forestry report

Fall 1979 (No. 23) Northern Forest Research Centre Edmonton, Alberta

Northern Forest Research Centre: Its first decade

The Northern Forest Research Centre (NFRC) first opened its laboratory and conference room doors in 1970, just as its parent organization, the Canadian Forestry Service, was entering a new phase. The Dominion Forest Service took root in Western Canada 80 years ago, born of the need to conserve the forests in what was then mainly federal crown land. For three decades this forerunner of the Canadian Forestry Service actually owned as well as tended the forests across the Prairies. That role ended in 1930, when all natural resources were transferred to the jurisdiction of the western provinces, and Canadian Forestry Service concentrated on the silviculture and forest protection research. This traditional approach did not change much until 1970, when operational research received emphasis and the program was broadened to include the study of the entire forest environment: land, air, and water.

The opening of the NFRC in Edmonton coincided with this broadening in research scope. NFRC serves the vast area lying north of the U.S. border between the Rocky Mountains and Ontario. Its clients include provincial forest services and environment departments, commercial tree nurseries, lumber companies, pulp and paper firms, national and provincial parks, federal and provincial agriculture departments, Department of Regional Economic Expansion, Department of Indian Affairs and Northern Development, and departments of the Government of the Northwest Territories.

For almost a decade the NFRC has maintained a high caliber of research in both traditional forestry and the newly emerged environmental disciplines and has contributed materially to improved forest management in the region. Now emphasis is shifting again, and the NFRC is challenged by the opportunity to focus its expertise on different targets. But before describing the new accent on providing planning and management guidelines and decision-making aids, it is appropriate, as the NFRC approaches its tenth birthday, to highlight some of the accomplishments in forestry and environment research achieved under the old program.

A running crown fire ignited in black spruce to test effectiveness of water and short-term retardant in inhibiting flames. In this test water and the retardant performed equally well.

Accomplishments 1970-79

Forest land not only produces timber, but shelters wildlife, protects watersheds, may provide fuel to run our cars, and offers a variety of recreational pastimes. As greater, and often conflicting, demands are placed upon forest land, managers require research-based decision-making aids for determining the wisest use of the resource.

Public hearings. Many NFRC research staff participated in public hearings on the environment by testifying as technical experts or preparing briefs.

- Berger Commission on the route of the Mackenzie Valley pipeline
- Environment Conservation Authority of Alberta hearings on land use and resource development on the East Slopes of the Rocky Mountains
- Environment Council of Alberta hearings on the environmental effects of forestry operations
- Manitoba Clean Environment Commission hearings on heavy metal pollution and the use of insecticides to control the spruce budworm

Brace, L. G. 1973. Land use in the East Slopes of Alberta. A brief by the Department of Environment of Canada to public hearings held by the Alberta Environment Conservation Authority.

Johnson, H. J. et al. 1971. Some implications of large-scale clearcutting in Alberta: a literature review. Information Report NOR-X-6.

Malhotra, S.S. and G.D. Hogan. 1977. A brief on emissions to the atmosphere from the operations of the INCO Metals Co. Ltd., Thompson, Manitoba. Presentation to the Manitoba Clean Environment Commission.

Symposia. As a background for environmental research, symposia were organized by NFRC scientists on topics such as sulphur dioxide pollution, reclamation of disturbed lands, watershed research, fire ecology, and various aspects of climatology.

Dubé, D. E. 1978. Fire ecology in resource management: Workshop proceedings. Information Report NOR-X-210.

Hocking, D. and D. Reiter. 1973. Proceedings of a workshop on sulfur gas research in Alberta. Information Report NOR-X-72.

Swanson, R. H. and P. A. Logan. 1977. Alberta Watershed Research Symposium Proceedings, 1977. Information Report NOR-X-176.

Economics. Three reports on the importance of forest-based industries in Alberta, Saskatchewan, and Manitoba were prepared from data collected by an intensive survey of pulpmills and sawmills.

Teskey, A. G. and J. H. Smyth. 1975. Employment, incomes, products and costs in Manitoba's primary wood-using industry, 1972. Information Report NOR-X-138.

Teskey, A. G. and J. H. Smyth. 1975. Saskatchewan's forest industry and its economic importance. Information Report NOR-X-140.

