scanning systems as well as Tivicon and Vidicon television system to establish if either instrument could contribute to fire detection or intelligence.

   While the Tivicon and Vidicon systems failed to produce convincing results, the Thermovision 750 system established the usefulness of hand-held infrared scanners in fire control. In 43 missions flown under widely differing conditions in various provinces the scanner convincingly showed that it can detect more holdover fires faster and more reliably than all other known methods combined.

   Numerous forestry personnel and representatives of private industry (170) as well as pilots (6) were exposed to the pertinent field operating techniques developed for the purpose of detecting holdover fires on forest land.

   The NFRC Sony vidicon system was successfully adapted to record the Thermovision imagery on tape in flight.

4. An NFRC developed 12 volt rechargeable heavy duty power supply unit designed to power remote sensing equipment in aircraft has operated trouble free for hundreds of hours during the last three years.

5. In order to provide client agencies with an opportunity to gain first hand experience in the operation of an infrared line scanner a "Barnes Airborne Fire Spotter" was purchased and tested. After power supply and mounting problems were overcome, the scanner was operated for several seasons by various fire control agencies on routine air patrol flights over selected targets. Despite some success all agencies found the unit too unreliable to be of value.

6. A joint project with the Alberta Forest Service to test "Quality Technology" lightning counters was abandoned because of conflicting results and difficulties to obtain a full complement of counters in time.

7. Sets of small scale aerial photography and satellite imagery were secured over a study area in the Slave Lake Forest, containing fire scars of various vintage. It was established that 1:120,000 aerial infrared false color photography is a suitable medium for mapping fire damage in a variety of forest cover.

8. Concluded work as member of a joint AFS Detection Task Force 69-4. This work is summarized in:

   Joint Task Force AFS 69-4 (Korsten, H., R.S. Miyagawa, J. Niederleitner). 1974. Detection System Analysis. Unpublished report to S.R. Hughes, Head, Forest Protection Branch, A.F.S.

9. Met with Saskatchewan fire control official and arranged the work schedule for the 1976-77 phase of the detection system evaluation in that province.

10. Secured unpublished information and test results highlighting the fire potential of catalytic converters on vehicle exhaust systems and distributed this material to fire control agencies in western Canada.

11. Designed and built a simple sighting device to aid air observers in estimating distances on the ground. Ten models of the device were issued to field personnel for testing.

12. Held a one week lookoutman's training course at Whitehorse, Yukon Territory for three consecutive years and provided fire management agencies with consultation and training assistance as requested.

13. Prepared the following reports:

    1. Wildfire Detection Study, Yukon Territory Telecommunications Supplement. (Draft of a progress report to the Yukon Forest Service).

    2. Intermediate Report, Wildfire Detection Study, Mackenzie Forest. (Draft of a progress report to the Mackenzie Forest Service).

    3. Interim Report, Wood Buffalo National Park, Wildfire Detection System. (Draft of a progress report to the Wood Buffalo Park administration).

    4. Infrared Scanners for Cold Trailing. (Draft of a progress report to the Alberta Forest Service).

5. Intermediate Report, Wildfire Detection Study, Yukon Territory.

6. Completed final file report to the Northwest Territories.

12. Goals for 1976-77:

1. Commence fieldwork for the purpose of evaluating the detection system of the western forest region in Saskatchewan by:

    1. taking sets of panoramic photographs from 35 existing lookouts

    2. drawing seen area field sketches from each site and investigating seen area obstructions or possible alternate sites in the immediate vicinity of each lookout location

    3. inspect lookout installations for safety (lightning protection, helicopter landing hazards) and efficiency (accuracy of fire finder, location and state of weather instruments, available maps).

2. Process field information collected in Saskatchewan:

    1. process, assemble, annotate, orient and interpret panoramic photographs (40 photos per lookout site - total 1400 photographs)

    2. construct cross-section profiles for each lookout site at (at least) 10° of azimuth out to 25 miles (40 km) from each lookout site (minimum of 1260 cross-section profiles)

    3. compile seen area maps for each lookout based on panoramic photographs and cross-section profiles

    4. compile and analyze all information, prepare a progress report to the client agency.

