The Role of Fire in Northern Circumpolar Ecosystems
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CHAPTER 15

Fire Management in Wilderness Areas, Parks, and Other Nature Reserves

MARTIN E. ALEXANDER

Great Lakes Forest Research Centre, Canadian Forestry Service, Ontario, Canada

DENNIS E. DUBÉ

Northern Forest Research Centre, Canadian Forestry Service, Alberta, Canada

ABSTRACT

Boreal forests are fire-dependent systems that would lose their vigour and faunal and floral diversity in the absence of fire. The objectives of natural area preservation imply maintaining the original character of the land and perpetuation of those plant and animal communities dependent on fire for their continued existence. This chapter focuses on the status and assessment of fire programmes in nature reserves of northern circumpolar countries, principally Alaska, Canada, north-central United States, and Fennoscandia.

The necessity for considering fire in natural area management is now widely recognized, particularly in North America. A considerable body of supporting research on fire as a historical–ecological factor exists. The need for active versus custodial fire management programmes is great but the employment of fire by prescription in nature reserves is still very much in its infancy. Conflicts between ecological processes and social concerns hinder widespread application of 'wilderness' fire management concepts and principles. Concern for human safety and adjacent lands severely restricts the management of fire on the scale required. Public understanding of fire's role and acceptance of management practices are needed. A gradual and conservative approach, education programmes designed to inform and involve, and application of existing technology will support effective fire management planning and implementation. The ingenuity and collaboration of managers, specialists, and scientists is needed to develop and bring progressive management strategies prescribing recurrent fire to an operational stage.

15.1 INTRODUCTION

Throughout northern circumpolar countries representative samples of major biomes and other areas of unique biological and environmental interest are being set aside for their educational, scientific, and cultural values (Harroy, 1971). Because fire has long played an integral role in the evolution and maintenance of the diverse flora and fauna of northern circumpolar forest habitats, managers of any wilderness area, park, or other nature reserve must consider fire in the development of resource management plans. If a major objective for such areas is to perpetuate the diversity of biological entities as well as the diversity of biological processes, then these areas should be managed in accordance with ecological principles that have led to their establishment, including the management of fire (Stone, 1965; Haapanen, 1965, 1973; Heinselman, 1965, 1970a, 1978; Hendrickson, 1971; Van Wagner, 1973; Wright and Heinselman, 1973; Addison and Bates, 1974; Wright, 1974; McClelland 1977; Van Wagner and Methven, 1980).

Fire management suggests that fire, in an ecological sense as well as a protection sense, should be considered in developing land and resource management objectives. Once these objectives have been set, fire-related activities should be designed to achieve the objectives (Barney, 1975). Fire management in wilderness areas, parks, and other nature reserves generally favours a biocentric focus, allowing for the natural role of fire to the maximum extent possible with consideration for public safety and adjacent lands. This approach favours using 'random'-ignition prescribed fires (those fires of unplanned origin that are allowed to burn, based on predetermined criteria, because they are expected to achieve specific objectives). Where such an approach cannot be tolerated or specific situations or benefits are desired, traditional planned-ignition prescribed fires or even complete fire exclusion may offer the only viable alternatives. Fire management alternatives and their consequences are covered in greater detail by Agee (1974, 1979) and Heinselman (1970a,b, 1971, 1973a,b, 1978).

On federally owned lands in the continental United States and Alaska, the Forest Service and National Park Service have developed fire management policies that allow for planned- and random-ignition prescribed fires (Agee, 1977; Davis, 1979; Nelson, 1979; USDI National Park Service, 1979). Parks Canada (1979) recently released a more definitive policy on fire management for the Canadian National Park System (Falkner and Carruthers, 1974) than was previously stated (Flanagan, 1972). In Canadian provincial parks and wilderness areas, fire management is in a fire suppression mode, although resource management policies generally recognise the importance of fire (e.g., Miller, 1979). Similarly, the management of Ecological Reserves in Canada addresses the importance of fire (Weetman and Cayford, 1972; Maini and Carlisle, 1974). Fire management programmes in wilderness areas, parks, and other nature reserves of northern circumpolar countries are not nearly as developed as those of the western United States national forest wilderness areas, national parks, and national monuments (Kilgore, 1976; Heinselman, 1978).