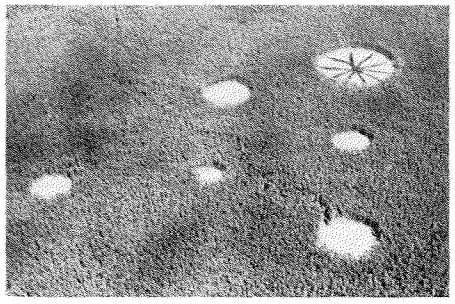
Teskey, A. G. and J. H. Smyth. 1975. The economic importance of sawmilling and other primary wood-using industries in Alberta, 1972. Information Report NOR-X-145.

Watershed research to improve water yield and quality has been carried on for 18 years at Marmot Creek and other basins in the foothills.

- Impact of forest harvesting on water yield documented
- Logging patterns proposed to increase runoff and extend the period of runoff.
- Simulation models developed to predict the effects of removing or manipulating vegetation on water yield
- Operational guidelines described for reducing the deleterious effect of harvesting and logging roads on water quality

Rothwell, R. L. 1978. Watershed management guidelines for logging and road construction in Alberta. Information Report NOR-X-208.

Swanson, R. H. and G. R. Hillman. 1977. Predicted increased water yield after clear-cutting verified in west-central Alberta. Information Report NOR-X-198.



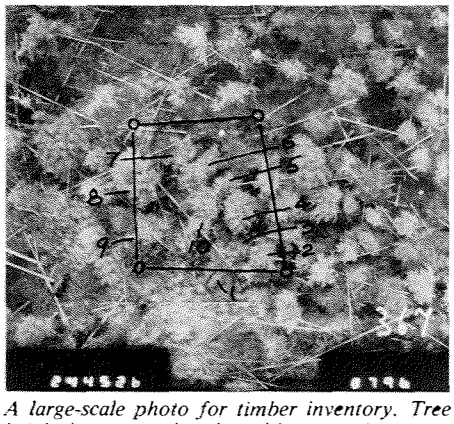
Circular logging cuts in the foothills trap more snow, thus increasing the amount of streamflow and prolonging peak flows into the summer.

Remote sensing

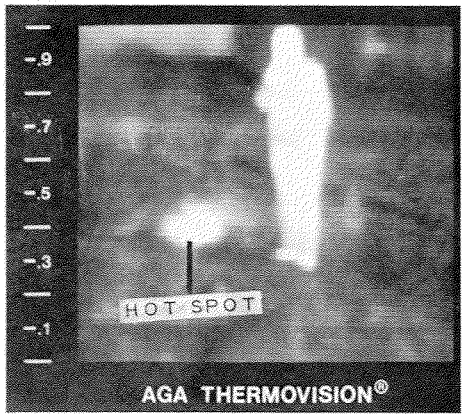
- Techniques for assessing regeneration stocking, carrying out forest inventories, and identifying insect outbreaks and climatic damage (red belt) using LANDSAT satellite imagery and large-scale photo sampling developed
- Camera and interpretation system developed for assessing forest regeneration

Kirby, C. L. 1973. Forest and land inventory using ERTS imagery and aerial photography in the Boreal Forest Region of Alberta, Canada. 3rd Earth Resources Technology Satellite Symposium 1:127-136.

Kirby, C. L. and P. I. van Eck. 1977. A basis for multistage forest inventory in the Boreal Forest Region. Pages 71-94 *in* Canadian Symposium on Remote Sensing.



A large-scale photo for timber inventory. Tree height is measured and used in regression equations to determine basal area and volume of timber.



A hot spot (coals that produce no smoke but are capable of rekindling a forest fire if not extinguished) is invisible to the eye but readily sensed by the AGA Thermovision infrared scanner.

Fire

- Fire behavior guides developed
- National fire danger rating system calibrated for operational use in the Prairies and Northwest Territories
- Fire-line construction and suppression methods (airtankers, bulldozers, men, water, chemical retardants) assessed
- Models developed and tested for most effective initial attack strategy
- AGA 750 thermovision scanner tested and promoted for detecting holdover fires
- Effects of and techniques for prescribed fire for reducing fire hazard and preparing seedbeds determined
- Fire prescribed for resource management objectives in national and provincial parks

Grigel, J. E. 1974. Role of the helitanker in forest fire control. Information Report NOR-X-123.