3. Complete all reporting in respect to the work done in the Yukon Territory, in the Wood Buffalo National Park and the Northwest Territories. Publish the detection/communication plan for the Yukon and the detection plan for N.W.T. as information reports.

4. Investigate the feasibility and develop procedures for the use of the Thermovision 750 system in fire mapping, observing fire behavior and monitoring of airdrops through vision obscurring smoke.

5. Investigate the suitability of the Barnes Airborne Fire Spotter as a support tool to aerial patrols over boreal forest cover.

6. Help the Northwest Lands and Forest Service in the Wood Buffalo National Park administration in implementing the recommendations contained in the submitted reports by guiding construction crews to the respective sites, advise on type of installations to be used, etc.

7. Provide fire management agencies with consultation and training in the field of fire detection, surveillance or communicatons as requested.

8. Goal added: Investigate the possibility of using the Thermovision 750 system as detection tool to cover strips up to 2 km wide in one flight for the purpose of lightning fire detection.

9. Goal added: Conduct a comparative test between the AGA Thermovision 750 and the Hughes Probeye to determine which instrument is best suited for the various aspects of forest fire detection.

13. Accomplishments 1976-77:

1. Completed fieldwork as planned in Saskatchewan, i.e.:

    1. took photographs from all lookouts located west of 106° longitude (28)

    2. completed seen area field sketches

    3. inspected lookout installations.

2. Processed field information as planned - including processing, assembling, interpreting photographs, profiling each site, determining seen area and prepared progress report to the agency.

3. Completed final report for Wood Buffalo National Park.

4. No work was done with the AGA Thermovision 750 in respect to fire mapping, observing fire behavior or airdrops because suitable fires were lacking in Alberta.

5. The Barnes Airborne Fire Spotter was operated one season by the Yukon Forest Service.

6. No requests for assistance were received from the Northwest Lands and Forest Service and the Wood Buffalo National Park's administration.

7. Trained aerial observers of the Yukon Lands and Forest Service in operating the Barnes Airborne Fire Spotter. Assisted the Ontario Ministry of Natural Resources in detecting holdover fires with the AGA Thermovision 750 during their severe fire flop in in the Dryden area.

   Presented paper and slide shows on holdover fire detection techniques at the Third Infrared Information Exchange (IRIE) in St. Louis, Missouri , as well as to fire control personnel in California, the Yukon Territory, Manitoba, Saskatchewan and Alberta. Partly due to our efforts, hand-held infrared scanners will be used during the coming fire season by eight provinces and territories and some states in the U.S.A.

8. Built a prototype device intended to cover a strip of terrain approximately two km wide with the AGA Thermovision 750. Initial field tests with the device were encouraging (AGA SCAN EXTENDER).

9. Subjected the Hughes Probeye and the AGA Thermovision 750 to comparative laboratory and field tests.

10. Continued to collect information on catalytic converters - a sort of an afterburner built into the exhaust system of new cars. Although these devices can get hotter than a welding torch, no problems have surfaced in western Canada, however, this does not change the fact that converters have a fire starting potential.

11. Prepared a file report titled: "Thanks to infrared technology sleeper fires are finding less rest these days".

14. Goals for 1977-78:

1. Continue the seen area mapping for Saskatchewan by selecting 25 lookouts in the settlement fringe area and:

    1. take sets of panoramic photographs from 25 existing lookouts

    2. draw seen area field sketches from each site and investigating seen area obstructions or possible alternate sites in the immediate vicinity of each lookout location

    3. inspect lookout installations for safety (lightning protection, helicopter landing hazards) and efficiency (accuracy of fire finder, location and state of weather instruments, available maps).