In this chapter we review past and current fire research and survey the status of fire management planning and operational activities in the boreal forest and adjacent transitional zone nature reserves of northern circumpolar countries.

15.2 FOREST FIRE PROGRAMMES IN NORTHERN CIRCUMPOLAR NATURE RESERVES

15.2.1 Alaska

The future jurisdiction and classification of thousands of square kilometres of land in Alaska was, until recently, uncertain (Hendee *et al.*, 1978; Vale, 1979). This has made it difficult to assess the status of fire management planning in the vast northern boreal forest or taiga region of interior Alaska. In 1978, the Alaska Land Managers' Cooperative Task Force was formed with a fire management subcommittee having representatives from several state and federal agencies. A pilot area of 56 650 km^2 was selected in east-central Alaska to test new fire management concepts. Two broad objectives were agreed upon: (1) to reduce fire suppression costs commensurate with actual values threatened, and (2) to accommodate the various resource management objectives of the participating agencies (Kelleyhouse, 1979). As a result of this effort, the Fortymile Interim Fire Management Plan was completed (Anon., 1979) for operational implementation during the 1980 fire season. The prescriptions for random-ignition prescribed fires are considered conservative, but annual revisions to the plan are expected. Within the Fortymile Fire Management Area are portions of two recent additions to the US National Park Service system of natural areas. This includes about 5670 km^2 of the Yukon–Charley Rivers National Preserve (6933 km^2 total) and 4000 km^2 of the Wrangell–St Elias National Park and Preserve (49 850 km^2 total) (Figure 15.1). Approximately 70% and 30% of those portions of the Yukon–Charley Rivers and Wrangell–St Elias preserves, respectively, that lie within the Fortymile planning unit are forested.

The new Denali National Park and Preserve in central Alaska encompasses the former 7850 km^2 Mount McKinley National Park plus 15 223 km^2 of northerly and southerly extensions (Figure 15.1). At least 68 fires are known to have covered more than 40 000 km^2 in Denali, with the majority of area burned resulting from lightning fires (S. Buskirk, 1976, unpubl. rep.) An inter-agency fire planning effort patterned after the Fortymile endeavour will involve 121 400 km^2 north of the Alaska Range; the Tanana–Minchumina fire management area will include approximately 70% of Denali.

The Kenai National Moose Range (Figure 15.1) is a 7000 km^2 unit of the US National Wildlife Refuge System established in 1941 primarily to ensure

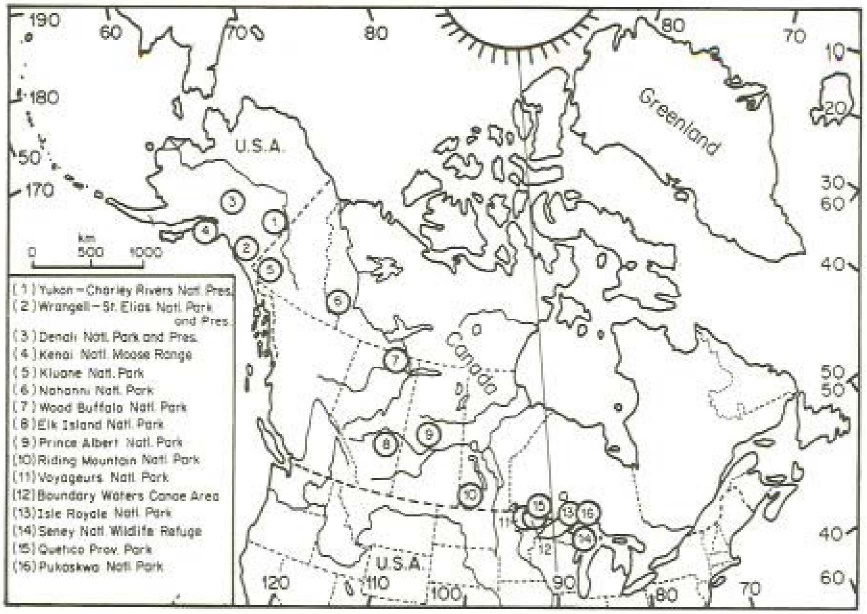

Figure 15.1 Geographical location of wilderness areas, parks, and other nature reserves in North America referred to in the text

