Research Links

SPECIAL FIRE MANAGEMENT ISSUE

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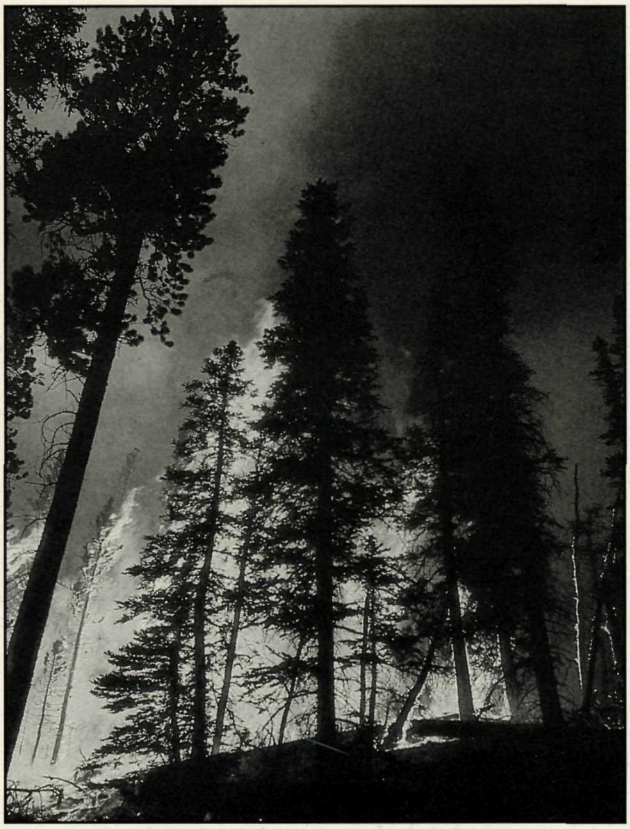
FIRE IN PROTECTED AREAS

Fire management challenges the very fundamentals of Parks' policy and purpose

Stephen Woodley



A new way of thinking: fire as a natural and necessary process

Possibly nothing in the entire spectrum of managing protected areas causes so many difficulties as dealing with wildfire. It is a force of nature that can be absolutely terrifying, transforming forests to ashes, and green nature to black devastation. Wildfire can destroy property and even take lives. As small children, we are all taught to be careful with fire, to protect nature and ourselves by carefully extinguishing our campfires. As adults, when the fire weather index goes up in our parks, we leap into preparedness. Specially trained crews stand at the ready, aircraft are hired, campfires banned, and the public gravely warned of the danger. The beast of wildfire lurks nearby.

Yet, the science of ecology tells us a completely different story. Most of the ecosystems of Canada have evolved with, and been formed by, wildfire. Wildfire is as "natural" as wind or rain. Ecosystem science shows that many of the ecosystems we seek to protect within national parks are fire-adapted—they *need* wildfire. To eliminate fire from those systems is as direct an ecological insult as damming a river or shutting out rain. Yet that is exactly what we have done to the vast majority of protected areas over the past 50 years.

How can we possibly reconcile our management of protected areas with the reality of wildfire? How can park visitors, adjacent land owners, managers, and park staff be brought into the solution and convinced that wildfire is essential? What policy options is Parks Canada pursuing to ensure wildfire plays its essential role in maintaining ecological integrity? I will try to address these questions in this article.

A BRIEF HISTORY OF WILDFIRE MANAGEMENT

The development history of the fire policy and current practices has been well reviewed (Woodley 1995; Lopoukhine 1993; Westhaver 1992; Day *et al.* 1988; Van Wagner and Methven 1980). While there have been some notable exceptions, the most common reaction has been to suppress all wildfire. One of the main reasons for the development of the Warden Service in the Rocky Mountains was to control wildfire. The service was so successful in its job, the annual area burned during the last 60 years has been reduced to three percent of the previous, long-term average. The vast majority of fire researchers believe that the lengthening of the fire cycle is substantially due to fire prevention and suppression. The elimination of native burning is also a critical (but unresolved) issue *(see Kay, p. 20).*

After 1945, in response to a dramatic increase in the number of visitors to Canadian national parks, Parks Canada embarked on a "protection" stage of management. Parks were considered natural and wild, and the job of park management was seen as protecting parks from threats such as poaching, trampling, and fire. Fire suppression became much more effective, and it is likely that, during this period, fire control began to alter the historical fire regime.

In the '70s, there was a growing realisation that parks were not always self-regulating, natural ecosystems. Instead of "natural," park ecosystems were increasingly seen as "impaired" and management was deemed necessary to correct this condition. Fire was increasingly viewed as an important dynamic element in ecosystems, and research clearly demonstrated that some ecosystems were fire-dependent. Parks Canada responded to these changing attitudes with a 1979 policy permitting, under certain conditions, active management or manipulation of the ecosystem. This was the beginning of Parks Canada's "fire management" era. With a new directive produced in 1986 and a comprehensive fire policy review, Parks Canada embarked on a new relationship with fire. Fire was officially recognized as an important element in the ecosystem and it was to be restored to its "natural role" by active management. Unregulated wildfire was considered impossible in most parks because of the values—public safety, protection of property, protection of rare species or habitat—at

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"Fire Management"

STATEMENT OF PURPOSE

The main goal of this publication is to foster communication between scientists, resource managers, and science and management. Please note the views of authors do not necessarily represent the views of Parks Canada or its employees.

FEATURE ARTICLES

DEPARTMENTS

FRANCOPHONES

Le texte de cette publication est offert en français. Vous pouvez l'obtenir en écrivant a l'adresse dans la p. 24.

SUBMISSIONS WELCOME FOR WINTER ISSUE. DEADLINE IS OCTOBER 16, 1995.

EDITORIAL

Since I heard of their existence, I wanted to see the geysers of Yellowstone National Park, and so, in 1989, I went to Yellowstone for a holiday. It was the first summer after the large-scale fire that burned most of the park, and for seven days, I slept between burnt tree remnants, wandered among ashes, and wondered at fire's desolation. I was fascinated by the destructive power, by how little was left. I didn't notice the greening of the underbrush; I don't remember the geysers.

The image of Yellowstone burnt, destroyed, and desolate stayed with me for a long time. When sitting in front of a campfire, I would suddenly see burnt tree stumps or imagine what it might be like if it spread out of control, devouring everything in its way. The sound of fire sirens would send my imagination running; the smell of smoke would triple my heart rate. Fire fascinated and frightened me more than any other aspect of nature. I think fire has this dual effect on most people. It is easy to understand why fire evokes both fear and enchantment, why we have strived to control and suppress its wild existence, why it is such a pervasive element of our mythologies and religions. To understand fire itself is not so easy; by extension, it can't be easy to manage it—something Parks Canada has been trying to do for more than a century.

I have spent the last four months getting to know fire and fire management, in the peculiar way that editors get to know things: through the articles and people featured in this issue. It has been an exciting and challenging process, during which I found myself reconsidering and shedding assumptions I did not even realise I held.

Yellowstone was the first time I realised, consciously and emotionally, the scope of fire's uncontrollable force; editing this issue of *Research Links* was the first time I perceived, consciously and intellectually, fire as a crucial ecological process. I think Parks Canada's journey, as described by Stephen Woodley in the lead article of this issue, mirrored my own: we both started with fear of fire's destructive power and reacted with a desire to suppress and control; as our knowledge increased, we began to think of managing and understanding, not just suppressing *(see Woodley, p. 1)*. To make that step, and to continue beyond it, we had to shift our perception of fire and, in fact, the natural world. Suppression and control take place in a homocentric world, where human needs and wants are the be-all and end-all; a desire to manage and understand takes us to a new, more sophisticated level, where humans become just one of the species affected by fire.

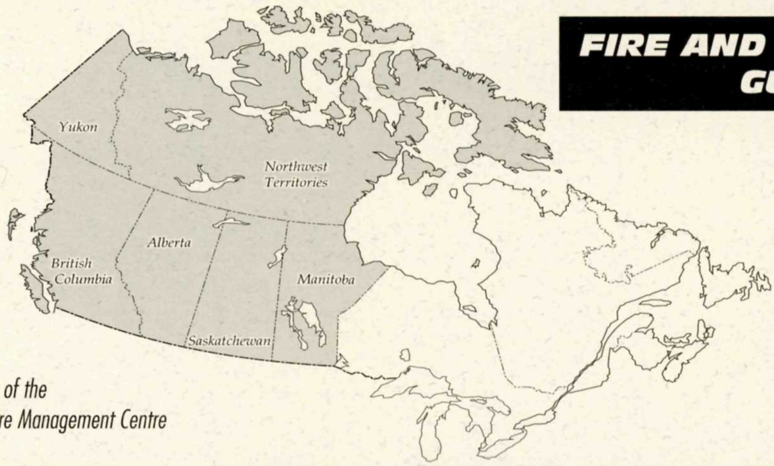
To think of fire as we are trying to do now—a crucial ecological process, an important part of our natural environment—is, I think, one of the most important developments of human consciousness. To recognize the dependence of other species on fire processes, to strive to maintain or restore fire processes because other species need them heralds that we are ready to shed the centuries-old view that the Earth and all other species are ours to exploit. To witness the beginning of such a change is exciting and heartening; as Ian Pengelly suggests in the closing piece of this issue, it gives hope that we will finally figure out how to co-exist peaceably with other species on our small planet *(see Pengelly, p. 23)*.

The *Research Links* editorial board decided to produce this special fire management issue to highlight and publicize some of the most significant ecological developments of the last half-century. I hope this issue shows readers a view of fire I was not cognizant of until I read the work of our contributors, who have studied, managed, and lived with fire most of their careers, and in some cases, lives. On behalf of the *Research Links* editorial board, I would like to thank all of them for their contributions to this issue. I would especially like to acknowledge Alan Westhaver and the Western Fire Management Centre staff—many of whom are featured in the Natural Region Highlights Profiles *(see p. 12 & 13)*—for much needed help and support during the production of this issue.

A few weeks ago, a friend of mine visited Yellowstone. She talked about the geysers, which I didn't remember, the beautiful scenery, which I didn't see, and the regenerative power of the old fire, which I, back then, didn't understand. I wonder what I would think if I saw Yellowstone today….

Marzena Czarnecki
Production Editor

This issue marks the debut of Research Links on the Internet. Look us up at http://www.worldweb.com/ParksCanada-Banff/



Geography of the Western Fire Management Centre

The Western Fire Management Centre: development and implementation

Alan Westhaver and Bruce Sundbo

The Western Fire Management Centre (WFMC) was designed as a client-driven, cost-efficient means of delivering increased technical and professional expertise in fire management and of coordinating fire preparedness for field units in British Columbia, the Yukon and Northwest Territories, Alberta, Saskatchewan, and Manitoba. It was created in February 1994 through a Tri-Regional Accountability Agreement.

The WFMC represents an innovative way of doing business and of serving the operational, ecological, and administrative aspects of fire management within the three western-most regions of Parks Canada: it operates as a consolidated centre for coordinating, expediting, supporting, and providing leadership to fire management functions in the area. The purposes of the WFMC are:

- to maximize delivery of operational and "ecological" fire management support services to all field units;
- to coordinate effective intra/inter-regional resource sharing;
- to optimise inter-agency cooperation with British Columbia, Alberta, Saskatchewan, Manitoba, the Yukon and Northwest Territories, and the Canadian Interagency Forest Fire Centre; and,
- to ensure efficient use of forest fire suppression funding.

Both the operational and ecosystem management aspects of fire management within the three regions are expected to improve through this approach.

Operationally, the WFMC serves prime coordinating functions in terms of fire preparedness systems, emergency suppression response, fire finances, fire reporting, equipment management, and inter-agency liaison. The development of fire/vegetation management plans and integration of fire programmes with regional ecosystem management initiatives will be accelerated by incorporating extensive involvement by Parks Canada ecologists and park specialists. Administratively, the WFMC serves as a programme advocate, facilitates the activities of regional fire management and technical working groups and represents the three regions to other fire management agencies. It is not designed to replace or duplicate programme headquarters coordination or leadership in fire management at the national level.

Core resources for the WFMC were derived by co-locating the two existing regional fire management officer positions of Alberta and Prairie and Northwest Territories in Calgary; currently these are held by Alan Westhaver and Bruce Sundbo. The Alberta Region equipment cache and Gord Watkins, its manager, have also been integrated with the WFMC.

Staff of the WFMC report to Bernie Lieff, acting manager of Ecosystem Management Services, Alberta Region. A tri-regional committee, consisting of Doug Walker, Greg Fenton, Paul Galbraith, Cliff White, Brian MacDonald, Bill Browne, Stephen Woodley, David Henry, Peter Achuff, and the above mentioned Alberta Region staff, serves as a board of directors for the purposes of guiding short- and long-term work plans for the WFMC. This committee will have ultimate responsibility for evaluating the concept's performance at the end of a two-year trial period. To date, there has been much positive feedback regarding the WFMC. The record-breaking 1994 season allowed many new concepts and innovations to be tested "by fire."

***Alan Westhaver** and **Bruce Sundbo** are regional fire management officers at the Western Fire Management Centre in Calgary. For further information, please call (403) 292-4516.*

FIRE AND VEGETATION MANAGEMENT GUIDELINES AND PRINCIPLES

The guidelines and principles below are part of a draft paper, "Principles for the Management of Vegetation in Canadian Mountain Parks," currently in preparation by Stephen Woodley, Alan Westhaver, Peter Achuff, Nik Lopoukhine, and Mark Heathcott.