2. Process field information collected as follows:

    1. process, assemble, annotate, orient and interpret panoramic photographs (40 photos per lookout site - total 1400 photographs)

    2. construct cross-section profiles for each lookout site at (at least 10° of azimuth out to 25 miles (40 km) from each lookout site (minimum of 1260 cross-section profiles)

    3. compile seen area maps for each lookout based on panoramic photographs and cross-section profiles.

    4. compile and analyze all information, prepare a progress report to the client agency.

3. Complete all reporting in respect to the AGA Scan Extender and the comparative tests of the AGA Thermovision and the Hughes Probeye. Publish the detection/communications plan for the Yukon and the N.W.T. as information reports.

4. Help the Northwest Lands and Forest Service and the Wood Buffalo National Park administration in implementing the recommendations contained in the submitted reports. Investigate the feasibility of additional lookout and communications sites for both administrative areas and survey possible sites in the field.

5. Examine the feasibility and develop procedures for the use of the Thermovision 750 system in fire mapping, observing fire behavior and monitoring airdrops through vision obscurring smoke.

6. Provide fire management agencies with consultation and training in the field of fire detection, surveillance and communications as requested.

15. Publications:

Up to 1976-77

Niederleitner, J. 1971. Remote sensing in forest fire control. Report on symposium June 1971, Missoula, Montana. Inf. Rep. NOR-1.

Northern Forest Research Centre - Forestry Report

Vol. 1 - 1 March 1971 - pp. 8.
Vol. 2 - 1 July 1972 - pp. 8.
Vol. 3 - 1 June 1973 - pp. 8 (Infrared assistance to the aerial observer)
Vol. 3 - 3 Oct. 1973 - pp. 12 (Mapping burned-over forests)

These reports described in abbreviated manner results of current research at NFRC in fire suppression and fire behavior.

Niederleitner, J. and G.R. Lait. 1972. Tivicon television camera: A new fire line reconnaissance tool; laboratory trials. Can. For. Serv. Internal Rep. NOR-15.

Niederleitner, J. 1972. Demonstration of AGA Thermovision System 680 in Edmonton. Can. For. Serv. Miscellaneous Rep. NOR-Y-16.

Niederleitner, J. and P. Bihuniak. 1976. A heavy duty 12 volt dc power pack to operate airborne remote sensing systems. Can. For. Serv. Inf. Rep. NOR-X-147.

Niederleitner, J. 1976. Detecting holdover fires with the AGA Thermovision 750 infrared scanner. Can. For. Serv. Inf. Rep. NOR-X-151.

Niederleitner, J. 1975. The fire mop-up "Shell Game". Odds now improved. Forestry Rep. 4(4). Dec. 1975.

1967-77

Niederleitner, J. 1976. A pocket fire size estimator for aerial observers. Can. For. Serv. Inf. Rep. NOR-X-157.

Niederleitner, J. 1976. Detecting low intensity sleeper fires with the airborne AGA Thermovision 750 infrared scanner. Paper presented at the Third Biennial Infrared Information Exchange at St. Louis, Missouri. Proceedings in press.

16. Signatures:

Investigator

Program Manager

Director G.T. Silver

NOR-6-086

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1977 - 78

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 7, 1977

1. Project: Evaluation and rating of fire behavior and effects in forest ecosystem.

2. Title: Fire behavior in boreal forest fuels.

3. New: Cont.: X 4. No.: NOR-6-086

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: 1973 Revised: 1980
c. Estimated total Prof. man-years required: 5.0
d. Essential new major equipment items for 1977-78 with costs: Nil
e. Essential new major equipment items beyond 1978 with costs: Nil
f. 1977-78 man-years

Prof.	1.0	(Chrosciewicz)
Supp.	1.0	(Gordey)
Casual	0.6	
Total	2.6	

12. 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 initiated in 1975 on 16 jack pine plots, and these were scheduled for completion in 1976.

