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The Probabilistic Fire Analysis System:
Hot New Tool in the Wildfire Management Arsenal

In the eyes of those charged with managing wildfires in Canada's forests, not all wildfires are the same. And not all warrant their suppression efforts. Indeed, about 10% of the fires that occur in Canada every year are allowed to burn, playing a natural ecological role.

Allocating limited fire management resources is akin to triage on a battlefield. The fires that start close to the wildland–urban interface, near towns, suburbs, and even cities, threatening people, wildlife, property, and utility corridors, automatically go to the top of the firefighting list. The fires that start far from human settlement and industrial operations go to the bottom of the list. In between are the wildcard fires that are not of immediate concern but may pose a threat if they continue to spread.

Wildfire suppression in Canada: an annual $500-million bill

Deciding which fires to manage and when is the responsibility of the provinces and territories. The wildfire managers in each of these jurisdictions must assess a host of factors before sending firefighting crews, equipment, and other resources to where the need is most urgent. Parks Canada faces the same challenge in carrying out its responsibility for operational fire management in national parks and reserves.

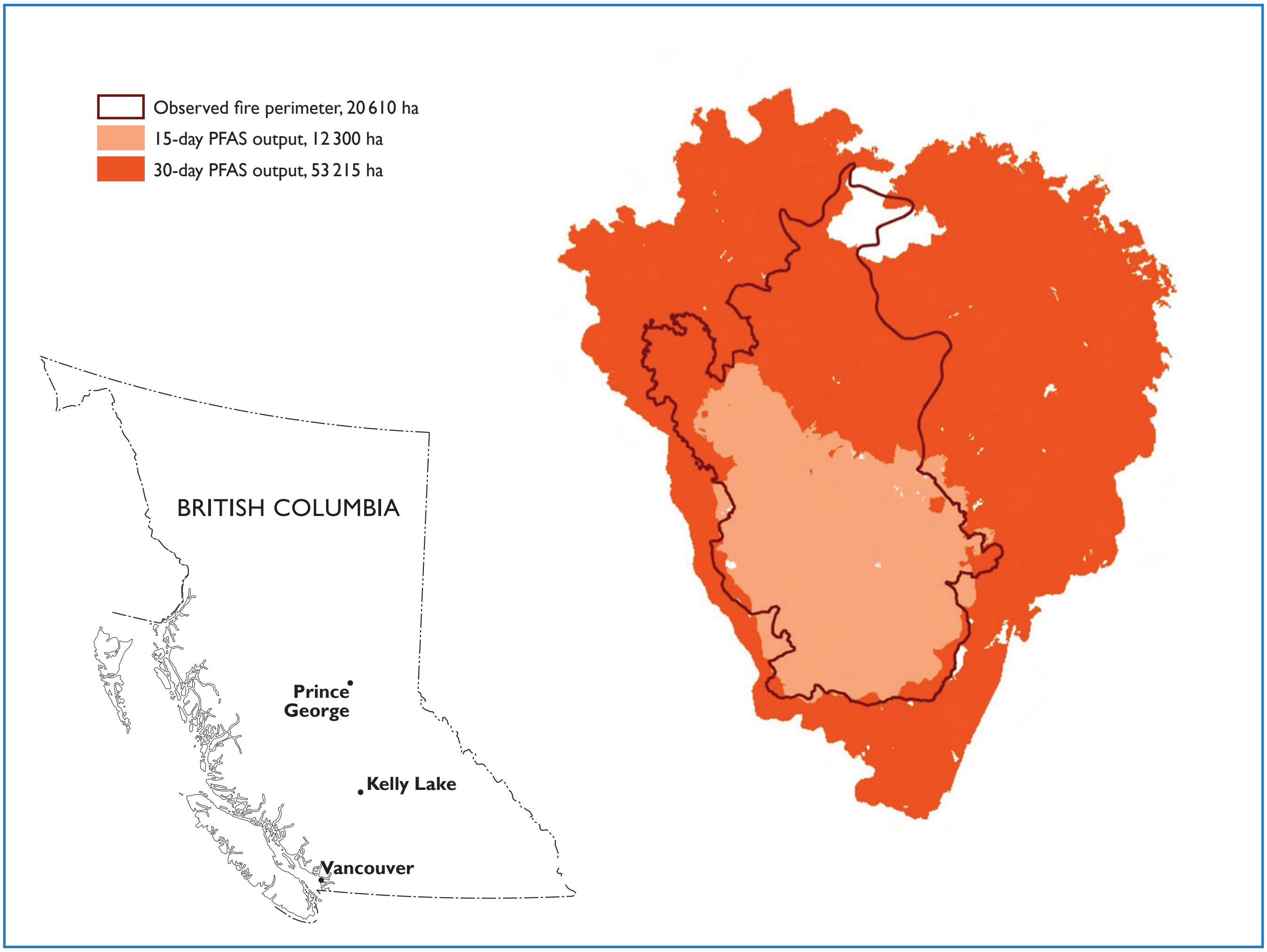
That resource deployment exercise is relatively straightforward if only a few outbreaks occur at a time. Decisions are more difficult when ignition-favorable weather and fuel conditions develop. The usual high-hazard mix is a long hot dry spell, tinder-dry forests, and thunderstorm activity. Under fast-changing circumstances, wildfire managers must choose which fires to fight and which to allow to burn. Given that the cost of fighting wildfires in Canada averages about $500 million annually, a tool that helps authorities predict which fires do not justify deploying people and equipment can contribute to enormous public savings.