These guidelines and principles are a synthesis of current policy, scientific research, socio-economic considerations, and ecosystem management concepts. They were developed for managing vegetation dynamics in the Rocky Mountain national parks and to provide a common understanding and consistent approach to vegetation and fire management.

GUIDELINES

1. There must be a consistency of understanding within the Rocky Mountain national parks on the management of vegetation and dynamic elements (*e.g.* fire protection and prescribed burning). A lack of commonality leads to conflicting management actions/in-actions among parks, confusion within Parks Canada about vegetation and fire management, and inconsistent messages and interactions with our neighbours.

2. A science-based, adaptive management approach will be taken to all vegetation and fire management activities. Management actions should be treated as experiments, with clear, measurable, and ecological objectives, and a detailed monitoring programme. The results of the experiments must be appropriately recorded and evaluated.

3. Fire has been a significant force in Rocky Mountain ecosystems and it should continue to play a prominent role. The current practice of full suppression of fire, which leads to fire exclusion in several mountain parks, is not acceptable. Given the values at risk (*e.g.* economic assets, tourism, public safety), the role of fire must be maintained through prescribed burns and less-than-full-force approaches to wildfire. There is an urgent need to develop plans and advanced methodologies for the use of prescribed fire and modified suppression of wildfires in the Rocky Mountain national parks.

4. Parks Canada will maintain adequate fire control regulations and capabilities

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Fire, weather, and history

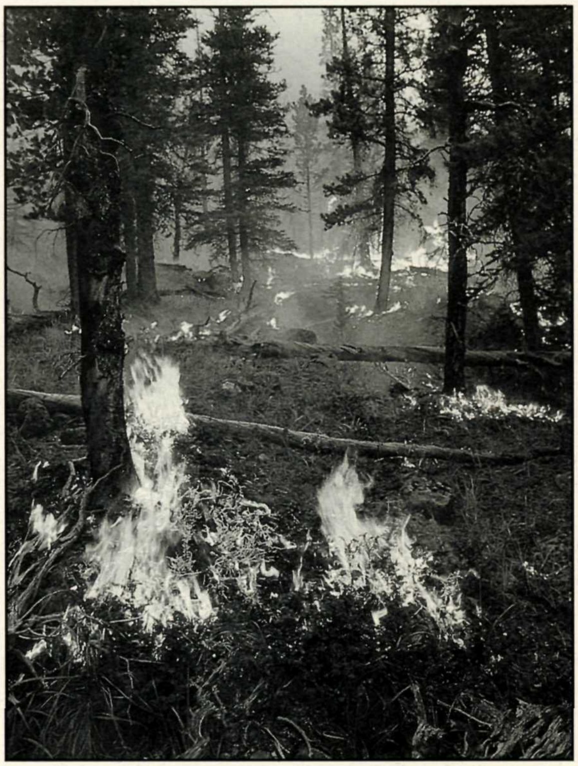
Fire and weather history of the last millenium sheds light on today's fire patterns

C.E. Van Wagner

Most of Canadian forest is normally recycled and renewed by random, periodic fire. The majority of pine, spruce, aspen, and birch species, as well as some far western species like Douglas fir, do not germinate and survive well under a closed canopy. Instead, they have evolved over long ages to depend on disturbance by fire for their continued existence in large numbers. Many of Canada's national parks are clothed in forests of this sort.

Clearly, if fire were permanently removed from such species' environments, orderly renewal would cease, and forests of different structure would eventually result. Tree species not dependent on fire would likely predominate. However, in spite of a reduced burning rate in some regions, nowhere has such a process proceeded to obvious completion. No one yet knows, therefore, just what the replacement forests would be like.

The purpose of Canada's national parks is to preserve representative samples of landscape, along with their plant and animal life, in natural state. But this preservation is obviously dynamic—continuation of the normal vegetation renewal process is implied. The historical rate of this renewal process is therefore of great interest in parks with fire-dependent forests. Its study is fire history, a branch of forest ecology.



Prescribed burns attempt to recreate natural fire cycles

Two recently completed reports, *Analysis of fire history for Banff, Jasper, and Kootenay National Parks* (Van Wagner 1995) and *A century of fire and weather in Banff National Park* (Fuenekes and Van Wagner 1995), deal extensively with forest fire data analysis in the Rocky Mountain national parks, from the present to several centuries into the past. This article will highlight some of the reports' findings.

FIRE CYCLE

Given that a forest is essentially managed by fire, the simplest measure of how fire "manages" forests is the "proportion of the whole area burned annually on the average." By inverting this fraction, one obtains the fire cycle: the number of years needed to burn an area equal to the whole area in question. The definition is worded this way because fire may burn some areas more than once during a cycle, and others not at all. In fact, the most useful assumption is that fire strikes without regard for age. Mathematics then lead to the negative exponential curve as the most likely form of the distribution of area by age: a forest's fire history is embedded in its age-class distribution. The fire cycle is found directly from the logarithmic slope of the negative exponential curve, and measures the average interval between fires that produce new forest (Van Wagner 1978). The forest landscape becomes a patchwork quilt of differently sized and shaped areas that originated after fires at various times. Some areas will be older, some younger than the cycle period; live survivors may or may not be present. The very existence of such a forest landscape is reasonable proof that renewal by fire is the main dynamic ecological process. The main requirement for a fire history study, then, is a map delineating each patch with its area and age. Once this information has been arrayed as a data-set in terms of area by age, the analysis can proceed.

FIRE HISTORY ANALYSIS

The chief complication of fire history analysis procedures is the "scale problem," with dimensions in space and time. Caused by the immense variation in burned area from year to year and decade to decade, the problem is that the smaller the area, the more erratic is its record, to the point until no pattern may be evident. The Rocky Mountain parks, with their complex topography, are none too large for confident analysis.

The results of the fire history analysis for Banff, Jasper, and Kootenay National Parks, are, in brief:

- there has been little or no burned area in Banff, Jasper, and Kootenay for the last five to seven decades (0.2, 0.69, and 2.61 per cent of area since 1945 respectively);
- a broad analysis of the previous four centuries yields fire cycles of about 155 years for Banff, and 110 years for Jasper and Kootenay;
- a more detailed analysis reveals that for Banff and Jasper (but not for Kootenay), the burning rate may have slowed around 1700 CE. If so, then a fire cycle of only 50 years or so prevailed before this shift; since then, the cycle in Banff has been about 190 years and about 150 years in Jasper; Kootenay had a constant fire cycle of 110 years until about 60 years ego.
- very large single-year burns, such as the 1988 fire in Yellowstone National Park (US), were extremely rare: as much as two centuries apart; and,
- at no time in the entire five-century record has there been a period of 60 years or so with little or no fire.

It is thus quite clear that for several centuries before about 1930, the forests of the three parks burned at a rate ranging, on a reasonable time scale, from one-half to one percent per year. This process has for the time being nearly ceased. The obvious question is "Why?"

FIRE WEATHER ANALYSIS

There are three factors in a modern fire regime: ignition, suppression, and weather. For the study of last century's fire and weather in Banff, the first two were set aside and the question reduced to "Is it because of the weather?"

Fortunately, recording of various weather parameters began daily at Banff townsite back in 1894, and in 1953, standard fire weather data for the Canadian Forest Fire Weather Index (FWI) System were col-

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Science and Paradox

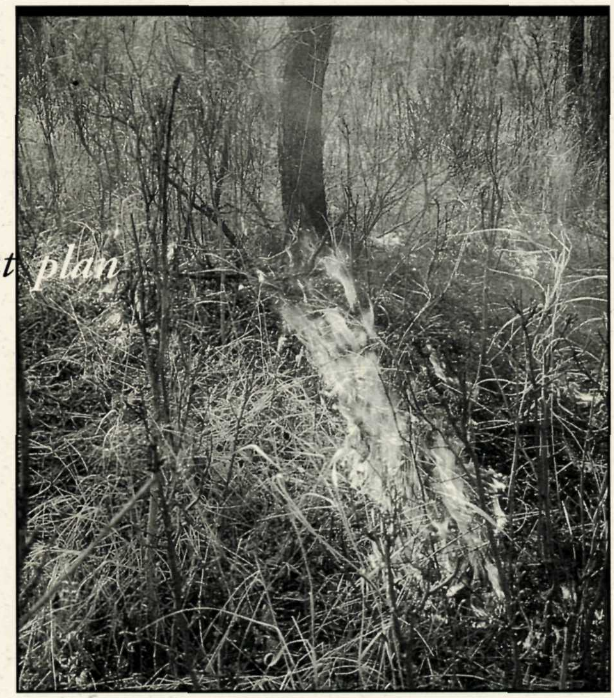
The development of Kootenay's fire management plan

Robert C. Walker

The Kootenay National Park Fire Management Plan is the culmination of six years of labour and enquiry. Plan development began with a fire history study in 1988 and continued through extensive discussion, consultation, and revision until the summer of 1994. Although plan development is now finished, the document will undergo periodic review and will be adaptive to new scientific and management information.

Fire history studies define the past role of fire as an ecological process and provide the essential scientific basis for management decisions. The results of the Kootenay fire history study were interesting as they contradicted one of the underlying assumptions of recent Parks Canada fire management. During most of the last century, there has been a considerable reduction in the area burned by wildfire throughout western North America. The common assumption, based on both research and intuition, has been that this reduction is the effect of several decades of fire prevention and suppression *(see Woodley, p. 1; Van Wagner, p. 4)* as well as an absence of aboriginal burning since European colonization *(see Walker, p. 18; Kay, p. 20)*. The Kootenay fire history results, however, indicate that long-term climate variation is the primary causal agent responsible for the observed reduction in area burned within the park (Masters 1990).

Several fire history studies in the Canadian Rocky Mountains either support or assume the suppression effect (Tande 1979; White 1985). Other studies, however, support climate as the primary causal factor driving fire frequency and area burned (Johnson *et al.* 1990; Johnson and Larsen 1991). The relative contribution of causal factors behind the observed decrease in area burned has some important implications for Kootenay fire management, as Parks Canada policy directs national parks be managed with minimal interference to natural processes, but with active management allowed when ecosystem structure or function is seriously altered. Therefore, if the suppression effect is real, Kootenay's mandate is to actively manage affected aspects of the ecosystem, especially if suppression has caused, or can be expected to cause, serious alteration of the structure or function of the ecosystem. If the suppression effect does not exist, or its effects have been less than serious, however, then Kootenay may be imposing an unnatural regime on ecosystems by active management actions such as prescribed burns. Several current research efforts in Kootenay focus on further defining the effects of climate, suppression, and land-use changes to ensure the park's fire regime reflects past conditions.



An increasingly rare sight in Kootenay

The nature of wildfire causes further complications. The same characteristics that make wildfire the dominant ecological process shaping the forest landscape within the Canadian Rocky Mountains also make it an awesome, destructive force with serious potential impacts on life and property. As a result, fire management is constrained by considerations of neighbouring land values, physiography, and public perception of fire as wasteful and damaging. The destructive nature of wildfire creates a paradox for fire management. There is a need both to maximize its critical role in the ecosystem and to protect values at risk.

Against this background, the Kootenay National Park Fire Management Plan unfolded. It was necessary to define a management strategy that followed Parks Canada policy, used the best available science, and operated within the reality of contemporary constraints. The paradox between current fire management thought, which supports the suppression hypothesis, and the results of Kootenay's fire history study, which indicated an essentially natural, climate-driven fire regime, made developing the plan a very challenging task. Three fire management strategies were considered:

- to continue to actively suppress all ignitions, maintaining ecosystem structure and function by relying on infrequent, high intensity fires that inevitably occur and escape all control efforts;
- to continue to actively suppress all ignitions, maintaining ecosystem structure and function by using prescribed fire across the landscape;
- to continue to actively suppress all ignitions in those areas of the park where no reasonable alternative exists due to risk of serious adverse effects on public safety or neighbouring lands; meet specific management and boundary protection requirements with prescribed fires; protect staff, visitors and facilities through both fire suppression and fuel hazard reduction; and maintain ecosystem structure and function through designating as much of the park as possible as random ignition burn areas, based on management prescriptions and fire evaluation systems, which will define conditions under which natural ignitions can run their course within random ignition areas.

Both the first and second alternatives present an untenable situation for Kootenay National Park fire management. A programme of automatically suppressing all ignitions can be likened to a predator control programme—it directly contravenes current Parks Canada policy by interfering with a natural process. A simple interpretation of the climate effect hypothesis would suggest that alternative one can succeed at maintaining ecosystem structure and function. Realistically, however, suppression and prevention must alter some aspect of the historical fire regime even if that effect is short-term and local. Alternative two complicates the situation further by advocating the wide-scale use of planned ignitions. If unjustified by results of park fire research, planned ignition fires create further manipulation of the ecosystem.

Alternative three is consistent with Parks Canada policy in that it reduces interference with the fire process to a practical

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GUIDELINES

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to protect values at risk, to cooperate with adjacent land managers, and to manage national park ecosystems appropriately.

5. Management actions will be undertaken in consultation and collaboration with neighbouring land managers and other regional stakeholders inside and outside national parks.

6. The active management of vegetation and dynamic processes will include active management intervention based on principles of restorative ecology, using techniques such as prescribed burning, silviculture, planting, and less-than-full-force strategies of fire, insect, and disease control to maintain or restore disturbance regimes and ecosystem structure as closely as possible to conditions within the normal range of variability.