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 1976-77:

1. Publication of the following:

    1. Chrosciewicz, Z. 1976. Large-scale operational burns for slash disposal and conifer reproduction in central Saskatchewan. Inf. Rep.

    2. Chrosciewicz, Z. 1976. Jack pine regeneration following burning and seeding treatments in central Saskatchewan. Inf. Rep.

2. Submission of the following for publication:

    3. Chrosciewicz, Z. 1976. Seasonal variations in foliar moisture of four conifers in central Alberta. Can. J. For. Res.

3. Analysis of data re. seasonal variations in foliar heat content of the four conifers calorimetrically tested in 1975.

4. Assessment of postburn conditions (plant succession and tree regeneration) on more recent experimental and operational burns.

5. Completion of stand inventory on the remaining jack pine plots, 4 for trees, ground vegetation, dead dimensional fuels, litter, duff, etc., and 12 for shrubs.

6. Setting-up a pilot test to study both fire behavior and aerial suppression methods through burning a lowland black spruce stand, 2 ha in area.

7. Goal added: Initiation of destructive sampling for fuel-weight determinations on jack pine plots.

8. Goal added: Completion of stand inventory on six black spruce plots.

13. Accomplishments in 1976-77:

1. Paper (1) was prepared, and it is now under review; paper (2) is nearing completion. They both should be ready for publication as Information Reports before the end of fiscal 1976-77.

2. Paper (3) is currently in preparation, and it will be submitted to the Canadian Journal of Forest Research by the end of fiscal 1976-77.

3. Analysis of data re. seasonal variations in foliar heat content of four conifers was completed with good results.

4. Assessment of postburn conditions (plant succession and tree regeneration) was carried out on more recent experimental and operational burns.

5. Stand inventory (trees, shrubs, ground vegetation and various surface fuels) was completed on all sixteen jack pine plots.

6. To study fire behavior and aerial suppression, six black spruce plots were established on a lowland site.

7. Destructive sampling of various living and dead plant materials was initiated in the stand next to the jack pine plots for fuel-weight determinations.

8. Stand inventory (trees, shrubs, ground vegetation and various surface fuels) was completed on all six black spruce plots.

14. Goals for 1977-78:

1. Publication:

1. Chrosciewicz, Z. 1977. Large-scale operational burns for slash disposal and conifer reproduction in central Saskatchewan. Inf. Rep.

2. Chrosciewicz, Z. 1977. Jack pine regeneration following burning and seeding treatments in central Saskatchewan. Inf. Rep.

2. Preparation:

3. Chrosciewicz, Z. 1977. Moisture variations of conifer foliage in central Alberta. Can. J. For. Res.

4. Chrosciewicz, Z. 1977. Calorific variations of conifer foliage in central Alberta. Can. J. For. Res.

3. Continuation of destructive sampling for preburn fuel-weight assessments on pine plots in central Alberta.

4. Experimental burning for fire behavior determinations on jack pine plots in central Alberta.

5. Experimental burning for aerial suppression studies on black spruce plots in central Alberta.

6. Postburn assessments of plant succession and pine regeneration on experimental plots in southeastern Manitoba.

7. Processing field and laboratory data as they become available.

8. Providing on request consultative services and conducting seminars.

15. Publications:

Up to 1976-77.

Chrosciewicz, Z. 1967. Experimental burning for humus disposal on clear-cut jack pine sites in central Ontario. Can. Dep. For. Rural Develop., For. Br. Publ. No. 1181. 23 p.

Chrosciewicz, Z. 1968. Drought conditions for burning raw humus on clear-cut jack pine sites in central Ontario. For. Chron. 44(5):30-31.

Chrosciewicz, Z. 1969. Brûlage expérimental afin de'éliminer 1'humus dans les bûchés à blanc de pin gris en Ontario central. Can. Min. Pêches Forêts Dir. Gen. Forêts, Publ. No. 1181F. 22 p.

