Fire Technology Transfer Note

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Fire Management in Canada - Lessons for New Zealand

By Grant Pearce

Recently, as part of my continued training as a fire researcher, I was lucky enough to embark upon a study tour of fire research centres and fire management organisations in Canada. The study tour began in the maritime provinces of New Brunswick and Nova Scotia in mid-April, and involved travelling west across the country ending up in Victoria, British Columbia, some four months later.

Although a brief presentation summarising the main findings of the tour was made at the recent FRFANZ Annual Conference in Wellington, the introduction of the new forest and rural Fire Technology Transfer Note provides an ideal forum for presenting a brief written summary of my conclusions and recommendations from the trip; they are:

Forest land tenure - Compared with New Zealand, Canada is a very large country with a land base of more than 900 million hectares, of which some 450 million ha are forested[1]. Hence, Canada is a forest nation. A significant difference from New Zealand is that more than 90% of this forest land is publicly owned - provincial governments own and manage about 80% while another 10%, mainly in the Yukon and Northwest Territories, is the responsibility of the federal government. In addition, more than half of Canada's forests are only marginally productive and do not form part of the country's commercial forest lands. The economic importance of this resource, and the need to protect life and property, are the primary reasons for Canadian fire management and fire research agencies having developed one of the world's most sophisticated forest fire management programmes.

Fire management philosophy - Protection of Canada's large forest reserves from unwanted wildfires has been the focus of extensive efforts throughout the 20th Century, and organised fire suppression has generally been successful, although significant wildfires are still common. During the 1970s, however, there was a growing realisation in Canada that total fire exclusion was neither economically feasible nor ecologically desirable. The pursuit of this goal has entailed considerable social and economic costs and, despite constantly increasing expenditures (Canadian fire management agencies are now spending in excess of $400 million annually on controlling wildfires), there has been no corresponding decrease in the number and impact of fires. This is coupled with an increasing awareness of the natural role of fire in maintaining ecological diversity, particularly in the boreal forest regions of Canada. These changes have led to the evolution of a new fire management strategy in which consideration is given to the ecological role of fire, the economics of fire suppression, and the priority of values at risk.

At the top of the priority scale are the increasing number of wildland-urban interface areas, while high-value forest industry and recreational sites also receive vigorous protection. Conversely, fire is often allowed to burn naturally in lower priority areas such as wilderness parks or remote forested areas of limited economic value, where fire is an integral component of forest ecosystems. This policy of "modified suppression" is in effect in northern regions of the provinces of Quebec, Ontario, Manitoba and Saskatchewan, as well as in parts of the Northwest and Yukon Territories.

Magnitude of the fire problem - The forest fire season in Canada runs from April through to October, with fire occurrence peaking from June to August. However, unique fire problems occur outside this period because of the flammability of deciduous material prior to winter green-up, the annual burning of rank grass by landowners in spring, and the burning of blueberry thickets to promote growth. Approximately 10 000 fires occur annually across the country, with some 2500 reported annually in British Columbia, 1700 in Ontario, 1000 in Alberta and Quebec, followed by Manitoba and Saskatchewan with almost 700 fires, while the remaining provinces and territories record less than 500 fires annually. (By way of a comparison, New Zealand records approximately 1100 fires per annum).

Lightning fires - Dry lightning is a major ignition source in many parts of Canada, and the forest areas most at risk are within the boreal forest region. Provincial fire management organisations have installed technologically-advanced lightning location systems as a means of monitoring the lightning-caused fire problem. While I was visiting the Alberta Forest Service, for example, there were 160 new fire starts in a three-day period, mostly from lightning strikes, and this illustrates the need in Canada for a coordinated approach to enable management of multiple fire situations.

Suppression methods - Some 95% of the population live within 100 km of the U.S. border, and the remainder of the country is sparsely populated. Hence, fire lookout towers and aerial detection patrols form the basis of the early detection system. Due to the isolation and distances involved, the use of aircraft for initial attack and suppression is more common in Canada than in New Zealand, although aerial suppression is almost always followed up by ground operations. Ontario and Quebec make extensive use of water-bombing aircraft, such as the CL-215, due to the presence of many lakes; elsewhere, aircraft dropping fire retardants are used. Where ground access is possible, firefighting equipment and methods are similar to those used in New Zealand.