7. Management interventions must be based on clear objectives and clear plans that are open to review and scrutiny. Efforts must be taken to fully consult and inform the public on management actions.

8. It is essential to consider the interactions of fire and other disturbances (*e.g.* herbivory, insect and disease activity) and human disturbances when developing management plans. For example, there is an urgent need to examine the interactions of elk herbivory, fire, and vegetation change in the montane ecoregion.

9. In accord with Parks Canada's Guiding Principles, the management of vegetation and disturbance regimes will generally follow the policy of minimal intervention. Where management intervention is required, techniques will duplicate natural processes as closely as possible.

PRINCIPLES

1. Ecosystems are dynamic, changing with both long-term (*e.g.* climactic change) and short-term (*e.g.* herbivory) variables. The structure and function of ecosystems that we seek to maintain in national parks can be realised by maintaining or restoring dynamic elements and processes with which the system has evolved in a regional context. The main dynamic elements for

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Parks' Fire Information System:

Using communication technology and information transfer in nation-wide fire management activities

Mark Heathcott

Virtually every aspect of fire management is amenable to some form of scientific inquiry, with most dimensions depending on fundamental knowledge about fire weather, fire occurrence, and fire behaviour. How a programme acquires, applies, and shares this knowledge is basic to its mission. The major reforms in fire management within Parks Canada are inextricably bound up with contemporary communications systems, which facilitate the acquisition, application, and exchange of fire management knowledge between parks, regions, and agencies. The function of the Parks' Fire Information System (PFIS) is to move information and provide computer-assisted decision support.

In the late '80s, a programme-wide review of fire management within Parks Canada resulted in the initial development of PFIS (CPS 1989). Advances in communications technology and fire science are reflected in the current version of PFIS.

The platform of PFIS consists of personal computers at each site, with the 486, hub, and Pentium array located at National Parks Directorate. Communication is accomplished through use of fixed telephone lines, a 1-800 number, and 14.4 K baud modems. Internet and satellite transmission are also used for a number of components *(see Figure 1)*. The necessary software is either commercially available or has been developed under contract to Parks Canada. Research and development of the PFIS modules, including fire occurrence modules, fire weather, and fire behaviour prediction have been led by The Canadian Forest Services, with Parks Canada and a number of private companies concentrating on technology transfer.

Parks Canada relies on the Canadian Forest Fire Danger Rating System (CFFDRS) to assess various elements that affect ignition potential and probable fire behaviour. This system currently has two operational components: the Canadian Forest Fire Weather Index (FWI) System and the Canadian Forest Fire Behaviour Prediction (FBP) System. A third component, the Canadian Forest Fire Occurrence Prediction (FOP) System is under development *(Figure 2)*.

Fire weather is monitored by individual parks, either in a manual observation programme or through the use of automated weather stations. Data capture, analysis, and archival functions are facilitated by Weather Plus™, a DOS-based software package. For the purpose of fire management, this software is programmed to calculate the codes and indices of the FWI System, however, it is completely programmable by the user, allowing wide-ranging versatility. Weather Plus™ data files are uploaded to the master data base each time a user phones PFIS. These data files may then be downloaded by other park users.

Weather conditions are also monitored using a number of other sources. Atmospheric Environment Service uploads their alphanumeric data stream to the ANIK series of satellites. This data stream is captured by a dish at Parks headquarters and transferred to

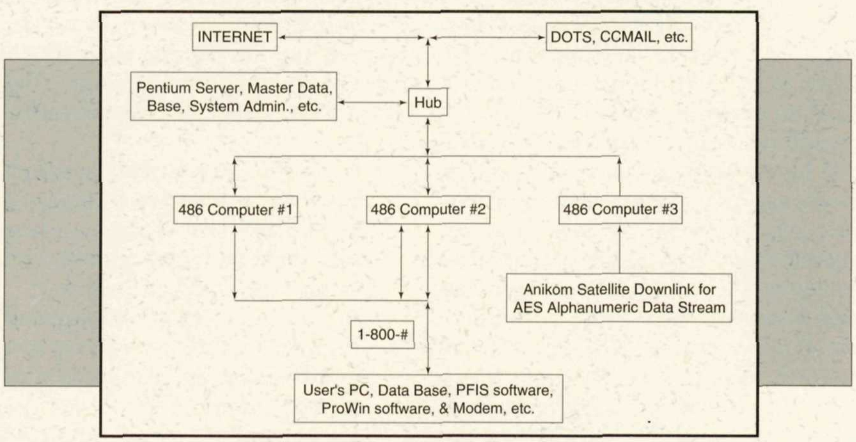

Figure 1: The technology of the Parks' Fire Information System

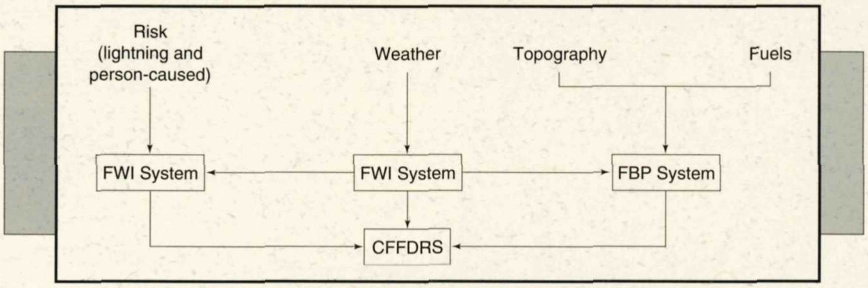

Figure 2: Components of the Canadian Forest Fire Danger Rating System

the master data base, which is accessible to park users. Some of the information available includes forecasts, surface station data, and upper air soundings. A wide range of weather products are accessible through the Internet. Atmospheric Environment Service's World Wide Web server at Downsview (http://www.dow.on.doe.ca/) provides charts and satellite images. A number of American universities (*e.g.* University of Michigan—http://cirrus.sprl.umich.edu/wxnet/) also provide detailed meteorological information useful for fire management.

In addition to weather variables, fire behaviour prediction requires topographic and forest fuels knowledge. PFIS contains a number of predictive tools. FBP93™ is a stand-alone, DOS-based software package that allows the user to input on-site weather variables, fuel conditions, and topography to predict fire behaviour variables such as rate of spread, head fire intensity, and crowning potential. The Canadian Forest Service World Wide Web site (http://www.nofc.forestry.ca/fire/fbp/) provides national maps of predicted fire behaviour. The future of fire behaviour prediction within Parks Canada will focus on continued research and development of Geographic Information System–based fire growth models, which are currently operational in the main fire parks including Wood Buffalo, Prince Albert, Banff, Jasper, Kootenay, and Yoho. Future refinements may include the acquisition of higher resolution forest fuel information, the inclusion of digital terrain models, and the use of regional atmospheric modeling systems. Fire growth models provide opportunities for both operations and planning; more accurate fire growth models may enhance fire effects prediction and monitoring.

Fire occurrence information transfer is accomplished through PFIS. Park situation reports are exchanged throughout the fire season, both within parks and between agencies. Parks Canada, along with the 10 provinces and two territories, reports daily to the Canadian Inter-agency Forest Fire Centre (CIFFC) in Winnipeg. Reports include information concerning the number of fires, fire size, status of control, resource requirements, and availability of internal resources for sharing. Agency reports are transferred and captured through the Internet. The potential for fire occurrence prediction is rising, with most agencies willing to increase sharing of lightning and fire occurrence information. Parks Canada, with its wide-ranging system of parks, stands not only to benefit but also to facilitate increased information transfer. Future goals for PFIS fire occurrence modules include the development of a national lightning occurrence map, useful for both operational and research purposes. Cooperating agencies to date include the Yukon and Northwest Territories, Alberta, and Saskatchewan.

In the past, communications was thought of as a fire management service function, something designed to support fire detection or suppression. More recently, because the capacity of modern communications systems to move information is so great and the process of computer-assisted decision making is so powerful, communications seems to drive the other functions rather than serve them. Despite these advances and developments though, information is no substitute for action, and sophisticated knowledge of fire behaviour cannot replace traditional fire-control technology such as fireline construction.

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Weather Plus™ and FBRP93™. Software.
Available from REMSOFT Inc., 620 George Street, Suite 5, Fredericton, NB, E3B 1K3.

PRINCIPLES

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vegetation in the Rocky Mountain parks are fire, herbivory, insect and disease activity, windstorms, avalanches, and flooding. Human influences in these processes are also in evidence.

2. Detailed ecological goals are essential for sound ecosystem management. The management of (for instance) vegetation dynamics is a means of achieving a particular goal. Such a goal could be based on evidence provided by historical disturbance regimes. While this historical approach provides an important reference, it will not provide complete answers by itself. Historical research on fire cycles, paleoecology, or archaeology cannot always be directly applied to the modern context for many reasons. These include short term data sets, uncertainty over the role of aboriginal fire, and a changed regional and local context in which fire occurs.

3. Disturbance regimes within regional ecosystems, including some portions of national parks, have been altered by management actions such as fire suppression, timber harvesting, agriculture, and elimination of aboriginal land use.

4. Active adaptive management is required, in some cases, to ensure disturbance regimes are present at levels required to maintain ecological integrity, which includes sustaining native biodiversity and evolutionary potential within the regional context. A policy of complete "hands-off," "natural regulation," "let-nature-take-its-course" is not possible in many portions of national parks for many ecosystem processes.

5. Economic, social, and biological constraints preclude the option of an absolutely "natural" disturbance regime, for processes such as wildfire, forest insects, and diseases, in management of most if not all ecological/management zones in national parks.

6. Maintenance of pre-European vegetation structure and disturbance regimes cannot be achieved in all portions of national parks. However, knowledge of historic vegetation conditions and disturbance regimes has fundamental value in guiding the development of vegetation management objectives and methods.

***Nik Lopoukhine** is acknowledged for his role in refereeing internal peer review of this portion of the paper.*

Sleuthing in the Mountain Parks

Extensive fire history studies in the parks attempt to reconstruct fires of the past

Marie-Pierre Rogeau

For several years, forest and fire managers of the mountain parks stressed the need to reconstruct past fire events to better understand the role of fire and the fire regime of their region. A fire regime encompasses different attributes such as fire frequency, size, intensity, and "periodicity to return" in a pre-defined area. Fire history studies are a key factor in determining the fire regime of a specific ecosystem.

Since the early '80s, each park has painstakingly completed its own historical fire investigation. As part of the management strategy for a large scale ecosystem unit—the Central Rockies Ecosystem—the fire history studies from Kootenay, Yoho and Banff National Parks were joined with those from Mount Assiniboine Provincial Park, BC, and Kananaskis Country, AB. To date, with the subsequent inclusion of data from Jasper National Park, this study is likely the largest continuous fire history database in North America. This one landscape level fire history map encompasses over 21 562 km^2 of land.

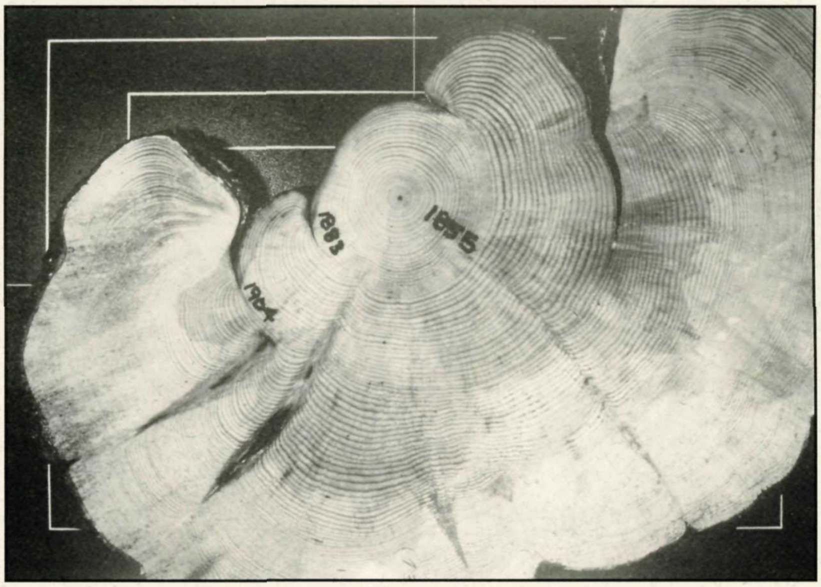

Figure 1: A cross-section of a fire-scarred tree

Different methodologies exist to reconstruct past fire events. In a sub-alpine environment, such as the Rocky Mountains, all studies have relied on the use of "time-since-fire" maps (Johnson and Gutsell 1994). Time-since-fire mapping consists of delineating, on a topographic map, forest stands of similar age that are known or believed to have regenerated from fire. This method is considered the most appropriate because the fire regime of mountain regions is mainly governed by large, infrequent, high intensity, stand-replacing fires (White 1985; Johnson and Wowchuk 1993).