Chrosciewicz, Z. 1970. Regeneration of jack pine by burning and seeding treatments on clear-cut sites in central Ontario. Can. Dep. Fish. For., Can. For. Serv. Inf. Rep. O-X-138. 13 p.

Kiil, A.D. and Z. Chrosciewicz. 1970. Prescribed fire--its place in reforestation. Can. Coun. Res. Min., For. Reader, Pap. No. 7. also For. Chron. 46(6):448-451.

Chrosciewicz, Z. 1971. The growth response of young jack pine to moderate and extreme stand densities. Can. Dep. Environ. Bi-mon. Res. Notes 27(1):6.

Chrosciewicz, Z. 1971. Silvicultural uses of fire. Can. Dep. Fish. For., Can. For. Serv., Prairies Reg. For. Rep. 1(1):4-5.

Quintilio, D. 1972. Fire spread and impact in lodgepole pine slash. Master's Thesis, Univ. Montana, Missoula, Mon. 69 p.

Quintilio, D. 1972. A burning index for lodgepole pine logging slash with descriptive hazard chart. Can. Dep. Environ., Can. For. Serv., North. For. Res. Cent. Supplement NFRC-1. 4 p.

Chrosciewicz, Z. 1973. Controlled burning in Saskatchewan. Environ. Can., Can. For. Serv., North. For. Res. Cent. For. Rep. 3(1):7.

Kiil, A.D., R.J. Lieskovsky and J.E. Grigel. 1973. Fire hazard classification for Prince Albert National Park, Saskatchewan. Environ. Can., Can. For. Serv., North. For. Res. Cent. Inf. Rep. NOR-X-58. 26 p.

Chrosciewicz, Z. 1974. Evaluation of fire-produced seedbeds for jack pine regeneration in central Ontario. Can. J. For. Res. 4(4):455-457.

Kiil, A.D. 1975. Fire spread in a black spruce stand. Environ. Can., Can. For. Serv. Bi-mon. Res. Notes 31(1):2-3.

Chrosciewicz, Z. 1975. Correlation between wind speeds at two different heights within a large forest clearing in central Saskatchewan. Environ. Can., Can. For. Serv., North. For. Res. Cent. Inf. Rep. NOR-X-141. 9 p.

Chrosciewicz, Z. 1975. The pill, the bomb ... and fire behavior. Environ. Can., Can. For. Serv., North. For. Res. Cent. For. Rep. 4(4):3.

1976-77

Chrosciewicz, Z. 1976. Burning for black spruce regeneration on a lowland cutover site in southeastern Manitoba. Can. J. For. Res. 6(2):179-186.

Chrosciewicz, Z. 1977. 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-175. 16 p.

Chrosciewicz, Z. 1977. 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-176. 18 p.

16. Signatures:

Investigator

Program Manager

Director G.T. Silver

NOR-6-168

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1977 - 78

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 7, 1977

1. Project: Evaluation and rating of fire behavior and effects on forest ecosystems.

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-6-168 (Formerly NOR-5-980)

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 document secondary plant succession in a subalpine site of recent fire origin.

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

4. 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 1977-78 with costs: Nil
e. Essential new major equipment items beyond 1978 with costs: Nil
f. 1977-78 man-years

Prof.	1.0	(Dubé)
	0.1	(Kiil)
	1.1	
Supp.	1.0	(Walters)
Casual	0.0	
Total	2.1	

11. Progress to Date:

Some client agencies have been made aware of the historical and natural role of fire. The implications of this heightened awareness has resulted in the development of programs aimed at re-introducing fire into areas having past-fire history.

Several contractural studies, elucidating the historical and ecological role of fire in designated areas, have been completed.

12. Goals for 1976-77:

1. Participate extensively in planning and implementing a fire management program in Jasper National Park.

2. Advise and assist in prescribed burning program in Prince Albert National Park.

3. Undertake assessments of post-burn succession in the subalpine, Vermilion Pass, 8 years after fire.

4. Discussion with client agencies and other C.F.S. establishments regarding their needs and priorities as to fire impact assessment.