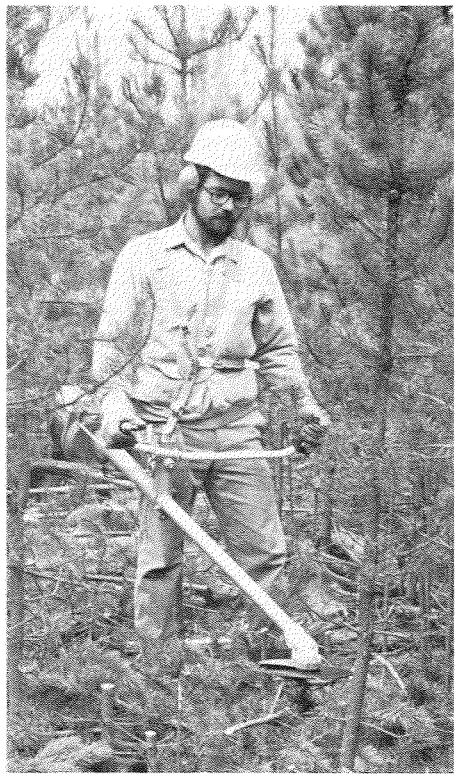
Niederleitner, J. 1976. Detecting holdover fires with the AGA Thermovision 750 Infrared Scanner. Information Report NOR-X-151. (Also available in French).

Growth and yield

- Regeneration stocking standards established for Alberta
- Variable-density yield tables for lodgepole pine stands devised
- Model developed to describe competition between individual trees for the analysis and simulation of stand growth
- Thinning regimes for trembling aspen and jack pine developed
- Optimum spacing of lodgepole pine being determined

Bella, I. E. and J. P. De Franceschi. 1978. Assessment of regeneration stocking standards used in Alberta: A follow-up. Information Report NOR-X-211.

Johnstone, W. D. 1976. Variable-density yield tables for natural stands of lodgepole pine in Alberta. Canadian Forestry Service Technical Report 20.



The brush saw has proven to be an effective tool for thinning overdense lodgepole pine up to 10-15 years old.

Silviculture

- Comprehensive container planting trials established throughout the three Prairie Provinces
- Guidelines for rearing coniferous container seedlings published
- Operational-scale regeneration programs carried out by the provinces surveyed to measure success and identify research needs. Conifer plantations, scarification and direct seeding of white spruce, and scarification for natural regeneration of jack pine evaluated
- Clone bank of promising jack pine established
- Ingress and juvenile height growth of lodgepole pine and white spruce on cutovers in Alberta assessed

Carlson, L. W. 1979. Guidelines for rearing containerized seedlings in the Prairie Provinces. Information Report NOR-X-214.

Froning, K. 1972. An appraisal of recent plantations in forests of the Prairie Provinces. Information Report NOR-X-31.

In this issue:

Atmospheric pollutants, a research program established in the early 1970's, has already borne fruit.

- Short- and long-term toxic effects of sulphur dioxide, oxides of nitrogen, and heavy metals (nickel, copper, lead, zinc, arsenic, vanadium), alone or in various combinations, on forest vegetation and soils assessed
- Biomonitoring techniques (lichens) developed to detect effects of air pollution on forest vegetation
- Techniques developed for identifying sulphur dioxide damage to vegetation before symptoms are visible
- Symptomology handbook on natural and air pollution damage to boreal forest species for use by field personnel now in final stages of review

Hocking, D. and R. A. Blauel. 1977. Progressive heavy metal accumulation associated with forest decline near the nickel smelter at Thompson, Manitoba. Information Report NOR-X-169.

Malhotra, S. S. and D. Hocking. 1976. Biochemical and cytological effects of sulphur dioxide on plant metabolism. New Phytologist 76:227-237.

Typical damage caused by sulphur dioxide to a poplar leaf: chlorosis (yellowing) between the leaf veins.

Mountain avens (Dryas octopetala) and a lichen (Caloplaca sp.) typical of the alpine environment. Vegetation, soils, and landforms of Banff and Jasper national parks are being classified in a biophysical inventory to enable park planners to protect areas sensitive to human disturbance, such as the alpine, and locate recreational facilities in the most suitable places.