Most fire history studies have dated forest stands by using such evidence as fire scars, a sudden "release" in tree ring growth patterns, age of forest stands, and recorded information such as fire occurrence reports, archives, and old explorers' diaries. *Figure 1* represents a cross-section of a fire-scarred tree. Fire scars occur when heat kills part of the tree cambium. When fire scars exist, the fire event is dated by simply counting the number of annual growth rings between the bark and the fire scar. Another reliable method of dating past fire events, which is useful in stands without fire scars, is to sample older trees that have survived fires. Trees located on the edge of a fire disturbance, or which are surrounded by post-fire-regenerated trees, often show a "release" in the growth ring pattern *(Figure 2)*. This increase in growth rate is produced shortly after a fire event by a dramatic reduction in the competition for light and nutrients from the now dead neighbouring trees. This release will generally be more pronounced on the side of the tree facing the burn area.

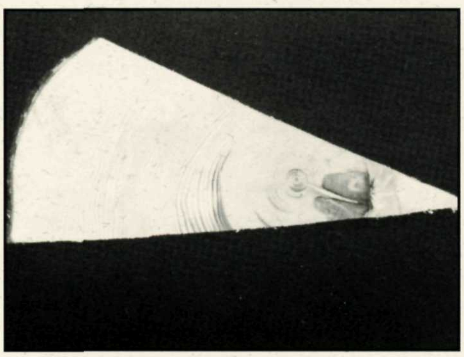

Figure 2: A release in growth-ring pattern

The Central Rocky Mountain Ecosystem fire history data base is a valuable research tool. Marie-Pierre Rogeau, as part of her research towards a PhD, is using it to assess the impact of factors of ignition and terrain on fire distribution. Rogeau is studying lightning distribution, human use patterns, and effect of aspect, elevation, main and side valley orientation, and proximity to the Continental Divide on the age-class distribution of forest stands of Banff National Park. The objective of this research is to better understand why there are extensive areas of old age forest in the park. Those areas, older than 300 years, cover more than 26 per cent of the entire Park, and do not appear to be randomly distributed. This project will attempt to determine if the distribution is in fact random, or if there are ignition and/or topographical controls at work, which have played a role in the fire distribution over the past five centuries. Parks Canada, the University of Alberta, and Forestry Canada's Green Plan are providing funding for the project.

– *continued on page 9* –

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Sleuthing in the Mountain Parks

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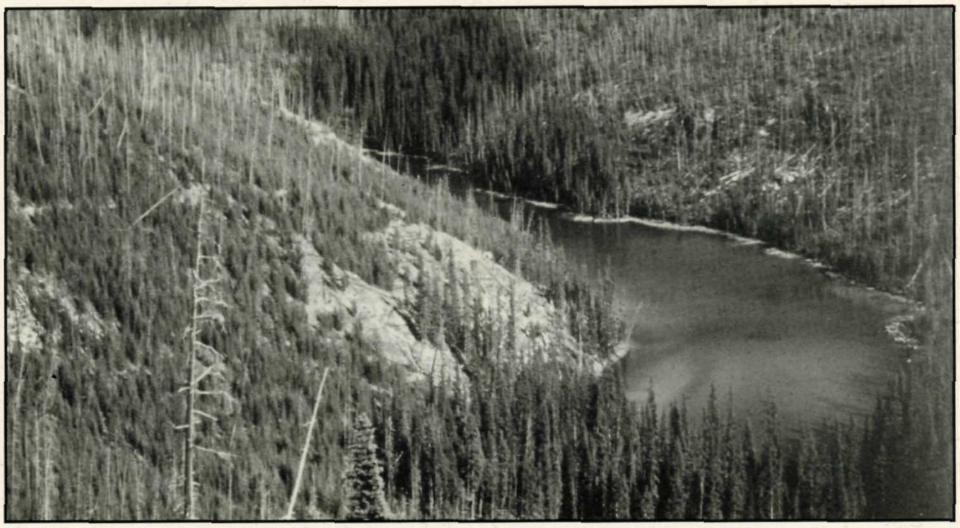

Solving mysteries of the past will help us manage today's forests

METHODOLOGY

The time-since-fire map was digitised and stored numerically in a Geographical Information System (GIS). The total surface area of similarly aged stands was determined and tabulated as a percentage of the total area of the study area, to produce a "cumulated age-class distribution" or a "survivorship curve" (Johnson and Gutsell 1994). The fire regime of the park was identified by studying fire occurrence reports, lightning strike distribution patterns, and recent and past human use patterns. The impact of terrain on fire distribution was tested by comparing mean ages and survivorship curves of forest stands that are located on different landscape attributes. For example, the effect of elevation was assessed by comparing mean ages and survivorship curves of forest stands for each 100 m elevation interval. In the near future, factors of terrain that have the greatest impact on fire distribution will be tested by multiple regression analysis and by the use of neural network.

Results from the project, in a report on the fire regime and the influence of terrain on fire patterns in Banff National Park, will be available later this year. The results of this research will be used to determine the probability of burning for each forest unit in Banff, which, in turn, should be a valuable asset for ecosystem and fire management.

Marie-Pierre Rogeau *is a renewable resources consultant and a graduate student at the University of Alberta under Dr. P. Woodard. She has been working on fire history studies in the Rocky Mountains since 1991. For further information, please call (403) 492-7313.*

Banff's modeling system: predicting effects of disturbance

David Gilbride

The understanding and management of vegetation in Banff National Park is dependent on many if not all the factors that will affect the health of the park over the next decade. Vegetation cover in Banff National Park is diverse in the extreme due to environmental factors such as climate, elevation, geomorphology, and, to a lesser extent, latitudinal and longitudinal variations. One way of understanding such a complex resource and of making some reasonable management decisions is to use a model to simplify the problem and test various management scenarios. The purpose of building models is to learn how a real system works and how it will react to any modification. In the case of vegetation management, an additional purpose is to decide on appropriate strategies to meet the goals of the managing agency; in Banff's case, Parks Canada.

"The model can be used to predict, for example, that in a scenario of a natural fire regime of 200 years, the wet spruce-fir will return to a wet spruce-fir state 70 per cent of the time, to spruce-fir 20 per cent of the time, and to shrubs 10 per cent of the time."

For its ecosystem management planning process, Banff is using Woodstock, a very flexible modeling system developed for forestry management. The vegetation succession model developed by Banff is based on the park's biophysical mapping, digital elevation model, park-defined management areas, ecoregion map, and forest stand origin mapping, which are combined in a series of layers on which the model runs.

The model is then developed using the Woodstock language for various vegetation disturbance scenarios such as no disturbance (death by old age), natural fire regime, prescribed fire, browsing by wildlife, and logging. Each of the landcover themes is defined as to how it might react to the various disturbances and the model is run to show the percentage change over time.

The model can be used to predict, for example, that in a scenario of a natural fire regime of 200 years, the wet spruce-fir will return to a wet spruce-fir state 70 per cent of the time, to spruce-fir 20 per cent of the time, and to shrubs 10 per cent of the time. The model makes similar predictions for landcover such as the wet-dry mosaic, pine forest, deciduous forest, and grassland. All landcover types have to be defined for each scenario and the model can be run with different fire regimes or management actions.

Modeling is only one part and one step in the ecosystem management planning process, but it can be a critical step in understanding our natural resources and the results of management actions. It is also an excellent way of demonstrating the possibilities of the plan, in an innovative and visual way, to both the public and parks staff.

David Gilbride *is a resource conservation park warden at Banff National Park. For further information, please call (403) 762-1495.*

RECENT RESEARCH

The following is a partial summary of recent, on-going, or up-coming research and development projects related to fire management that are conducted within Parks Canada. Most of the projects are collaborative efforts between Parks Canada and other agencies; a significant number were made possible through Canada's Green Plan. Projects marked with an * are featured in this issue of *Research Links.* For further information about any of these projects, please call the Western Fire Management Centre at (403) 292-4516.

RESEARCH PROJECTS

* **Jack Wierzchowski** evaluated the use of aerial photography, Landsat TM, and Compact Airborne Spectrographic Imager in comparing fire intensity, severity, and size of burn patches of prescribed burns and wildfires in Banff National Park *(see Wierzchowski, p. 22).*

Parks Canada is initiating a study of differential flammability of sites within mountain landscapes due to differences in slope angle and direction, wind and sun exposure, and other factors. The objective of the study is to develop better predictions of fire behaviour.

James Bridgeland, Cape Breton Highlands National Park's ecologist, is developing a canopy gap model to investigate the impact of moose on post-budworm vegetation change. Bridgeland is also coordinating the park's fire history studies.

* **Marie-Pierre Rogeau** is completing a spatial landscape analysis of slope, direction, elevation, valley orientation, and distance from the continental divide variables to determine which, if any, of these factors cause different fire regimes in the Central Rocky Mountains *(see Rogeau, p. 9).*

* **Charlie Van Wagner** has undertaken an analysis of existing fire history data for Banff, Jasper, and Kootenay National Parks in an on-going study *(see Van Wagner, p. 4).*

David Hamer studied recent burns in Banff National Park to determine the relationship between buffaloberry

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Fire in Protected Areas

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risk. Thus, Parks Canada began to use prescribed fire to restore the "natural" fire regime (Prescribed burns are now used in three Parks Canada regions). However, in most parks, all wildfire continued to be suppressed.

THE GREAT DILEMMA

Revisions to the National Parks Act in 1988 introduced the term "ecological integrity" and a new model for ecosystem management (Woodley *et al.* 1993). During the early years of park establishment, Canadian national parks were often islands of civilization in a sea of wilderness. Today, the impacts of forestry, agriculture, tourism, and urbanization have effectively isolated most parks as islands in a sea of human development. Large-scale ecological insults such as acidic precipitation and climate change have no consideration for park boundaries. Within parks themselves, large-scale tourism facilities and road networks have been developed. It is increasingly obvious that, instead of being natural, self-regulating ecosystems, parks and protected areas are remnant islands impacted by a variety of human-caused stresses. Everywhere, protected areas managers have reacted by increased reliance on ecosystem management as a guiding concept.

With ecosystem management comes the dilemma of active management, some forms of which are required within national parks if the scale and scope of endemic vegetation dynamics are to be maintained. The very notion of active management is a difficult concept for many people working in protected areas. Traditionally, parks and protected areas managers thought of parks in terms of "wilderness" or "pristine nature." These terms have been used worldwide to describe human desires for protected areas: essentially, places where humans have minimal impact and nature reigns supreme. However, given our current understanding of protected areas, applying these concepts is highly problematic. There are virtually no protected areas in the world that are not affected by long-range pollutants, exotic species, species loss, or change in historical disturbance regimes. We also have to realise that parks have been actively managing wildfire and vegetation for over 50 years through fire suppression.

We are into the era of ecosystem restoration and active management. Ecosystem management implies that goals must be set for the ecosystem. The very act of setting such definitive goals takes the manager away from the traditional reliance on "wilderness" and "pristine nature" concepts. The use of detailed ecosystem goals is an important change. For Parks Canada, such goal statements form a clear understanding of what the public can expect in terms of conservation. Parks Canada policy states

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We are into the era of ecosystem restoration and active management

that vegetation and disturbance regime management should generally follow the policy of minimal interference with natural ecosystem function and, where management intervention is required, techniques will duplicate natural processes as closely as possible. The use of wildfire is one of the most powerful tools we have to restore and maintain fire-dependent ecosystems. In many parks, *e.g.* the Rocky Mountain parks, management action on wildfire is obviously required. The important questions then become what type and scale of management actions are appropriate.

The area burned historically by a single, large-scale fire may often exceed the total area of a national park. Clearly, it is unacceptable for such a fire to occur in many national parks, as it would reduce the entire park to an early successional stage, with consequent loss of habitat for older age-class dependent species. It would also endanger lives and property in and around the park. Such a situation is clearly not acceptable in a park that is imbedded in a landscape of intensive agriculture, forestry, and urbanization.

The ecological integrity approach to park management seeks to protect ecosystem structure and functions that are characteristic of the region, unimpaired by human-caused stresses, and likely to persist (Woodley *et al.* 1993). However, the desired ecosystem structure and function must be defined in realistic terms. The most realistic way to do this is in terms of biodiversity. Fire management is an exercise in patch dynamics, whereby each burn creates a patch on the landscape. The important question for managers is what configuration, type, and size of landscape patches are likely to protect native biodiversity.

Most people recognise that parks must be managed in cooperation with neighbouring land management agencies as well as a wide range of other stakeholder groups. This process is well underway with many excellent examples in Canada. Databases, vegetation maps, fuel maps, and other planning tools are being prepared on the basis of regional ecosystems instead of park boundaries *(see Heathcott, p.6)*. There has been a dramatic increase in inter-agency cooperation in fire protection. However, many important stakeholder groups are uncomfortable with the use of wildfire and prescribed burns. Parks Canada must develop an on-going dialogue with all interested parties on the issue of wildfire. Such a dialogue is now underway in the Rocky Mountain District, with a consultation programme coordinated by the Western Fire Management Centre, park ecosystem managers, and staff from Parks Headquarters.

CONCLUSION

There is wide agreement that fire is an essential process in many Canadian national parks. Unfortunately, no exact formula for the role of fire in national parks exists. Individual parks must choose a combination of observation zones with unregulated wildfire, evaluation zones with case-by-case response to fire, full suppression zones, and zones where prescribed fire is used.

One thing is certain. The management of wildfire involves risks and Parks Canada must be willing to stand by the risk-takers. We must remember that we have been in active management of wildfire for over 50 years, except that we have been intervening primarily to suppress wildfire. We must also remember the consequences of not allowing wildfire to play its ecological role in our parks. The elimination of wildfire eliminates our fire-adapted ecosystems and fire-adapted species. For these systems, the elimination of wildfire is no less than the elimination of rain or wind or other critical processes. We must be adaptive managers, rely on good research, and involve a wider community in the process.