A unique assessment and decision-making tool, the Probabilistic (formerly Prescribed) Fire Analysis System, or PFAS, has been developed by Canadian Forest Service (CFS) scientists in response to this need.

The Probabilistic Fire Analysis System: a wildfire modeling breakthrough

A multi-scale spatial computer model, PFAS makes long-term predictions about how far a forest fire is likely to spread before burning out. The model uses localized climate, landscape, and other data to calculate both the probability of a fire's spread and the probability of it being extinguished naturally by rain or similar weather event. It then combines these two prediction calculations into spatial representations that show the fire's maximum extent.

Wildfire suppression efforts cost Canadians hundreds of millions of dollars annually. A computer model developed by Canadian Forest Service scientists could help whittle that cost down substantially.



The Probabilistic Fire Analysis System projection map of a fire in Edge Hills Provincial Park near Kelly Lake, British Columbia.

Other computer simulations and modeling of fire behavior and impacts exist (http://cwfis.cfs.nrcan.gc.ca/en_CA/index). PFAS is unique because its predictions can extend for weeks and in some cases even months. Most other fire-growth models project only a few days and typically only hours.

With this predictive strength, PFAS enables wildfire managers and emergency planning teams to assess, classify, and prioritize wildfires according to the threat they pose, not just today but in the weeks ahead. Firefighting resources could then be sent to where the need is most urgent, and—key from a budget optimization standpoint—withheld where need is less urgent.

The burning question that started it all

Kerry Anderson, a fire research scientist with the CFS Northern Forestry Centre in Edmonton, is the person behind PFAS. Anderson started working on the model in 1997 when Parks Canada asked the CFS for help with a fire management problem.

Parks Canada staff wanted to know the outcome if wildfires in the areas they managed were allowed to burn out. Fires have an ecological benefit. Allowing them to run their course naturally is desirable in some situations as long as no other values, for example, the safety and well-being of people, are threatened. Would it be possible, Parks' staff wondered, to predict confidently how far a given wildfire might advance if it continued to burn for weeks or even months before rain or snow extinguished it?

Anderson and a team of CFS scientists set out to develop a prototype system to answer this question. They envisioned a system that could predict not only the probable extent of a fire's spread but the probable duration of the fire if it were left alone. Refinements and validation of the model followed. This process included trial applications in northern Alberta's Wood Buffalo National Park where prescribed fires have long been used in ecological management plans. Testing confirmed the utility of the new long-range fire-growth model both for assessing the risk of fire spread and for analyzing threats to identified values.

It was during large wildfire outbreaks in the same park that PFAS also underwent its first operational tests in 2003 and again in 2007. Even run alongside other fire-growth models used in those two cases, PFAS's performance was notable. Parks Canada staff made their strategic decisions independent of the new model's output, but the information PFAS generated clearly corroborated those decisions. Consequently, the model's reputation as an innovative and pertinent tool in the wildfire management arsenal grew.