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

6. Prepare as Information Reports:

   1. Early plant succession following fire in the subalpine forest of the Canadian Rockies by D. Dubé.

   2. Fuel build-up and successional development of four sites in subalpine forests.

   3. Fuel weight of lodgepole pine crowns in trees under 4" in dbh.

7. Goal added: Participate in reviewing and refereeing publications originating from N.F.R.C. as requested.

8. Goal added: Act as liaison officer between C.F.S. and Univ. of Saskatchewan to ensure fulfilment of contract pertaining to Subarctic Ecology and Fire.

9. Goal added: Coordinate the initiation and implementation of a fire-related research and services program in western and prairie regions of Parks Canada (Kiil).

13. Accomplishments in 1976-77:

1. Participated in several meetings with Park personnel to plan and implement a fire management program consistent with Park objectives and ecological considerations.

   Submitted guidelines and an operational plan for a prescribed fire on Henry House Prairie, Jasper National Park, including objectives, burning prescriptions, pre-burn preparation, ignition and burning techniques, manpower and equipment requirements and agency responsibilities. Established a weather station on site in June to monitor fire weather throughout the summer and autumn months. Conducted pre-burn vegetation sampling in July. Directed and coordinated a prescribed fire on September 23, 1976. Met with Jasper personnel in December 1976 to discuss the fire and future work.

2. Reviewed, on site, the results of Spring burning in Prince Albert National Park. Sampled, analyzed and submitted to C.W.S. information on fuel loading of the aspen/grassland floor. Recommended that fire weather be consistently monitored on site.

3. Located and re-sampled 120 permanent plots, established in 1971/72, on the Vermilion Pass burn. The objective is to provide a long-term record of plant succession after fire in the subalpine and provide the National Parks with interpretative information as well as providing basic ecological data to support an evolving National Park policy regarding fire management.

4. Participated in several discussions of a formal and informal nature with several agencies to determine needs and priorities relating to fire management activities.

    1. Elk Island National Park - Recommended that Park personnel assemble and document historical records of fire occurrence and define resource goals as a prelude to developing a realistic fire management plan.

    2. Nahanni National Park - Submitted a study proposal for the development of a preliminary fire management plan for the Park. The proposal was formally presented to Park and prairie region personnel in Winnipeg.

    3. Riding Mountain National Park - Discussed the feasibility of C.F.S. obtaining "stand origin" information in support of an Ungulate Habitat Study Proposal in 1978/9.

    4. Northwest Lands and Forest - N.W.L. & F. have requested our assistance in providing suitable methods to be used in assessing and monitoring fire impact in the Mackenzie Valley development corridor.

    5. Province of Alberta; Alberta Forest Service - Informal discussions suggest a growing interest and readiness to explore a broader fire mandate and alternatives in fire management decision making.

    6. Province of Alberta; Parks, Recreation and Wildlife - Informal discussions indicate an interest in exploring and developing fire management guidelines.

    7. Province of Manitoba - Discussions centered on information exchange between N.F.R.C. and Northern Manitoba, resulting from a one-week trip in June.

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

    1. Ad Hoc Fire Research Committee.

    2. Elk Island Park wardens and naturalist.

    3. Canadian Broadcasting Corporation T.V. documentary.

    4. Fifth Annual Prescribed Natural Fire/Prescribed Burning Work

6. Goal not accomplished.

7. Accomplishment added: Reviewed and refereed three publications from N.F.R.C. and coauthored two of these.

    1. Stevenson, Waldron, Logan and Dubé. 1977. Trees and Forests of Jasper National Park.

    2. Quintilio, Fahnestock and Dubé. 1977. Fire behavior in upland jack pine - the Darwin Lake project.

    3. Klein. 1976. Survival and growth of red pine populations in Manitoba, 15 years after planting.

8. Accomplishment added: Participated in four meetings, as liaison representative for C.F.S., with Univ. of Saskatchewan personnel and other federal agencies involved in funding of Subarctic ecology and fire program.