***Stephen Woodley** is a forest ecologist at National Parks Directorate, responsible for national coordination of the fire management program. For further information, please call (819) 994-2446.*

RECENT RESEARCH

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(Shepherdia canadensis) production and time-since-fire, vegetation type, forest canopy cover, moisture, elevation, slope aspect, and angle. A similar study on *Hedysarum* species has since been initiated; both projects will contribute to predicting grizzly bear response to fire management actions.

B.H. Luckman and E.D. Seed of the University of Western Ontario are using tree ring records to analyse fire-climate relationships and trends in the mountain national parks. Results are expected soon.

E.A. Johnson of the University of Calgary is the principal investigator in the collaborative N-BIOME project, funded jointly by the U of C, Concordia University, the Environmental Innovation Programme, and Parks Canada, which is investigating wildfire, vegetation dynamics, and climate change in montane and mixed-wood boreal forest ecosystems.

Canadian Forest Service researchers at the Northern Forestry Centre, with Parks Canada sponsorship, are quantifying the effects of fire suppression by reconstructing expected behaviour of fires suppressed over past decades in Kootenay National Park.

Jeff Weir, a Prince Albert National Park warden, has developed a detailed time-since-fire map of Prince Albert, which reveals much about the fire history of the area.

Dr. Ross Wein is leading a team of University of Alberta researchers, who have undertaken research in Wood Buffalo National Park in a number of related areas. Ian Nalder is conducting a project to model carbon replacement and to calibrate equations for determining the energy content of dead and down woody fuels in the northern boreal forest. Barbara Saunders is measuring decomposition rates of pine and spruce stands affected by fire. Michael Liston is developing a 200–300 year fire history using palynology methods, with validation by monitoring carbon deposits from current fires in lakes and peat banks. Park ecologist Kevin Timony continues to investigate fire effects in the Peace/Athabasca Delta incident to flood his-

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FIRE SPECIALISTS

ALAN WESTHAVER

Regional Fire Management Officer
Western Fire Management Centre

Alan Westhaver has been working in National Parks since 1974. His academic background includes a diploma in Forestry/BioScience from the Northern Alberta Institute of Technology and degrees in Forestry and Wildlife Biology from the University of Montana.

After he spent four seasons with the Canadian Forest Services doing ecological land classification in Banff, Yoho, and Jasper National Parks, Alan joined the Parks Canada Warden Service. As park warden, he spent 10 adventurous years in Banff National Park, becoming increasingly involved in aspects of natural resource, vegetation, and fire management. Relocating to the aspen parkland, Alan coordinated a very active resource management programme in Elk Island in 1988–1990.

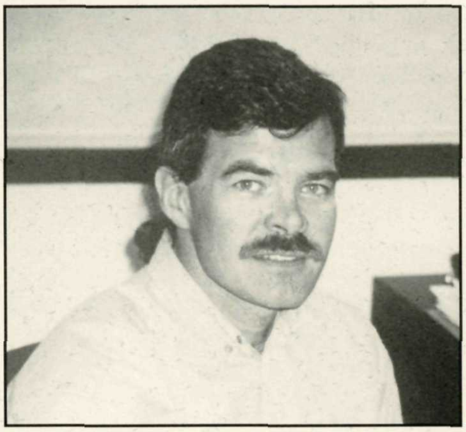
Feeling that the founding work to initiate modern fire management in Parks Canada (as laid by others) was too important to slip away, Alan opted to carry the flame another mile as regional fire management officer for the Prairie and Northern Region in 1990–1992. He had many opportunities for gaining operational and ecological perspectives in the boreal and grassland environments as a result of this work. He continues this work in a similar position for Alberta, Prairie and Northern, and Pacific-Yukon Regions through the Western Fire Management Centre in Calgary.

Although not entirely in tune with their urban environment, Alan, his wife Lisa, and their three daughters live in Calgary. They escape regularly, though not often enough, to greener pastures.

BRUCE SUNDBO

Regional Fire Management Officer
Western Fire Management Centre

A newcomer to the Western Fire Management Centre, Bruce Sundbo recently moved to Calgary from Kluane National Park where he has worked as a warden for the past nine years. Bruce was raised in Prince Albert, SA, and spent his summers in Prince Albert National Park, first working in the park in 1975 with General Works. Because of his interest in natural places, Bruce entered the Renewable Resources Technology programme at Kelsey College in Saskatoon, and received his diploma in 1978.



Bruce's experience in fire suppression operations is diverse and extensive. He has worked in a variety of fire operations in Western Canada and the Territories, gaining much of his experience while working with the Alberta Forest Service, as well as wardening for the past 15 years.

Fire issues have always been a keen interest of Bruce's. An advocate of fire on the landscape and low-impact suppression activities, he is encouraged with the direction that the fire management programme in the national parks is progressing.

MARK HEATHCOTT

Fire Management Officer
National Parks Directorate

Mark Heathcott started his fire management career in 1981 as an initial attack firefighter with the Alberta Forest Service, following graduation from the University of Calgary with a BSc in Environmental Biology. Mark continued these seasonal responsibilities until the summer of 1983, when he accepted a term warden position with Parks Canada at Glacier National Park. In 1983, Mark was introduced to Cliff White, fire manager for Banff National Park, whose enthusiasm persuaded Mark to work seasonally in Banff in a fire management function during 1984–1987. In the spring of 1988, Mark accepted the position of assistant fire management officer in Wood Buffalo National Park. He remained year round in this large operational programme until spring of 1993, when he accepted the position of national fire management officer in the Natural Resources Branch at Parks Headquarters.

Mark now lives in Aylmer, PQ, with wife Carolyn and sons Nick and Alex.

MURRAY PETERSON

Fire/Vegetation Specialist
Mount Revelstoke and Glacier National Parks

Murray Peterson arrived at Mount Revelstoke and Glacier National Parks in September '94, having parachuted in on assignment from Wood Buffalo National Park. He spent seven years in Wood Buffalo (and loved every minute of it), ending with the position of Peace/Athabasca Delta Project coordinator. His main interests at Mount Revelstoke and Glacier are landscape-level management and Geographic Information Systems, although visitor-use impact is coming increasingly to his attention. Old forest management, land-use conflicts, and the role of Mount Revelstoke and Glacier in the Columbia region have been Murray's primary preoccupations to date. With support from his wife and two children, Murray will be with the park until March '97.

PETER L. ACHUFF

Conservation Biologist and Vegetation Ecologist
Waterton Lakes National Park

Peter Achuff has more than 20 years experience with natural resource inventory, planning, and management, and with environmental impact and monitoring studies. He has worked widely in North America and eastern and central Asia.

His interest in fire and its ecological role was kindled by summer work with the US Forest Service in California. Currently based in Waterton Lakes National Park, Peter is revising the vegetation and ecological land classifications for the park. Peter was featured in *Research Links* 1 (1).

HIGHLIGHTS

IAN R. PENGELLY
Senior Park Warden
Fire and Vegetation Management
Banff National Park

Ian Pengelly has a BSc in Physical Geography from the University of Calgary. He joined Parks Canada in 1975 in Jasper National Park. In 1976–1980, he was a park warden in Pacific Rim and Glacier National Parks. Ian has worked in Banff National Park since 1980, becoming the supervisor of the Fire and Vegetation Management programme in 1989.

In an earlier era, he remembers hiking, canoeing, and horse-back riding trips. Now, a job with a bottomless in-basket ensures he doesn't have too much fun. Two kids (three-year-old Leah and month-old Jack) and a big mortgage provide the incentive to go to work day after day, year after year.

KEN SCHROEDER
Resource Management Coordinator
Yoho National Park

Ken Schroeder has been with Parks Canada since 1982 and has spent time in Glacier, Elk Island, Banff, Kootenay, Nahanni, and Yoho National Parks. He completed a diploma programme at Selkirk College in 1979 and is presently completing a Bachelor of Environmental Studies through the University of Waterloo. Ken has participated in fire management in most of the parks he has worked in, including some early prescribed burning in Elk Island in 1982.

Ken has been in Yoho since the fall of 1993. At this time, Yoho's fire management efforts focus on working jointly with the surrounding parks to develop a more unified fire management programme. The provincial forest along most of Yoho's western boundary ensures Yoho and its neighbours all have a keen interest in how one another manages fire.

In addition to fire management, Ken is involved in a non-native plant project and ongoing forest insect and disease monitoring.

ANNE DICKINSON
Fire/Vegetation Specialist
Elk Island National Park

During a family camping trip in 1974, Anne Dickinson attended an interpretive programme at Whistlers Theatre in Jasper National Park and became inspired to pursue an environmental career. She had no idea that 10 years later, she would be standing on the same stage, delivering her first interpretive programme (on prescribed burning, no less!).

Born in Toronto and raised primarily in the United States, Anne worked for the forest service in West Germany and the Smithsonian Institute's Environmental Research Centre in Maryland as a coopera-

tive education student while pursuing a BSc in Natural Resource Management (forestry) from Rutgers University, NJ.

In search of *big* trees and "real" forestry, Anne headed west and found both while studying western red cedar on Vancouver Island for her MSc thesis at the University of British Columbia. Alas, there are no red cedars in Elk Island, but Anne is learning all she can about how to burn aspen trees and how to restore native prairie.

RICK KUBIAN
Park Warden, Fire/Vegetation Shop
Jasper National Park

Rick Kubian spearheads many of the day-to-day fire management activities in Jasper National Park. Rick has a BSc in Geography, and has been a park warden since 1990, with a stint in Wood Buffalo National Park before coming to Jasper. Rick has been instrumental in the establishment of the Yellowhead Ecosystem Working Group and the Canadian Forest Service Modified Response research proposal, especially on the climatological study aspects. Rick is a top-notch hockey player and runner, setting a pace outside work equal to that at work.

STEVE OTWAY
Senior Park Warden, Fire/Vegetation Shop
Jasper National Park

Steve Otway worked for nearly 12 years with the Alberta Forest Service before joining Parks Canada at Wood Buffalo National Park in 1990, where, in 1992, he received a regional award of excellence for his efforts in terminating logging in the park. He moved to Jasper National Park to assume his current position late in 1993. Currently, Steve is taking correspondence towards a BSc. His current research focus is less-than-full-suppression in wildfires through a modified response approach, a project he is working on in conjunction with the Canadian Forest Service. His family and sports, including Taekwon-do, keep him busy outside of work.

MIKE EDER
Seasonal Park Warden, Fire/Vegetation Shop
Jasper National Park

Mike Eder manages Jasper National Park's non-native plant and facility protection aspects, as well as a plate of fire duties. Mike has a BSc in Forestry and has British Columbia Registered Professional Forester status. Research initiatives in non-native plant control and monitoring are his focus. Mike is a skilled scuba diver and avid outdoor enthusiast.

GUEST PROFILE: CHARLES E. VAN WAGNER

Dean of Canadian Fire Behaviour Research

profile prepared by Mark Heathcott

Charles Van Wagner spent the bulk of his career (over 30 years) working for the Canadian Forest Service at Petawawa National Forestry Institute. An eminent fire scientist, he has published widely and is considered the "dean" of fire behaviour research in Canada.

One of his most considerable accomplishments stems from his work with the Canadian Forest Fire Danger Working Group, where he was principal scientist for many years: all fire management agencies in Canada and many others around the globe use fire weather and fire behaviour prediction models developed by the group during this time. Additionally, Charlie is a recognized authority of fire history and ecology. A major contribution of his to that field is the negative exponential model of age-class distribution used for estimating the forest fire cycle, which is widely accepted by boreal forest ecologists.

Charlie considers national parks to be important lands, and he has volunteered his expertise in their stewardship for many years. He was instrumental in developing the 1986 Parks Canada directive for fire management, which formed the modern foundation of Parks Canada's approach to fire. Although now retired, he continues to volunteer his expertise and services to protected area management. Currently, Charlie is helping with projects in Alberta and Atlantic regions, as well as in the province of Ontario.

In his free time, Charlie is still an active canoeist and cross-country skier. Recently, he completed the first ski descent of Cataract Peak at the headwaters of the Pipestone River. *Research Links* is pleased to present his work in the Fire Management Issue.

RECENT RESEARCH

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tory and vegetation regeneration studies.

Jasper and Banff National Parks researchers have teamed up to initiate a multi-year herbivory study. The project will establish a series of range-type enclosures to measure the impact of herbivore browsing in burned and unburned areas of the montane zones of these parks.

David Schindler is leading a paleoecology study in Jasper National Park. Schindler will develop a disturbance history of the past millennium using frozen cores of lake varves and analysis of carbon, pollen, and macrofossils.

Steve Barrett, a consulting research forester from Kalispel, MT, is conducting fire history investigations for Waterton Lakes. When completed, the fire history will be linked to one already done for Glacier National Park (US), providing a regional view of fire regimes.

MONITORING AND TECHNICAL DEVELOPMENT

* Parks Canada has worked with Tom Grimes of IDSYS Inc. to develop an interactive communications network and bulletin board system that conveys weather- and fire-related information and documentation to all park users. It also allows Parks Canada to share fire information with other Canadian agen-

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Fire, weather, and history

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lected as well. By comparing the parallel records of these past 40 years, a normalized, homogeneous daily fire weather data set was constructed for the whole century, suitable for processing through the FWI System. The chosen indicator was the FWI Daily Severity Rating, averaged in various ways for each year of the century.