Land and vegetation surveys

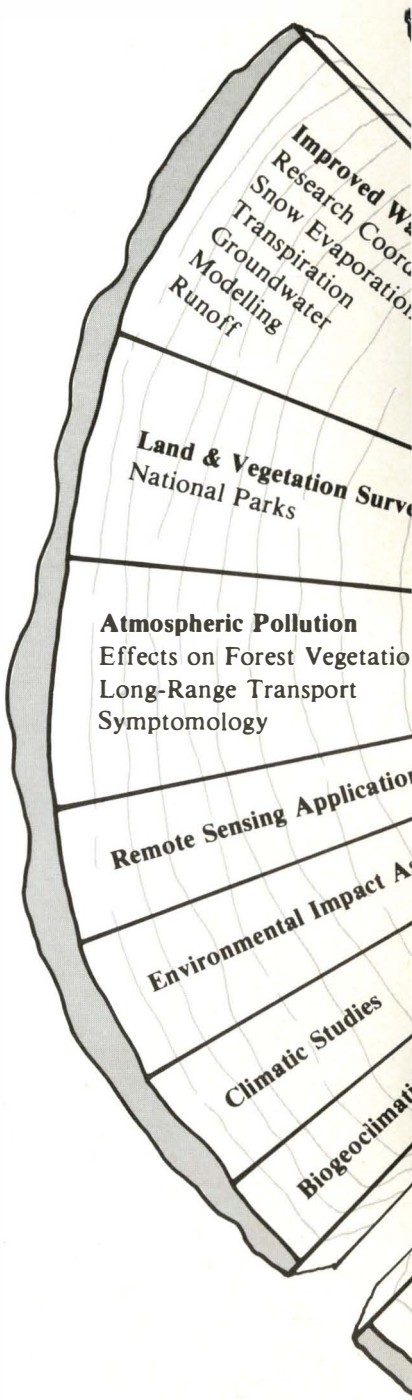
- Soil survey completed for master planning in Waterton Lakes National Park; biophysical inventory of Banff and Jasper national parks to be concluded in Fall 1979
- Biophysical survey provided background information for proposed recreational development in Lake Louise area
- Biogeoclimatic survey, jointly sponsored by the Alberta Forest Service, currently under way to classify forest land in Alberta and provide information necessary for intensive forest management
- Terrain and vegetation surveyed and classified along proposed Mackenzie Valley and polar pipeline routes through the Canadian Arctic
- Sites of proposed new national parks in the Northwest Territories surveyed

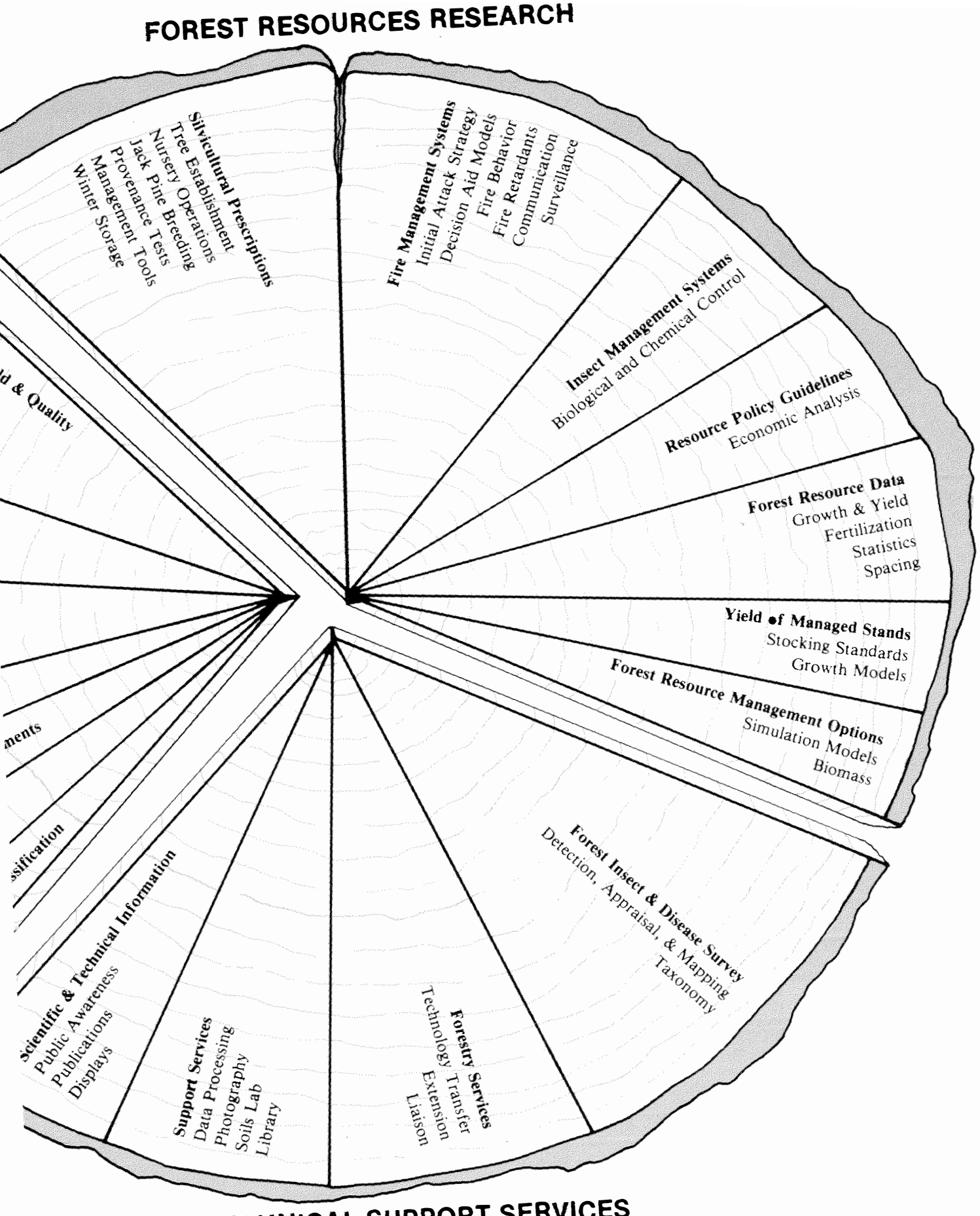
Coen, G. M. and W. D. Holland. 1974. Soils of Waterton and interpretations, Waterton Lakes National Park. Information Report NOR-X-65 and Alberta Institute of Pedology No. S-73-33.