9. Accomplishment added: Participated in meetings to define objectives and assisted in field program concerned with the initiation and implementation of a prescribed burning program in Jasper National Park. Participated in field reconnaissance of Nahanni and Elk Island National Parks to discuss and assess needs and opportunities for development of fire research programs in these Parks. Prepared a preliminary outline for initiating a study and assessment of fire management related work in Nahanni National Park (Kiil).

14. Goals for 1977-78:

    1. Prepare as Information Reports:

        1. Early plant succession following fire in the subalpine forest of the Canadian Rockies by D. Dubé.

        2. Fuel build-up and successional development of four sites in subalpine forests.

        3. Fuel weight of lodgepole pine crowns in trees under 4" in dbh.

    2. Develop a preliminary fire management plan for Nahanni National Park by determining the historical role of fire, the probable long-term pattern of occurrence and evaluating short- and long-term impact of wildfire on biophysical environmental factors.

    3. Assist in the development of fire impact and assessment guidelines for the Northwest Lands and Forest Branch, Northwest Territories.

4. Advise and assist in prescribed burning program in Prince Albert National Park.

5. Prepare a progress report on prescribed fire at Henry House Prairie, Jasper National Park and continue the development of guidelines for fire management planning within the Park.

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

15. Publications:

Up to 1975-76

Douglas, G.W. 1974. Ecological impacts of chemical fire retardants. Inf. Rep. NOR-X-109.

Fahnestock, G.R. 1974. An opportunity for fire ecology research in Jasper National Park. File Report. NFRC, CFS. Edmonton.

Fahnestock, G.R. and D. Dubé. 1974. Prospectus for an exploratory study of the natural and historic role of fire in Wood Buffalo National Park. File Report. NFRC, CFS. Edmonton.

Johnson, E.A. and J.S. Rowe. 1974. Studies on vegetation and fire in the wintering ground of the Beverly caribou herd.

Rowe, J.S. and E.A. Johnson. 1974. Problem analysis and pilot studies of fire in the western subarctic with particular reference to the caribou range, N.W.T.

Fahnestock, G.R. 1975. Fires, fuels and flora as factors in wilderness management: the Pasayten Case. 15th Tall Timbers Fire Ecol. Conf. Proc. (in press).

Fahnestock, G.R. 1975. Suggestions for fuel management to protect settlements in Yukon Territory. File Report. NFRC, CFS. Edmonton.

Fahnestock, G.R. 1975. Operating plan for experimental prescribed burning in Prince Albert National Park. File Report. NFRC, CFS. Edmonton.

Heinselman, M.L. 1975. The history and natural role of forest fires in the lower Athabasca Valley, Jasper National Park, Alberta.

Johnson, E.A. and J.S. Rowe. 1975. The buried seed population in the subarctic forest, east of Great Slave Lake, N.W.T.

Fahnestock, G.R. 1975. Experimental prescribed burning in Prince Albert National Park. File Report. NFRC, CFS. Edmonton. (Progress Report No. 1).

1976-77

Dubé, D.E. 1976. Early plant succession following a 1968 wildfire in the subalpine zone of the Vermilion Pass, Kootenay National Park. Unpubl. M.Sc. Thesis, U. of A. Edmonton.

Dubé, D.E. 1976. Guidelines and operational plan for a prescribed fire on Henry House Prairie, Jasper National Park. File Report. NFRC, CFS. Edmonton.

Dubé, D.E. 1976. Study proposal for development of a preliminary fire management plan for Nahanni National Park. File Report. NFRC, CFS. Edmonton.

Dubé, D.E. 1976. Fuel weight and depth by vegetation type and organic layers for prescribed burn units in Prince Albert National Park. File Report. NFRC, CFS. Edmonton.

16. Signatures:

Investigator

Program Manager

Director G.T. Silver