When the trends of annual weather severity are plotted, it is obvious that the weather during the recent half-century was not much different from that in the first half. Yet the burned area decreases dramatically about 1940. In fact, there were many individual fire-free years after 1940 with weather severities that fully matched those that produced substiantial burned area before 1940 The reasonable conclusion is that the recent lack of burned area in Banff is not due to cooler, wetter weather. The answer to the question must be sought elsewhere.

CONCLUSION

It is worth noting that the fire history record says nothing about sources of ignition over the centuries—whether lightning or human. In other words, no long-term analysis of area burned by either lightning or humans alone, as a proportion of the whole, is possible *(see Walker, p. 18)*.

The fire management dilemma can best be defined in terms of the scale problem: whether to make some attempt to keep patch size and burning schedule on some scales to match the dimensions and human attention span of the park, or to trust completely to chance with its unpredictable wide swings in burned area and time.

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Science and Paradox

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minimum, while considering circumstances such as public safety, facility protection, and neighbouring land values. To maintain ecosystem structure and function, as wide a spectrum of fire behaviour as possible operates in as great an area of the park landscape as is practical. The constraints of public safety and neighbouring land values define the random ignition areas. Within random ignition areas, management prescriptions and daily fire analyses dictate when and where suppression is withheld. Considering Kootenay's fire history results, a random ignition-based approach to fire management should maintain the "natural" fire regime in those areas where it is applicable.

Two decades ago, it was unthinkable to preserve a park's ecological integrity by burning it

IMPLEMENTATION

Implementation of the Kootenay National Park Fire Management Plan has now begun. The strategic direction supports ecological integrity, addresses critical information gaps and provides rational, adaptive management. The preliminary stage focuses on four objectives:

- designating suppression, random ignition, and planned ignition areas;
- reducing fuel hazard around facilities and on boundaries;
- long term monitoring; and,
- identifying research requirements and opportunities.

Kootenay is approaching the designation of fire management zones conservatively. Currently, the entire park is divided into either suppression or planned ignition zones, while the ultimate goal is to create random ignition zones in as great an area of the park landscape as possible. Before Kootenay can achieve such a set up, vulnerable boundaries and facilities have to be protected through fuel hazard reduction. The Vermilion Valley will be the first random ignition zone, with planned ignition zones designated at three critical boundary areas of the valley. The remainder of the park landscape will be considered for random ignition designation based on safety, future research results, and operational experience in the Vermilion Valley.

Long-term monitoring will follow landscape and community level trends both within the park and within the greater regional ecosystem. The fire research priority over the short term is to further define the relative role of possible causal factors for the recent decline in area burned in Kootenay. This priority is shared regionally and nationally within Parks Canada fire management. However, local fire research will be pursued and supported as opportunities present themselves.

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RECENT RESEARCH

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cies *(see Heathcott, p. 6).*

Under the direction of **Michel Terriault**, La Mauricie National Park fire officers continue to monitor the effects of past prescribed fires on the park's vegetation *(see Quenneville, p. 16).*

Sue Hairsine is managing the Mountain Park Weather Network Project, in which Waterton Lakes, Banff, Jasper, Kootenay, Yoho, Mount Revelstoke, and Glacier National Parks are upgrading their weather monitoring network. The network will integrate the parks' avalanche, fire management, highway maintenance, and resource studies information.

The Canadian Forest Service, with assistance from Parks Canada, has begun a project to develop a system for evaluating random fire occurrences and assessing opportunities for less-than-full -force suppression responses. Such a system would reduce the economic and environmental impacts of fire suppression, while maintaining fire in ecosystems. Additional interest and partners are still sought.

Parks Canada is a member of a multipartner project the objective of which is to minimise risk of wildfire losses to facilities, homes, and commercial developments located in wildland or rural settings. Phase one of the project will develop recognized standards for assessing and mitigating those risks as applied to building structures, their immediate site and surrounding environments; phase two will see actual evaluation of park facilities and recommendations for hazard reduction measures.

FROM THE EAST

The first prescribed burn

On July 24, 1992, La Mauricie National Park witnessed the first prescribed burn east of Manitoba, about a decade after planned ignition fires began in the west

Raymond Quenneville

Early in the afternoon of July 22, 1992, computers and brains were running at full capacity in La Maurice National Park's operations centre. All signs indicated that the right conditions would occur within the next few days. Since June 24, when leaf flush in the forest was complete, the team had, to all intents and purposes, been on stand-by. The conditions required for burning the "U" area could occur at any moment. An automatic weather station, set up near the site, was consulted every day to determine the probable date of "U Day."

On July 23, Environment Canada's "Foret Météo" Team reviewed the AWS forecast and confirmed favourable conditions for the next day. "U Day" would be July 24, 1992. The burning teams were put on alert and the communications plan went into effect.

FIRST BURN OF A STANDING FOREST

During the previous few years, the La Mauricie National Park team conducted controlled burns in white spruce plantations in the southeastern part of the park. These burns were intended to restore the balance of nature in park ecosystems by destroying part of these plantations (about 60 years old), so that natural regeneration could take place.

An initial, experimental prescribed burn, the Mekinac project, was carried out over a 13 ha area in 1991. This was a "traditional" slash burn, where the trees were first cut down and distributed evenly over the site. The "U" project took place the following year, on July 24, 1992. A nine hectare area of standing plantation was ignited under the direction and observation of the Natural Resources Conservation Service of La Mauricie National Park and La Société de conservation de la région Québec-Mauricie.

This project allowed for the testing of a new burning technique, it also enabled us to consider with optimism the continuation of a controlled burning programme which would re-establish a balance in park ecosystems. Two other burns were carried out the following year and four more are planned for the next five years.

"These burns were intended to restore the balance of nature in park ecosystems by destroying part of these plantations (about 60 years old), so that natural regeneration could take place."

"U" DAY

Early in the morning, before the light fog had disappeared from the St. Maurice River, a technician from the Maniwaki Technology Transfer Centre launched the first balloon, carrying a sounder which could detect weather conditions in the various strata of the atmosphere. The forecast for the day was favourable and we were able to begin preparations. While the suppression crews set up the fire pumps and hoses, the Fire Boss and the coordinating committee met to review the Prescribed Burn Plan. At 1 p.m., we reviewed the latest weather data and launched a second sound balloon. All forecasts were confirmed and met all prescription criteria.

At about 2 p.m., the suppression helicopter began to bucket the northern and southern boundaries with water. We also dropped several buckets of fire-foam in the most critical areas. Everything was now set for burning.

At 3:20 p.m., another helicopter, equipped with an aerial ignition device, launched the first incendiary balls, tracing a test line along the northern boundary of the site. After ensuring that the fire and the column of smoke were behaving as planned, the Fire Boss gave the signal to complete ignition. Everything went as planned. A hot spot was created in the centre of the site, with further ignition spiraling out from the middle to the periphery. This resulted in an intense convection column in the centre of the area, creating a suction effect and directing the fire from the edges toward the centre.

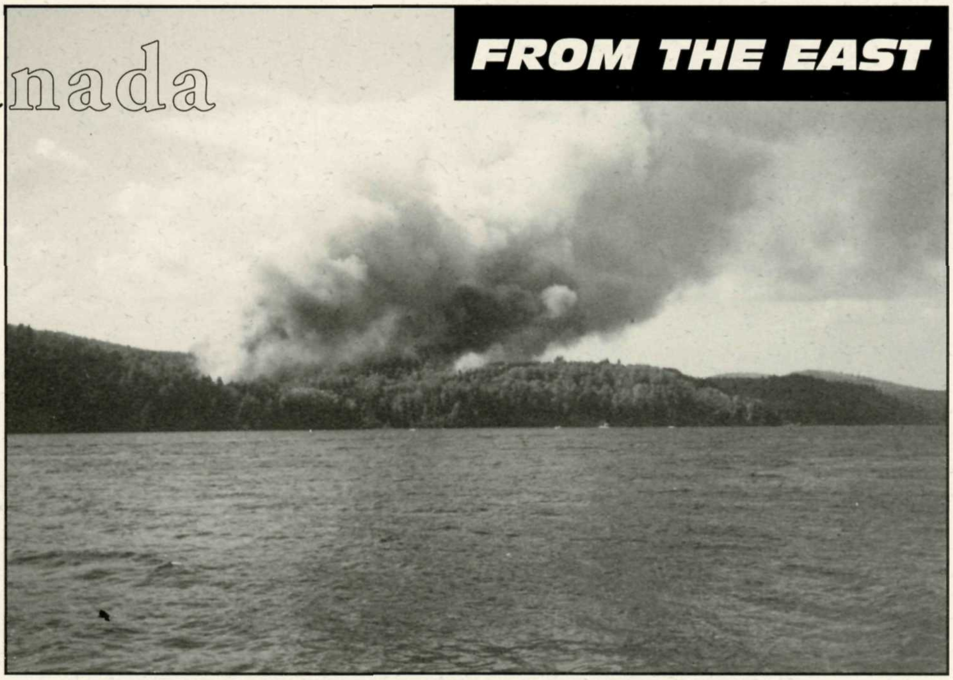
The height of the flames above the ground suggested that a great amount of energy had been released. The intensity of the fire was such that an intermittent crown fire (a fire which reaches the tops of the trees and ignites part of the canopy) was created. From that point on, we considered the operation a technical success. The conflagration quickly consumed the available fuel,

The day after sees spruce and seeds killed by fire

in Eastern Canada

to the point where, at about 4:45 p.m., the fire was almost over in much of the area. The flames did not extend beyond the firelines and no particular suppression measures were required.

We had just witnessed an intermittent crown fire, the first prescribed burn of its kind in Eastern Canada. Many previous burns had been carried out in the Western provinces *(see Woodley, p. 1)*. The fire remained under control at all times, to the great delight of the experts.



Note how the smoke rises upward, a result of atmospheric conditions chosen to minimise interference with human residents of the area

RESULTS

A visit to the site the following day confirmed the success of the operation. The fire had been very intense and certainly killed the spruce and their seeds. The duff layer was visibly reduced and the mineral soil had been exposed in some places. Fine fuel (stems 0–7 cm in diameter) had almost completely disappeared, while large fuel (7 cm and over) had been somewhat consumed. The crowns of the spruce in the understory were 70 per cent burned and partly scorched, while leaves in the upper strata had been 95 per cent scorched.

It is impossible for Parks Canada to confirm that all the objectives of the project have been attained, since, for the time being, we can only speculate on the quality of regeneration of the site by impending return of natural vegetation. The Natural Resources Conservation Service, however, has been monitoring the post-fire regeneration of natural vegetation, which should enable us, in the medium term, to compare the results obtained with our expectations.

***Raymond Quenneville**, one of the key players in the La Mauricie burn, is a fire management and emergency measures specialist at Quebec Regional Office. For further information, please call (418) 649-8253.*

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BACKWEST

Jasper wardens involve high school students in fire monitoring

Steve Otway

Explaining ecosystem management to children can be difficult, as it is hard enough to explain to ourselves. By using fire to link on-the-ground activities to the bigger ecological picture, Jasper National Park wardens have struck a chord with the local schools.

On May 2, 1995, Jasper conducted its second annual fuel reduction burn on the Pyramid Bench fireguard, adjacent to Jasper townsite. Mike Price's grade 10 high school science class helped park wardens set up five permanent photo monitoring plots. The purpose of these plots is to monitor over many years the pre-burn vegetation community and post-burn successional growth. While the burns themselves are approved yearly events (to protect the townsite), they additionally offer an excellent way of communicating Jasper's fire management work and explaining fire as a process on the greater landscape.

Prior to the burn, each plot was staked, with four cardinal direction photos taken. Details such as date, time, weather conditions, and current vegetation types were recorded. After the spring burn, the sites were revisited. The students understood the need to be able to consistently measure these plots, and documented their work, which included a methods section so that their work could be replicated and continued for many years. They created their own tally cards so that next year's class can jump on board with few problems.

Over the course of the next few years, different classes will be able to directly measure vegetation changes over time. As wardens will be burning each year in a different location, new plots, with different fuel types, slopes, aspects, and soil conditions, can be continually established.

Both the high school students and teachers enjoyed the link of their science labs to real data compilation and study that participating in the fire monitoring provided. By getting students involved in fire monitoring, Jasper wardens have been able to touch on very complex and fundamental issues, such as landscape disturbance and ecosystem health. Also, the project allows for practical education to take place in a visual, hands-on, outdoor environment, which makes it both more interesting and easier to understand.

The success of this venture was underlined by the subsequent interest of the townsite's elementary school, whose teachers requested three class tours of the burn site in the last month of the school year alone.

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FOCUS ON FIRE

"A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise."

– Aldo Leopold
A Sand County Almanac

FIRE MANAGEMENT: MORE THAN FIRE SUPPRESSION

Fire management today is more than just putting out fires. Parks Canada both suppresses fire and uses it to manage vegetation.

Part of Parks Canada's mandate is to preserve "representative" landscapes— a sampling of the many ecosystems in Canada. That means maintaining the ecological processes, like fire, that created them: we recognize that fire is neither good nor bad, but *essential.*

Rocky Mountain forests have evolved with, and are partially dependent on, forms of natural disturbance, like avalanches, severe winds, and insect or disease outbreaks. Forest fire has been the dominant form of natural disturbance in the Rocky Mountains.