Organisational structures - In Canada, responsibility for fire management rests with each of the 12 autonomous provinces and territories. The federal government is primarily responsible for research, facilitating inter-provincial coordination, and fire management on limited federal lands such as National Parks. Generally, the structure of provincial fire management organisations consists of three tiers of management - the provincial headquarters, regional fire centres, and district offices. This structure provides a balance between a manageable span of control that enables on-site decision-making at the district level and an economy of scale at the Provincial and Regional level that enables rapid initial attack coupled with swift expansion to a large-fire organisation if needed. In most provinces, fire management is highly decentralised, with most decisions being made at the local level while the central headquarters provides primarily a coordinating role. Other provinces, such as Quebec, are evolving towards a highly centralised organisation, with the provincial centre maintaining control over daily decision making.

Within any of the provincial fire management organisations, the basic responsibilities of each level of fire management are:

a) Overall responsibility for the fire organisation rests with the *provincial* fire centre. Strategic functions include establishing, planning, budgeting and auditing provincial fire programmes. Three major programmes that are managed at the provincial level include prevention, training and equipment, although these are delivered in cooperation with the regions. The provincial fire centre is also responsible for strategic fire operations including monitoring environmental conditions and fire activity, inter-regional resource deployment, and inter-provincial resource movement.

b) The *regional* centres focus on the coordination of fire management activities. That is, they control daily detection flights and, when a fire is detected, dispatch initial attack resources. They also establish alert levels and allocate resources among areas.

Airtankers and fire overhead teams are also generally dispatched at the regional level. Hence, the regional fire centres provide the interface between fire suppression activities and the provincial fire centre.

c) *District* or fire management areas are the operational level of the organisation. This level is responsible for transporting crews and equipment to the fire, firefighting, logistical support and fire command. District offices are also responsible for fire prevention, fire-cause investigation, enforcing fire prevention legislation, training local fire crews and maintaining district equipment. Initial attack crews are located in districts throughout a province, and are considered the front line troops of the fire organisation.

Weather services - All provinces maintain an excellent relationship with the national weather bureau, the Atmospheric Environment Service (AES). Most employ meteorological staff from AES during the summer fire season, and some provinces (e.g., the Alberta Forest Service) even maintain their own weather sections. The close relationship allows the provincial fire centre to gain access to up-to-the-minute weather information (e.g., satellite imagery) and technical services, and provides AES with a number of additional weather stations to better enhance its forecasting ability.

Research links - Provincial fire management organisations also maintain an excellent working relationship with fire research staff from Forestry Canada. For example, the provinces of Ontario and Quebec have worked very closely with fire researchers from the Petawawa National Forestry Institute and a Technology Transfer Centre has been set up in Maniwaki, Quebec to assist in the field testing and implementation of numerous research projects, including the Canadian FWI and FBP Systems, lightning location systems, weather radar, GPS for aerial detection aircraft, and computerised fire management information systems.

In addition, some of the provinces also maintain their own research sections, partly in recognition of the inability of Forestry Canada research staff to work on operational problems and to further develop the research products provided by Forestry Canada for specific provincial applications.

Fire research - Fire management in Canada has evolved as research and technology have provided new tools, and fire management agencies in Canada continue to be among the most advanced in the world. Some of the major projects currently being investigated by Forestry Canada and/or provincial fire research staff include fire behaviour and fire danger rating, prescribed fire, fire effects and fire ecology, the wildland-urban interface, fire management information systems, initial attack effectiveness, detection and infra-red technology, and fire equipment research and development. Within Forestry Canada, for example, fire research involves some 40 staff based in five regional research centres. A number of universities also include respected fire research personnel, and close ties exist between these and federal and provincial fire organisations.

International research links - Forestry Canada fire researchers are getting together with U.S. compatriots and moving towards an amalgamation of the Canadian and U.S. fire danger rating systems. Radically different approaches have historically been taken in the research; U.S. work has been laboratory-based, whereas the Canadian Forest Fire Danger Rating System is largely based on experimental burns in field situations. Although personality problems, combined with the divergent approaches, are currently providing stumbling blocks to the evolution of a North American Fire Danger Rating System, developments over the next few months will be very interesting.