PFAS in action: reinforcing million-dollar decisions

In the summer of 2009, British Columbia was in the midst of one of its worst fire seasons on record. In early August, more than 800 fires were burning, and despite drawing extensively on resources from other provinces and territories through the Canadian Interagency Forest Fire Centre (http://www.ciffc.ca/), 130 fires were burning without suppression. At the request of the BC Ministry of Forests and Range, the Canadian Forest Service supplied a task team of researchers and GIS specialists to assist provincial staff with strategic analyses of this very unusual fire situation.

The team ran PFAS projections for 32 fires, the first application of the model at such a large scale. The model predicted the fires' spread with reasonable accuracy, considering the difficulty of the problem. In the suite of tools that wildfire authorities rely on to make their million-dollar decisions, PFAS proved to be valuable when choosing which wildcard fires would likely need suppression and which ones should be allowed to burn.

Steve Taylor, a CFS research scientist with the Pacific Forestry Centre in Victoria, BC, coordinated the analyses in 2009. "There's no question that PFAS performed well," he says. "Even in that tough fire season, the model helped provincial authorities weigh firefighting options differently from how they would have without the predictions."

In 2010, British Columbia used PFAS for a second time to help rank wildfires. The fire season had begun quietly, but conditions changed dramatically in parts of the province by mid-summer. On the August long weekend, the Cariboo Region alone saw 150 fire starts. Again, even with the province's full forest fire management system in play—protocols, rapid mobilization of information resources, and much reliance on professional judgment—the value of PFAS as a decision-making support tool stood out. British Columbia's forests ministry is now working with the CFS to further integrate the model into the province's firefighting system.

Making PFAS better than ever

Further refinements and upgrades to PFAS will expand its utility. Work is now under way, for example, to improve the model's ability to handle weather conditions in complex terrain. Researchers hope that by redeveloping the CFS's Spatial Fire Management

Snapshot of PFAS's uses and benefits

Resource deployment decision making

The model's predictions about wildfire behavior and duration can help wildfire managers decide where suppression resources are most, and least, vital to deploy. This could save millions of dollars annually in firefighting costs. Of course, because authorities prioritize fires based on values at risk, protection of human lives and property remains the foremost consideration in all fire suppression decisions.

Forest ecological health management

The model helps forest managers and planners promote and justify the use of natural fire as an aid in ecological health management through, for example, fuel load reduction and pest control. It can also give fire authorities confidence that allowing some wildfires to burn will not affect communities and other identified values at risk.

Multi-scale approach capability

The model uses a multi-scale approach to fire-growth prediction. Therefore, through nesting with short-range (deterministic) and medium-range (ensemble) growth models, PFAS long-range predictions can more accurately and fully capture the initial conditions using observed and forecasted weather.

Research applications

Researchers used the model to simulate wildfires in a study of the effect of landscape composition on fire size in boreal forests in eastern Canada. The simulations enabled various forest-related characteristics to be observed and measured at space and time scales not possible to examine in other ways. Increasing interest in studying the effects of climate change on vegetation composition, ecosystem processes, and other factors will likely make the model even more useful.

The federal government, primarily through Natural Resources Canada, provides scientific and technical research and advice to support jurisdictions' efforts to protect people and property from wildfires.

Fire in the Cariboo Region. The red area in the forest is mountain pine beetle (*Dendroctonus ponderosae* Hopkins) damage.

System (SFMS), a platform that manages fuel, terrain, and weather databases, they will enable the two systems to run together, allowing users to launch PFAS from SFMS.

Automating more of PFAS's tasks is also on the to-do list. For instance, constructing fuel, topography, and other necessary inputs to the model would help accelerate the fire-growth projection process. Notes the Pacific Forestry Centre's Taylor, "The effectiveness of PFAS is likely to increase as the system is improved and can return projections more quickly—say, within a few hours of the first fire start."

Currently PFAS is available as a stand-alone software package from the Northern Forestry Centre. Time to prepare the dataset is required before the model is applied, but the CFS offers its support.

It is still early days for PFAS, but given its promising track record, interest in the capability of this unique long-range fire-growth model will continue to grow.

For further information, contact Kerry.Anderson@nrcan-rncan.gc.ca.

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