Fire-adapted communities adapt to a particular pattern of fire. Over time or over an entire landscape, fire that comes too often, not often enough, too intensely, or not intensely enough will cause the vegetation in the area to change.

Today, forest and grassland communities in national parks are changing because of fire suppression. The cost of these changes will be a loss of biodiversity.

THE FOREST RENEWED

Fires don't just destroy, they also create:

• Fires release a flush of nutrients over the whole site. In the Rocky Mountains, dead material piles up faster than it can decompose. Burning turns it quickly to fertilizer.

• Fires create an unpredictable mosaic of burned and unburned areas. Forest remnants provide animal habitat, supply genetic reservoirs for plants, animals, and microorganisms, and furnish microclimates that foster growth.

• Fires leave blackened soil that fosters germination and nitrogen fixation in its warmth.

• Fires expose mineral soil, which allows "pioneer" species like lodgepole pine to germinate.

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ABORIGINAL

A "season of burn" mountain park study attempts to identify pre-historical sources of ignition

Robert C. Walker

INTRODUCTION

Factors contributing to the present forest stand age distribution in the Canadian Rocky Mountains—climate change, land use change, fire prevention, and fire suppression—have been the subject of considerable controversy and debate within both the fire science and fire management communities. A "season of burn" project now underway in the mountain parks is part of a nationally coordinated Parks Canada effort designed to address critical information gaps in fire management and help quantify the ecological importance of aboriginal burning.

The season of burn project will provide unique information for the Canadian Rocky Mountains on the seasonal distribution of pre-historic fire events within their respective fire seasons. The project will investigate changing human land use patterns as a causal factor in present forest stand age distributions. Specifically, the data will allow a comparison of the seasonal timing of pre-historic fires with the seasonal distribution of lightning over the last several decades. The comparison may provide insight into the relative contribution of aboriginal fire to the pre-historic fire regimes in Banff, Jasper, and Kootenay National Parks.

BACKGROUND

The ecological role of aboriginal burning is an unresolved issue in the Rocky Mountain national parks, which may have important management implications. Ecological objectives for fire management, based at least in part on pre-historic fire regimes, are influenced by the relative proportion of ignition sources, lightning or aboriginal.

Current scientific opinion on the relative ecological importance of aboriginal burning is variable. Opinion ranges from aboriginal peoples completely defining the structure and function of the landscape through their activities to aboriginal peoples being an ecologically invisible component of the landscape. It seems reasonable to assume that aboriginal peoples strongly influenced fire regimes in some places and at some times. However, for much of the Rocky Mountain national parks, the spatial and temporal distribution of their influence is unknown.

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BURNING

Anecdotal evidence for aboriginal use of fire is widespread, but the accuracy and relevancy of such reports is difficult to assess. The results of fire history studies in the Rocky Mountain national parks and surrounding areas provide some information relevant to the question of aboriginal burning. According to White (1985), the primary cause of reduced fire activity since the 1880s in Banff National Park is the prevention of man-caused fires. Therefore, White concludes, aboriginal fires may have been an important element of the pre-historic fire regime. Jasper National Park has only incomplete fire history data and Tande (1979) does not discuss ignition source in his small-scale study around Jasper townsite. Masters (1989), based on the high level of lightning ignition occurring since park establishment, assumes that lightning was the primary source of ignition in Kootenay National Park. Johnson and Fryer (1987) conclude that, although human use must have had an influence, natural processes (site differences and lightning fires) have dominated vegetation changes in the Kananaskis Valley.

While the season of burn project is unique for the Canadian Rocky Mountains, similar studies exist elsewhere. In several studies from the southwestern and western United States, the seasonal occurrence of fires correlates with the lightning season (Baisan and Swetnam 1990; Brown and Swetnam 1994).

Lightning ignitions in the Canadian Rocky Mountains occur between mid-May and mid-September, but the highest concentration falls between the middle of July and the beginning of September. In Alberta, the largest area burned by lightning fires occurs in July and August, while the largest area burned by anthropogenic fires occurs in May and June (Johnson and Wowchuk 1993). The seasonal peak in lightning strike density corresponds to historical peaks in both ignition number and area burned. As a result of associated precipitation, however, neither the distribution nor the density of lightning strikes is a reliable indicator of either ignition number or area burned. Fire events, particularly large ones, are the result of a combination of local and synoptic weather of which ignition is just one important element.

If results indicate that many fire events occurred before peak lightning season, then an argument exists for an aboriginal component to the pre-historic fire regime. Although actual ignition source cannot be accurately determined for pre-historic fire events, results must be weighted according to anthropological, archaeological, and other fire studies. If an aboriginal component is probable, then it will be necessary to assess the relative contribution of the aboriginal ignitions to pre-historical areas burned.

METHODS AND SUMMARY

The project requires two stages of data collection and analysis. The first stage is to develop a cambial growth phenology for Douglas fir and lodgepole pine in the study area. Band dendrometers will be installed at two sites in each of Banff, Jasper, and Kootenay National Parks—one at valley bottom and one at mid-slope. The cambial growth phenology will detail the relative timing of growth within a growing season, resulting in several categories for fire scar analysis: early earlywood, generic earlywood, mid-earlywood, late earlywood, latewood, and dormant. Each active category should represent several weeks of growing season time.

> *"If results indicate that many fire events occurred before peak lightning season, then an argument exists for an aboriginal component to the pre-historic fire regime."*

The second stage is to collect fire-scarred tree sections from all three parks. The time of scarring, within the growing season, will be determined by way of the cambial growth phenology. Once the seasonal distribution of fire events has been determined, a comparison can be conducted with the seasonal distribution of lightning.

The season of burn project will use a cambial growth phenology and fire scars to assess the relative contribution of aboriginal burning to the historical fire regime. Lightning can occur from spring to fall. However, if fires before the peak lightning season have contributed to much of the pre-historic fire regime, then the aboriginal fire use may be an important part of pre-historic fire regime.

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FOCUS ON FIRE

• Fires help fire-adapted species to reproduce: they open the cones of lodgepole pine and prompt root suckering in aspen and shrubs.

BIODIVERSITY

Preventing fire allows "shade tolerant" tree species to dominate the forest and eliminates others, particularly fire-adapted or dependent species; in other words, eliminating fire from ecosystems may lead to loss of biodiversity. Biodiversity, most simply, is the species richness of a community or area. It is a measure of nature's health; a treasure that cannot be replaced.

To safeguard biodiversity, we need a variety of forest types and ages. Each type and age of forest supports a different group of plants and animals.

Habitat diversity is important for species diversity; species diversity is vital because as species disappear, they affect others in the web of life. Genetic diversity helps maintain species diversity and makes an ecosystem strong: a big gene pool helps a species adapt to changing conditions, an increasingly crucial feature as human activities cause rapid and radical changes to the natural world.

"NATURAL": A SLIPPERY CONCEPT...

Many people have the impression that when Europeans arrived, North America was blanketed with ancient, primeval forests, unchanged by aboriginal peoples. There is overwhelming evidence these images are wrong.

The "natural" condition of our forests is an idea public land managers struggle with. Are "natural" forests only those without changes made by humans? If so, there are few of them—humans have occupied and influenced the forests for 10 000 years. A hands-off, let-nature-take-its-course approach will not recreate conditions during which aboriginal use structured the landscape.

The idea of hands-off management also does not take into account lack of ecological integrity outside of parks. The growing lack of diversity "out there" limits our ecosystem's ability to recover from large disturbances Nature inevitably cooks up.

– from *Focus on Fire: Fire Management and Prescribed Burning in Banff National Park*

FUEL FOR THOUGHT

Pre-Columbian Human Ecology

Aboriginal hunting and burning have serious implications for park management

Charles E. Kay

INTRODUCTION

Western environmental philosophy, which influences how our national parks and natural areas are managed, rests on several assumptions (Kay 1995a). First, conservationists usually assume that, prior to the arrival of Europeans, North America was a wilderness untouched by the hand of man, and that this wilderness teemed with wildlife. Second, some people also think that the aboriginal peoples of North America were either poor, primitive, starving savages whose numbers were too low to have any impact on the "pristine" landscape or that native peoples were conservationists who were too wise to overuse their environment (Kay 1994).

According to this view, pre-Columbian North America was filled with uncountable numbers of ungulates, wolves, and other wildlife and Europeans were the evil that destroyed this idyllic state of nature. Under such a paradigm, all that is needed to restore our ecosystems to their original condition is to eliminate European influences. This is known as "letting nature take its course" and is often referred to as "hands-off" or "natural regulation" management. The beliefs formed by these assumptions are so strongly held by many that they seldom bother to consider whether they are, in fact, valid. If they are not true, then managing environments according to their precepts will not lead to the protection of biological diversity or ecological integrity. That is to say, if these underlying assumptions about nature are false, then management based on those beliefs will not produce the desired result; *i.e.,* the original ecosystems will be neither restored nor protected (Wagner and Kay 1993; Kay 1995).

Moreover, before ecological integrity can be preserved, as required by Parks Canada legislation, long-term ecosystem states and processes must first be quantified. As Aldo Leopold noted over 40 years ago, "If we are serious about restoring [or maintaining] ecosystem health and ecological integrity, then we must first know what the land was like to begin with." Historical journal observations, archaeological evidence, repeat photographs, and data on current ecosystem states and processes can be used to determine what factors structured ecosystems in earlier times (Kay *et al.* 1994; Kay and White 1995).

LACK OF WILDLIFE

Historical records do not support the view that the Rocky Mountains once teemed with wildlife. Between 1835–72, for instance, 20 different parties spent a total of 765 days traveling through Yellowstone National Park on foot or horseback, yet reported seeing elk only once every 18 days—today there are nearly 100 000 elk in that ecosystem (Kay 1994). The same was true in the Canadian Rocky Mountains where early explorers reported seeing elk only once every 31 days despite spending 369 days in the mountains between 1792 and 1872 (Kay *et al.* 1994, Kay and White 1995). Additionally, archaeological evidence indicates that elk and other ungulates were rare in pre-Columbian times.

Carnivore predation and aboriginal hunting are two factors that could have limited ungulate numbers. The age of their respective kills, however, indicates that aboriginal peoples were very different predators than wolves (Kay 1994, 1995). Unlike carnivores, which tend to kill the young, the old, the unfit, and the males, aboriginal hunters killed a predominance of prime-age females.

A preference for prime-age females runs counter to any conservation strategy. It is often claimed, however, that it was the aboriginal peoples' religious belief systems, and not a conscious ecological philosophy, that prevented them from over-hunting their prey. The native people of North America viewed wildlife as their spiritual kin: success in the hunt was obtained by following prescribed rituals and atonement after the kill. A scarcity of animals or failure in the hunt were not viewed as biological or ecological phenomena, but rather as a spiritual consequence of social events or circumstances. If an aboriginal hunter could not find any game, it was not because his people had over-harvested the resource, but because he had done something to displease his gods. Since they saw no connection between their hunting and wildlife num-

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The extent to which aboriginal peoples managed their environment, through hunting, burning, and other actions, is a crucial and, to date, unresolved, issue

bers, the aboriginal system of religious beliefs actually fostered over-exploitation of ungulate populations—religious respect for animals does not equal conservation.

Aboriginal hunters were essentially opportunistic and tended to take high-ranking ungulates regardless of the size of prey populations or the likelihood of those animals becoming extinct. They did not seem to have a concept of maximum sustained yield and did not manage ungulate populations to produce the greatest offtake. In addition, human predation and predation by carnivores are additive and work in concert to reduce ungulate numbers. Moreover, competition from carnivores tended to negate any possible conservation practices. Because aboriginal peoples could prey-switch to small animals, vegetable foods, and fish, they could take their preferred ungulate prey to low levels or extinction without any adverse effect on human populations. In fact, as ungulates populations declined, human populations actually rose.

ABORIGINAL BURNING

Aboriginal peoples also had a major impact on ecosystems by repeatedly burning the vegetation (Kay 1995a) to modify plant and animal communities for human benefit.

Determining how fires started is critical because fires set by hunter-gatherers differ from lightning fires in terms of seasonality, frequency, intensity, and ignition patterns (Kay 1995b). Most aboriginal fires were set in the spring, between snow melt and vegetation green-up, or late in the fall when burning conditions were not severe. Unlike lightning fires, which tend to be infrequent, high-intensity infernos, aboriginal burning produced a higher frequency of lower-intensity fires: aboriginal burning and lightning fires create different vegetation mosaics, and in many instances, entirely different plant communities. Moreover, aboriginal burning reduces or eliminates the number of high-intensity, lightning-generated fires. Once aboriginal fires opened up the vegetation, subsequent lightning fires behaved like those set previously by humans (Kay 1995a/b).

Historical journals, repeat-photographs, and fire-history studies all indicate that the Rocky Mountains and the western plains burned frequently in the past, and other data suggest that the majority of those fires were set by aboriginal peoples, not started by lightning (Kay 1995a/b). In the Central Canadian Rockies, critical montane habitats were once maintained by aboriginal burning (Kay *et al.* 1994, Kay and White 1995), while on the Canadian prairies, native-set fires swept so frequently that aspen in adjoining parklands were held in check (Kay 1995b).