Kojima, S. and G. J. Krumlik. 1979. Biogeoclimatic classification of forests in Alberta. Forestry Chronicle 55: 130-132.

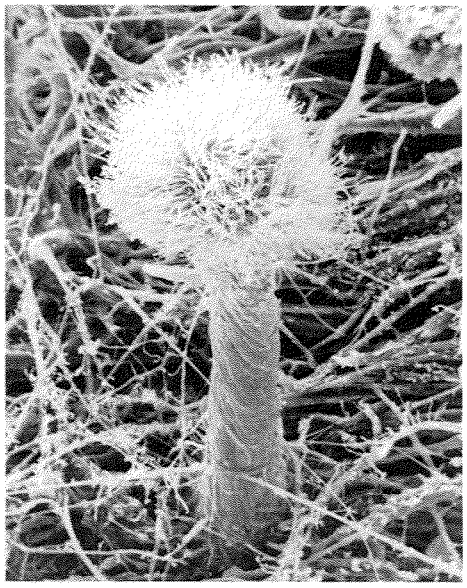
Zoltai, S. C. and W. W. Pettapiece. 1973. Terrain, vegetation and permafrost relationships in the northern part of the Mackenzie Valley and northern Yukon. Pipelines Task Force Report No. 73-4.

ENVIRONMENT RESEARCH





NFRC's new research program.



A synnema of ***Ceratocystis ulmi,*** *which causes Dutch Elm Disease, magnified 600 times under a scanning electron microscope. NFRC is cooperating with the Great Lakes Forest Research Centre to discover the mechanism by which C. ulmi kills elms.*

Insects and diseases

- Forest pest conditions monitored by Forest Insect and Disease Survey rangers and annual reports made to forest managers
- Identification services provided by Forest Insect and Disease Survey rangers crucial in combating Dutch Elm Disease in southern Manitoba
- Biological control for the larch sawfly developed; biological control for the forest tent caterpillar being tested
- Two major publications to synthesize the results of 30 years of research in entomology and pathology and assist forest managers in the identification and control of forest pests now under way
- *Pine stem rusts of Canada* published

Ives, W. G. H. 1976. The dynamics of larch sawfly populations in southeastern Manitoba. Canadian Entomologist 108:701-730.

Safranyik, L., D. D. Shrimpton, and H. S. Whitney, 1974. Management of lodgepole pine to reduce losses from the mountain pine beetle. Canadian Forestry Service Technical Report 1.