Recommendations for New Zealand

1. With the demise of the New Zealand Forest Service in 1987, no fire management organisation currently exists in New Zealand to match that found in any province in Canada. Rural fire authorities could benefit from a more cooperative and coordinated approach to fire management, and some streamlining of the current structure and the number of authorities responsible could achieve this. Practical solutions could include the sharing of more specialised fire management officers between Territorial Authorities (or Regional Fire Coordinating Committees), so that the PRFO is able to gain greater levels of knowledge and experience; and/or the coupling of PRFO position with Civil Defence roles, so that preparedness planning responsibilities for fire and other incident management are combined.

2. Closer ties need to be established between rural fire authorities and the NZ Meteorological Service. Overseas experience has shown that both parties can benefit from the cooperation, particularly fire authorities through access to up-to-date information and technical services. The establishment of such relationships would also enhance the chances of forming a coordinated weather station network for the country, thereby providing a sound basis for an integrated fire management information system on which to base preparedness planning and resource requirements.

3. To emulate the relationships that exist between fire researchers and provincial fire management organisations in Canada, rural fire authorities in New Zealand need to initiate and maintain links with the newly established fire research program at NZ FRI. By doing so, rural fire authorities can have a hand in defining research priorities (e.g., fire behaviour guidelines for specific fuel types through experimental burning) and, in turn, have their specific fire problems addressed by the research team.

4. Increased technology transfer activities between the NZ FRI fire research program and rural fire authorities are also necessary if New Zealand is to benefit from overseas experience. Marty Alexander's secondment and the recent Advanced and Intermediate Fire Behaviour training courses, together with the establishment of a Fire Technology Transfer Specialist position at NZ FRI, represent an excellent start to technology transfer, and the FTTN aims to continue this process.

5. Continued contact with fire management and fire research organisations in Canada (and the U.S. and Australia) is essential if New Zealand is to remain up-to-date with new developments (e.g., North American Fire Danger Rating System). New Zealand can benefit directly from much of the research that is being carried out and, in the case of the Fire Behaviour Prediction System, does not have to repeat the mistakes that were made in the early stages of development and operational implementation of this research in Canada.

   Further study tours, like those recently completed by Peter Smart from Forestry Corporation of NZ, and Ollie Kemp from Tasman Forestry, are also necessary for New Zealand fire management personnel to gain international experience and exposure. We hope to include articles on the experiences and conclusions following any such study tours in future editions of FTTN.

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[1]Stocks, B.J. and Simard, A.J. 1993. Forest fire management in Canada. *Disaster Management* 5(1): 21-27.

Forest fire fighting operations in Canada - lessons for New Zealand

By Peter Smart

Recently, I was fortunate enough to get some first hand forest fire fighting experience with the Alberta Forest Service, Canada, an organisation that is at the forefront of fire fighting technology. Forestry Corporation of New Zealand Ltd gave me the opportunity to spend 4 months "on the job" fire fighting to accelerate my learning in the "art and science" of fire protection and also to bring back ideas and technologies that could be used to enhance the fire protection systems in place within Forestry Corporation and New Zealand.

After a month of training, I spent 3 months fighting fires as a part of a seven man Helicopter Attack Crew. Their job is to carry out rapid initial attack of wildfires by rappelling (similar to abseiling) down a rope from a helicopter at the scene of the blaze. The aim of rapid initial attack is to suppress fires while they are still small and controllable, thus saving time and money. Our crew would spend 21 days continuous in the bush working, then have 6 days off.

Most of our fire fighting was done using knapsacks, shovels and pulaskis. We also carried a small WAJAX pump, but seldom had the opportunity to use it because of the lack of a water supply. Our helicopter, a Bell 205 (i.e., Iroquois), would support us by knocking down the head of the fire with a collapsible bucket it carried (capacity 1300 litres) and drowning hot spots that we had dug up.

This Technology Transfer Note is designed to share some of the more interesting practices, procedures and use of technology I saw with you and hopefully introduce some ideas I think would benefit rural fire-fighters in New Zealand.