CONCLUSION

Most national parks, wilderness areas, and nature reserves are managed to represent conditions that existed in pre-Columbian times; *i.e.,* so-called natural or pristine conditions. But what is natural? If the native people of North America determined the structure of entire plant and animal communities by firing the vegetation and by limiting ungulate numbers, then they created a completely different situation than the one we have today (Wagner and Kay 1993). A "hands-off" or "natural regulation" approach by modern land managers will not duplicate the ecological conditions of 500 years ago. Since aboriginal predation and burning created those ecosystems, the only way to maintain what we call "natural areas" today is to duplicate aboriginal influences and processes.

Moreover, the idea that North America was a wilderness untouched by the hand of man prior to 1492 is a myth, a myth created, in part, to justify appropriation of aboriginal lands and the genocide that befell native peoples. North America was not a wilderness waiting to be discovered, but home to as many as 100 million aboriginal North Americans before European-introduced diseases (and other, more deliberate means) decimated their numbers.

Aboriginal peoples were the ultimate keystone species, and their removal has completely altered ecosystems, not only in the Rocky Mountains but throughout North America. Setting aside an area as "wilderness" or a national park today, and then letting nature take its course will not preserve some remnant of the past but instead create conditions that have not existed on this continent for the last 10 000 years. That is to say, the Americas as first seen by Europeans were not as they had been crafted by Nature left to her own devices, but as they had been created by aboriginal peoples. Unless the importance of aboriginal land management is recognized and modern management practices changed accordingly, our ecosystems will continue to lose the biological diversity and ecological integrity they once had.

Charles E. Kay *is an adjunct assistant professor in political science at Utah State University. Dr. Kay, who holds a PhD in Wildlife Ecology, has been conducting research on long-term ecosystem states and processes in the central Canadian Rocky Mountains for Parks Canada since 1992. For further information, please call (801) 797-2064.*

Same or Different?

Banff study compares results of prescribed burns and wildfires

Jack Wierzchowski

Wildfire and planned fire produce different results under certain physical conditions

The main objective of the prescribed burning programme in Banff National Park is the reintroduction of fire into the park's ecosystem at a scale, pattern, frequency, severity, and intensity that duplicates the historical natural process as closely as possible. To evaluate the success of the programme, Banff researchers conducted a comparative analysis of wildfire patterns with patterns created by prescribed fires.

The analysis revealed the effects of prescribed fires in the montane zone of the park closely resemble those of wildfires, but the success of duplicating wildfire effects in the sub-alpine zone depends on the orientation of the slope. In the sub-alpine ecoregion, the currently used prescriptions perform well on south to southwest-facing slopes, but fail to produce the anticipated results on the north to northeast-facing slopes. Further analysis showed ignition of the stands occupying northeast-facing slopes leads to a high canopy mortality, but fails to involve duff in the combustion process, which in turn results in inadequate conditions for the germination and development of the successional forest.

Results also suggested prescribed fires cause greater fragmentation of vegetation than historically occurring wildfires. At the current stage of the prescribed burning programme in Banff, the ecological consequences of increased patchiness in a few isolated areas should not have significantly affected the functioning of the park's ecosystem. If, however, prescribed fires continue to produce highly fragmented vegetation mosaics, the system as a whole is likely to be affected.

The study also pointed to the difference in the fire spread mechanism between wildfires, which are wind-driven, and prescribed fires, which are driven by radiant and convective heat exchange. The failure of gently inclined slopes of lodgepole pine–dominated stands to burn is a direct consequence of burning during relatively calm weather. Research results indicated that in relatively windless weather, a 15–20° inclination is necessary to create burning conditions leading to high canopy mortality.

The study showed that elevation and the relative amount of solar radiation (expressed as a percentage of the maximum radiation for a given area) play a role in the way wildfires tend to burn the landscape. Prescribed burn patterns, on the other hand, were shown to be, with the exception of slope angle, generally unrelated to topography and insolation. Such a state of affairs is probably a direct result of applying multiple line ignition patterns that lead to the mortality of stands across the entire landscape.

***Jack Wierzchowski** is a GIS and remote sensing specialist at Banff National Park. He has been involved in the evaluation of Banff's prescribed burning programme for the past four years. This research was part of his Master of Environmental Design degree from the University of Calgary. For further information, please call (403) 762-1495.*

PODIUM

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One way to avoid "debate gridlock" is to gain acceptance for the practice of adaptive management. While we may never agree on all the details, we must reach agreement on a general direction and interim management actions that support the preservation of representative landscapes and biodiversity.

Adaptive management offers the opportunity to minimize our mistakes and maximize future options while we work out how to co-exist with other species on a small planet.

***Ian Pengelly** is a fire and vegetation management senior park warden at Banff National Park. For further information, please call (403) 762-1417.*

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PODIUM

Ian Pengelly

Forest fires, human use, and biodiversity:

Co-existing on a small planet

Journals and reports written by explorers and early park superintendents in the late 1800s and early 1900s often comment on the frequency and destructiveness of forest fires. Recent studies have confirmed that forest fires were frequent not only during the settlement period, but for hundreds and probably thousands of years. Fire, in fact, has been the dominant ecological process in the Canadian Rocky Mountains.

While fire may be destructive (in the sense of property damage or lost timber revenue), it is a necessary and stabilizing influence in Rocky Mountain ecosystems. This stabilizing influence has been missing from Rocky Mountain national parks for the past five to seven decades. The area burned within Canadian mountain parks since 1940 is approximately 161 km², about three per cent of the long-term average *(see Table 1 for pre-1940 figures).*

A study of the fire history data for Jasper, Banff, and Kootenay National Park (Van Wagner 1995) shows that large conflagrations (such as occurred in Yellowstone National Park [US]) are not how most forest burned in the past. Instead, smaller fires burned some area virtually every decade. A gap of 50–70 years in fire activity has never occurred in the past 300–500 years.

A recent analysis of weather data from Banff townsite (Feunekes and Van Wagner 1995) indicates that the reason for the decline of fire is fire prevention, fire suppression, or both, but not weather *(see Van Wagner, p. 4).*

Further research to determine the relative influence of prevention and suppression is on-going and has important implications for the future of fire management. For example, if the current lack of fire is due to suppression, then simply reducing suppression effort would be one possible management approach to restore fire. A research project with the Canadian Forest Services in Kootenay will estimate the area that might have burned during the past decade if fires had not been suppressed. Another research project with the Canadian Forest Services just underway will provide a method for estimating potential fire growth—an important step in modifying traditional fire suppression responses.

To further complicate matters, the frequency and distribution of lightning fire starts and other evidence suggest that, at least on the east side of the continental divide, aboriginal peoples were an important source of ignition, structuring forests and other vegetation through the use of fire.

The result is a dilemma for park managers, one we have little experience dealing with: if we are to maintain parks as ecological benchmarks representative of the Rocky Mountains, we must restore fire in both the deliberate manner of aboriginal peoples, and in the random pattern of the lightning fire regime. Both planned and natural fires require forethought, planning, and important decision making. In planned, management-ignited fires, we must decide how much fire, where, at what intensity, and during what season is desirable, necessary, and safe; in random lightning-ignited fires, we must determine how much risk, and in what areas, we are willing to take. Other issues, such as how much smoke is tolerable and how to integrate the fire activity into other park objectives must also be addressed.

If we are unwilling or unable to make such decisions, we must accept that inaction is in itself a decision with considerable consequences. Many plants depend on fire for propagation or renewal; in turn, they are depended on by a variety of fauna *(Tables 2 and 3).* Vegetation can be an indicator of representativity and ecological integrity and the individual plant species connection to fire. Loss or reduction of specific vegetation will affect the fauna which would be indicative of a representative ecosystem.

What kind of ecosystem parks could, or should be, promises to become a wide-ranging debate. Park residents, staff, environmental groups, and the public are likely to hold a wide range of views and objectives.

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Park (Historic Period)	Historic Burned Area	1940-1995 Burned Area
Jasper (1510–1930)	590 km²	5.8 km²
Banff (1488–1928)	267 km²	8.6 km²
Kootenay (1421–1931)	91 km²	4.5 km²
Yoho (1700–1980)	43 km²	10.6 km²
Waterton (estimate)	92 km²	nil km²
Total	1083 km²	29.5 km²

Table 1: Average burned area per decade in Rocky Mountain parks

Vegetation — Dependence / Adaption
ASPEN—root suckering, removal of competing shade-tolerant conifers
DOUGLAS FIR—insulating bark, periodic reduction of accumulating ground and surface fuels, removal of shade tolerant conifers
LODGEPOLE PINE—cone serotiny, preparation of a seed bed and seed release, removal of competing shade tolerant conifers
GRASSLANDS—tillering from root crowns and rhizomes, removal of competing tree species
SHRUBLANDS—resprouting from root crowns, rhizomes, removal of competing tree species

Table 2: Vegetation types adapted to or dependent on fire

Species — Forage / Prey
DEER—grasslands, aspen, Douglas fir/lodgepole pine forest
ELK—grasslands, aspen, lodgepole pine forest, shrublands
MOOSE—shrublands, early successional forest
SHEEP—grasslands, Douglas fir/lodgepole pine forest
GRIZZLY BEAR—buffaloberry, ants, rodents, ungulates
BLACK BEAR—buffaloberry and others, rodents, ungulate calves
LYNX—rabbits, other rodents
COUGAR—deer, sheep, elk
WOLVES—deer, elk, moose, sheep, rodents

Table 3: Indicator wildlife species which utilize fire successional forage, or prey adapted to fire successional habitats

MEETINGS OF INTEREST

Research Links

Fall 1995

Volume 3 • Issue 2

"Fire Management"

WRITE TO
Research Links
Parks Canada
#520, 220-4 Ave. S.E.
P.O. Box 2989, Stn. M
Calgary, AB, T2P 3H8

INTERNET ADDRESS
ResearchLink@
PKSWRO.DOTS.DOE.CA

SEPTEMBER 12–17, 1995

Annual Meeting of the Society for Ecological Restoration. Seattle, WA. The overall theme will address the role of restoration in ecosystem management. Contact Nikita Lopoukhine, tel: (613) 997-4900, or Society for Ecological Restoration, 1207 Seminole Highway, Madison, WI, 53711. Tel: (608) 262-9547.

SEPTEMBER 14–16, 1995

Waterton Writers Workshop. Waterton Lakes National Park, AB. Sponsored by Viewpoint Communications and Parks Canada, this unique workshop offers a wealth of information and ideas for nature, outdoor, travel, and environment writers. Contact Barbara Grinder at (403) 626-3658 or Kevin Van Tighem at (403) 859-5125, or write Viewpoint Communications, Box 127, Hill Spring, AB, T0K 1E0.

SEPTEMBER 24–27, 1995

Greater Yellowstone Predators: Ecology and Conservation in a Changing Landscape. Yellowstone National Park. This is the third biennial scientific conference on the greater Yellowstone ecosystem. It will be taking a broad look at predators and predation. Contact Peyton Curlee, tel: (307) 733-6856, or Paul Schullery, tel: (307) 344-2205.

OCTOBER 15–19, 1995

North America Chapter of the WCN Commission on National Parks and Protected Areas Regional Meeting. Lake Louise, AB. The meeting will focus on issues of biodiversity and sustainable use. Contact Antoine Lecherc, CNPPA, 25 Eddy Street, 4th Floor, Hull, PQ, K1A 0M5. Tel: (819) 994-2657, fax: (819) 994-5140.

OCTOBER 18–21, 1995

Canadian Coastal Conference 1995. Dartmouth, NS. Hosted by the Canadian Coastal Science and Engineering Association, in cooperation with Atlantic Geoscience Centre, Dalhousie University, and the National Research Council, the conference's theme is "State of the Coasts: Monitoring and Prediction." Contact A. Bowen, Department of Oceanography, Dalhousie University, Halifax, NS, B3H 4J2. Tel: (902) 494-7082, fax: (902) 292-2885, e-mail: tony.bowen@dal.ca.

NOVEMBER 6–11, 1995

Aquatic Ecosystem Stewardship. Toronto, ON. This is the 15th International Symposium of the North American Lake Management Society. Contact Murray Charlton, National Water Research Institute, Aquatic Ecosystem Restoration Branch, P.O. Box 5050, 867 Lakeshore Road, Burlington, ON, L7R 4A6.

NOVEMBER 7–8, 1995

Protected Areas in Resource-Based Economies: Sustaining Biodiversity and Ecological Integrity. Calgary, AB. Organised by the Canadian Council on Ecological Areas, the conference's mission is to create a forum to share information and expertise, construct solutions, and celebrate recent successes, and bring together members from science, government, business, and environmental groups. Contact Robyn Usher, Conference Registrar, Suite 200, 1122–4th Street S.W. Calgary, AB, T2N 1M1. Tel: (403) 269-9466, fax: (403) 269-1527, e-mail: gaiaenvr@cadvision.com.

DECEMBER 1–2, 1995

Third International Workshop on Advances in Geographical Information Systems. Baltimore, MD. The workshop will strive toward setting future research directions in GIS. Contact Dr. Patrick Bergougnoux, c/o Michele Cuesta, the University of Toulouse 1, CERISS Laboratory, Place Anatole, France, 31042 Toulouse Cedex, France. Tel: (33) 61-57-47-89, e-mail: bergougn@irit.fr.

MAY 18–23, 1996

The 6th International Symposium on Society and Resource Management. University Park, PA. The 1996 conference will focus on a better integration of social and natural sciences in addressing resource and environmental issues. Contact A.E. Luloff, 11 Armsby Building, University Park, PA, 16802. Tel: (814) 863-0401.