Climatic studies

- Climate of the Prairie Provinces classified for forestry purposes
- Effects of local and microclimates on the establishment and growth of pine and spruce seedlings planted on clear-cuts evaluated
- Effects of clear-cutting patterns on local and microclimates and on cycles of runoff assessed

Powell, J. M. and D. C. MacIver. 1977. A summer climate classification for the forested area of the Prairie Provinces using factor analysis. Information Report NOR-X-177.

G. R. Hillman, J. M. Powell, and R. L. Rothwell. Hydrometeorology of the Hinton-Edson area, Alberta, 1972-1975. Information Report NOR-X-202.

Extension and Information

- 810 scientific and technical publications released over the last decade
- Three-quarters of a million copies of NFRC publications distributed
- Visual appeal of NFRC Information Reports improved and typesetting by means of IBM Composer introduced
- *Forestry Report* begun in 1970 to highlight research developments in the various forestry disciplines. Twenty-two issues published to date
- Public Awareness Program operated at Kananaskis Forest Experiment Station from 1975 to 1979 to explain forests and forest management to the general public. Interpretive center, 3-km trail with displays and signs, and a brochure explain interrelationships of land use for timber, watershed protection, wildlife, and recreation
- Public awareness of the environment promoted by publications such as two *Ecotours* (Calgary-Golden and Calgary-Regina), which provide an ecological interpretation of the landscape along the Trans-Canada Highway, and an audio-visual program on multiple use planning in Marmot Creek basin

Oswald, E. T. and F. H. Nokes. 1970. Field guide to the native trees of Manitoba.

Stevenson, R. E., R. M. Waldron, P. A. Logan and D. Dubé. 976. Trees and forests of Jasper National Park.

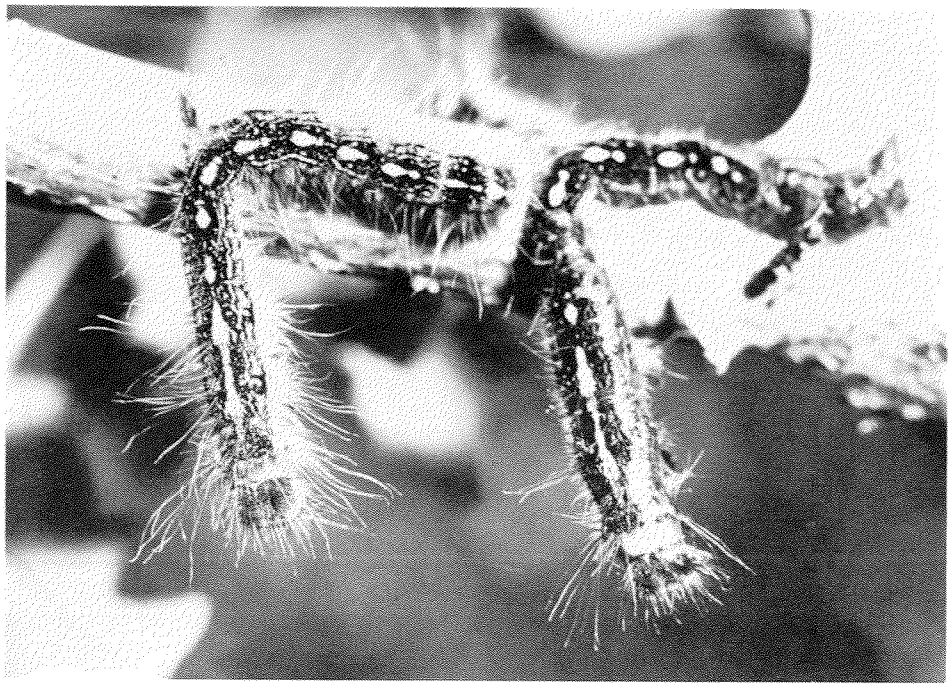
A few of the 25 pest leaflets written to help homeowners diagnose and control insect and disease problems on trees and shrubs. Preventive measures and nonchemical control are emphasized.

A complete listing of all publications may be found in: Dendwick, F. M., G. R. Stevenson, C. L. Rentz and J. R. Gorman. 1976. Forest research bibliography, 1968-1975 with 1976-1978 supplements. Information Report NOR-X-152.