Air attack boss - Fires that were too big or intense for an initial attack crew to deal with alone were left to the bombers. Alberta has squadrons of ex-wartime bombers and DC6 passenger aircraft converted to carry fire retardant. Custom built skimmer planes that refill from lakes and then inject foam into the cargo are also used. Each bomber squadron (1-4 planes) has a dedicated *Air Attack Boss* or *bird dog* plane which scouts the fire before the bombers arrive, to assess where the retardant drops would be best placed to halt the fire's spread. Some bird dog planes were equipped with a sophisticated FLIR (forward looking infra red) camera for "seeing" through wind blown columns of smoke to locate the most intensely burning sector of the fire, which is the priority for retardant and foam drops. The Air Attack Boss then controls the air operations at the fire, including fixed and rotary wing aircraft.

This co-ordinated approach means these expensive fire fighting tools are used to their optimum extent, rather than wasting water and retardant by letting each pilot make their own decisions, and getting in each others way. Although fixed wing operations are less common here, the use of a bird dog or air attack boss to implement the fire control strategy and co-ordinate the fire suppression of multiple helicopters would make aerial attack more effective and safer. The additional cost of a fixed wing bird dog would probably pay for itself in unburned area, helicopter time and retardant used. FLIR systems cost upwards of $100 000 and in New Zealand may be under utilised for the money invested, but the air attack boss role certainly deserves consideration. Training for this role is obviously necessary to ensure the savings this position can create are maximised.

Infra-red (IR) sensing for fire mop-up - Infra red sensing is used to locate hot spots during mop-up and it's effectiveness was proven to me during the five days I spent mopping up a 4500 ha fire. Rather than searching aimlessly for *hot spots*, the fire was scanned every evening with an IR camera.

Using the IR camera, hot spots were mapped and marked on the ground by dropping rolls of toilet paper from the aircraft, which could be easily relocated by a ground crew the next day.

This technology is occasionally used in New Zealand, but it's usefulness cannot be overemphasised. Most co-ordinating committees throughout the country will have access to infra-red cameras, and we need to maximise the use of this equipment. Training is once again necessary to achieve the best results.

Collapsible monsoon buckets - Collapsible monsoon buckets have a number of advantages over the rigid type prevalent in New Zealand. They are more compact to store and can be transported to the scene of a fire in the helicopter or on a vehicle along with other fire fighting equipment. Drag is reduced when the bucket is in the helicopter, so air speed is increased and time taken to arrive at the fire is reduced. Collapsible buckets are more robust than rigid buckets so careful handling when speed is a priority isn't so vital. Importantly they are more suitable for dip filling, because they can bounce off stream banks and rocks with less risk of damaging the bucket. Water points suitable for dip filling are usually more common, so turnaround times can be decreased because closer water supplies can be utilised. Dip filling appears to be avoided here by both pilots and fire managers, arguing it is more dangerous, but this may be a result of the bucket type used in New Zealand, rather than the operation itself.

Fire Management Information Systems and Weather forecasts - Because of the large proportion of random ignitions from lightning, Canada has developed comprehensive preparedness systems for combating the cost of fighting wildfire. Having a good knowledge of the fire environment (fuels, weather and topography) allows fire managers to better plan their resource allocation and spend their budget.

The Canadians have developed Geographical Information Systems (GIS) that combine these three factors using a computer model to generate maps of fire danger and fire behaviour prediction on an area by area basis. The fire management information system can then be used to show areas of greatest fire danger and determine optimal placement of resources for suppression.

The Alberta Forest Service monitors fire danger conditions using Remote Automatic Weather Stations and the Fire Weather Index System, as does New Zealand. But unlike New Zealand, weather forecasts are used at all levels of the fire protection organisation. The collection of accurate weather information is vital for Canadian meteorologists, who issued twice daily weather forecasts relevant to the part of the country we were working in. These forecasts are tailored to the fire-fighters needs, providing predictions of maximum temperature, wind speed, rainfall and minimum relative humidity (RH). The inclusion of all four inputs to the FWI System in the weather forecast allowed fire managers to calculate FWI figures a day in advance, therefore giving them time to organise the sufficient level of resources to handle the danger on that day. It also allows recognition of *dangerous* situations, such as temperature/RH crossovers, where "blowup" fires are likely.

In New Zealand, accurate weather forecasts would allow fire managers to better manage fire permit issues, burn-off operations, public awareness programmes, preparedness planning and wildfire situations, but the New Zealand Meteorological Service needs to provide RH predictions in these forecasts, so that they can be easily used by the fire manager.

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