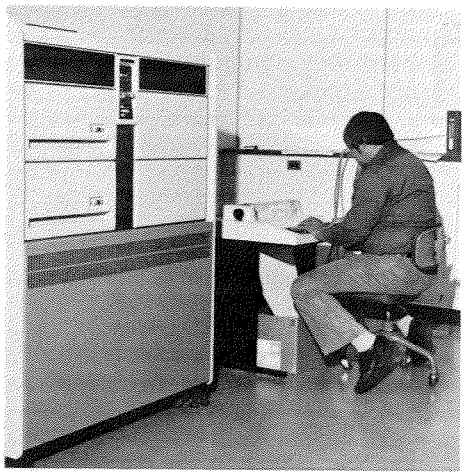
New direction for an old program

NFRC's traditional forest resources research program comprises silviculture, fire, insects, and diseases. Historically, research in these disciplines evolved in response to demands placed on the scientist by the practicing forester or other resource manager. These demands were, by and large, based on specific problems encountered in the field. Over the years, then, NFRC has amassed a vast amount of information, which, because of its volume, variety, and long period of assembly, is difficult to retrieve or to weave together in order to provide a complete, systematic approach to any one particular forest practice, such as the reforestation of cutovers taking into account site, ground vegetation, planting stock, time of year, and other factors.

The new forest resources research program rests on the premise that NFRC must decrease its role in responding to "spot fires" from field personnel and concentrate on a more systematic approach to research by (1) gathering and analyzing existing data for use in forest management planning and operations and (2) identifying those areas critical to systems planning and management and carrying out research in them. This approach recognizes the fact that provincial and federal resource management agencies and the forest industry have substantially increased their commitment to intensive forest management and are also assuming more responsibility for meeting their day-to-day research needs.



Forest tent caterpillars killed by a spray containing a naturally occurring virus, which seems to be capable of controlling infestations in areas that can be sprayed from the ground.



Bill Chow, Computer Systems Analyst, and the new PDP 11/60 minicomputer, specifically designed for scientific use. Simulation and modelling are integral parts of the fire, silvicultural prescriptions, watershed, biogeoclimatic, and economic research programs.

More effective transfer of information and new technology to resource managers is the ultimate justification of this new "core" forestry program. NFRC's role will be to provide research-based information packages and decision-making aids that will enable foresters and resource planners to better assess the impact of a variety of management practices (inventory, harvesting, and protection) and political and organizational policy decisions on forest replacement. Specifically, the revised program provides for research, development, and application of systems to

- predict productivity of different stands
- reduce damage and losses from fire, insects, and diseases
- develop guidelines for stand establishment following forest harvesting.

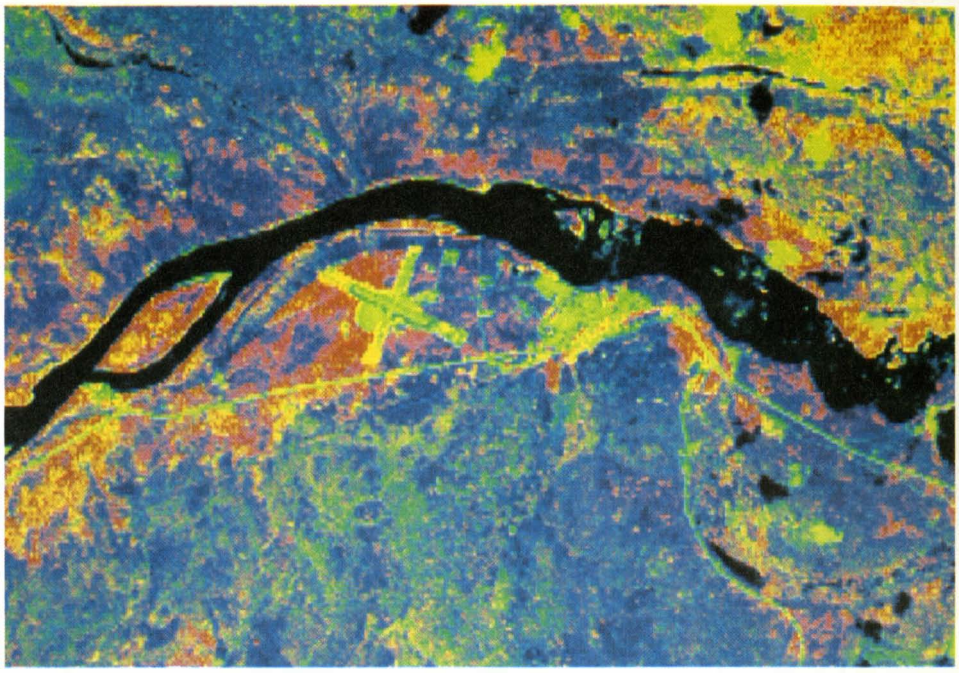
These information packages, when linked with economic and other forest resource data, are intended to provide the greatest possible benefits to the forest industry and provincial and federal forest management agencies in this region. One of the new programs that draws on both research results (in this case, productivity predictions) and economic considerations is the investigation into forest biomass as an energy source (ENFOR program).

Individual research project goals have now been identified and defined in cooperation with regional resource management agencies. These goals have been integrated into a 3-year program utilizing the critical path method of planning. Interactive computer data bases and simulation models, operated on our new PDP 11/60 minicomputer, are being developed or validated to improve technology and information transfer to clients. Data collected in previous years are being utilized to develop site-specific decision-making aids and to identify critical data gaps in research knowledge. Full implementation of the new research program in the early 1980's is designed to provide the research support necessary for intensive forest management within the framework of multiple forest land use.

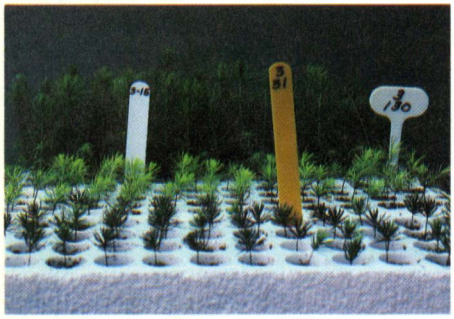
The 80-proof forest

Fossil fuels such as oil, natural gas, synthetic crude oil, and coal are relatively abundant in Alberta but finite. Because such reserves are dwindling there has been a fresh look at forest fuels, which are theoretically infinite: the forests can be renewed forever under wise management. "Forest fuels" used to mean logs burned in a fireplace or stove, but today it implies utilizing all of the living matter in a tree. Forest biomass, the total quantity of organic matter in the tree, is an energy source that is currently untapped and in some cases going to waste. By mechanical and fermentation processes, biomass may be converted into methanol (wood alcohol), a fuel alternative that can be mixed 1:5 with petroleum to run cars without modifying the conventional engine. Biomass may also be used for animal fodder and for producing chemical derivatives.

The Canadian Forestry Service is the lead agency in ENFOR (Energy from the Forests), a program funded by the Department of Energy, Mines, and Resources to ascertain the role of biomass in meeting Canada's long-term energy needs. At the NFRC several ENFOR activities are under way. One goal is to develop biomass prediction equations for the main tree species in the Prairie Provinces and Northwest Territories. This work will culminate in a pilot-scale demonstration for converting a conventional wood inventory (merchantable material) into a biomass inventory (stem, bark, branches, and leaves) for a selected area in the Prairie Provinces. Other studies include developing an aspen stand growth simulator, testing the line intersect method for determining quantities of woody materials in the forest, and assessing the effect of climate on biomass productivity.



An ARIES color enhancement of a LANDSAT satellite image of Fort Smith, N.W.T. Light green—barren land (note the 1500-m runways and the town of Fort Smith to their right); yellow—grasslands; red—deciduous trees; dark blue—conifers; blue-green shades—muskeg; black—water or cloud shadow.



The effect of fertilization on 14-week-old spruce seedlings. Back—optimum levels of nitrogen, phosphorus, and potassium; middle—no nitrogen; front—no fertilization.

Current biomass productivity in the forested areas of the Prairie Provinces and Northwest Territories ranges from less than 1 t/ha/yr in the north to over 3 t/ha/yr in some southern parts of the provinces. The initial estimate of the above-ground tree biomass reserve in Alberta is more than 1 billion t of oven-dry material. Annual biomass production amounts to 25 million oven-dry t, which in methanol represents twice the annual energy production from oil sands at the Syncrude plant in Fort McMurray.

However, before we start visualizing gas pumps in place of white spruce, it must be remembered that some of the biomass will be harvested for use by sawmills and pulp and paper industries, and that to date the large-scale production of methanol is not yet economic. The best short-term strategy for deriving energy from the forest seems to be the use of harvest residues and unmerchantable species—material now going to waste—by forest industries for fuel; forest industries, the largest fuel consumers in the country, could in effect become self-sufficient in energy. Large-scale production of methanol may become competitive in the future, particularly in the context of national or global rather than solely provincial needs.

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