the perpetuation of the giant Kenai moose (*Alces alces gigas* Miller). Past wildfires, responsible for creating favourable moose habitat, have tended to cause great fluctuations in the Kenai moose population in recent times. The unpredictable nature of wildfires has been a deterrent to long-term moose management on the refuge. Other resource and economic considerations also preclude the 'use' of wildfires. Planned–ignition prescribed fires have been conducted but have been difficult to arrange because of weather conditions (Spencer and Hakala, 1964; Johnson, 1975). Moose populations peaked from 13 to 22 years after a 125 455 ha fire in 1947. Current surveys indicate a declining population, the primary cause being the loss of quality winter range associated with vegetation development and over-utilization of browse (LeResche *et al.*, 1974; Oldemeyer *et al.*, 1977; Bailey, 1978). To assist in stabilizing the herd, habitat improvement was implemented by mechanically crushing areas of advanced plant growth with a complementary assessment programme (Bailey, 1978; Sigman, 1979); between 1974 and 1978, 2800 ha of the 1947 burn were treated. A limited amount (140 ha) of commercial logging took place during that same time. An additional 35 480 ha was burned by the 1969 Swanson River fire. Mechanical 'tree-crushers' were used to knock down and crush fire-killed stems in critical areas (4000 ha in total) in order to reduce the possibility of a reburn, to aid wildlife access to browse species, and for aesthetic reasons (Hakala *et al.*, 1971). Effects of the fire on wildlife were apparently minimal, although spruce grouse (*Canachites canadensis franklinnii* Douglas) densities were reduced one year after the fire (Ellison, 1975). The creation and/or enhancement of moose range by burning is presently not perceived as detrimental to the resident Stone caribou (*Rangifer arcticus stonei* Allen) population (Davis and Franzmann, 1979).

15.2.2 Northwestern Canada

Kluane National Park, formally established in 1976, is located in the southwestern corner of the Yukon Territory (Figure 15.1). Much of the park consists of valley glaciers and barren mountains, including Mount Logan, Canada's highest peak. Approximately 7% of Kluane's gross land area of 22 015 km^2 is forested. Douglas (1974) examined the montane plant communities of the park area and attributed the extraordinarily rich vegetation diversity and complex forest landscape pattern to climatic (micro and macro) variability and the frequency of fire and geomorphological processes. Through field reconnaissance and aerial photographs it has been estimated that about half of the forest zones in the park area showed evidence of fire within the past 80 years (J.B. Theberge, 1972, unpubl. rep.). The forest zones of Kluane, dominated by white spruce (*Picea glauca* [Moench] Voss), are characterized by a mosaic of stands ranging from 100 to 250 years old. The relatively wide distribution of age-classes and moderately low maximum ages are indicative of recurring fire and geomorphologic events (Douglas, 1974). Theberge (op. cit.) made a cursory survey of vegetation and wildlife use on eight burn areas (18–70 years old). Regeneration following fire was found to be quite variable. Moose and snowshoe hare (*Lepus americanus* [Erxleben]) utilized recent burned areas heavily. Theberge (1976) also examined the avifauna populations with respect to fire-induced secondary succession and found very little change in number of species or density and only minor changes in species composition. The extent to which man has altered the natural fire regime of Kluane has not been ascertained. The forested portion of Kluane is concentrated in the eastern half of the park adjacent to the Haines Road which joins the Alaska Highway, and this presents a number of potential limitations to the use of fire.

Nahanni National Park is a recently established (1971), remote, mountainous, wilderness park of approximately 4800 km^2 (Figure 15.1). Access to the park is difficult, limiting visitor use to about 200 people per year (July and August), mainly canoeists on the two principal rivers. The results of a current study of fire history and fuels will provide the basis and rationale for developing a workable fire management plan (Dubé, 1979). On-site observations and preliminary results attest to the prevalence of fire. Large fires have repeatedly swept the broad glacial-scoured, U-shaped valleys of the Flat and South Nahanni Rivers in the northwestern reaches of the park. Towards the southeast, fires have been generally smaller in size because of numerous natural barriers.

A similar study with nearly identical objectives is being pursued in Wood Buffalo National Park (Dubé, 1979). As Canada's largest national park (44 807 km^2), Wood Buffalo spans both Alberta and the Northwest Territories (Figure 15.1). Although much of the park is virtually inaccessible, an all-weather road transects the northern boundary. Fire management planning and implementation in this park are relatively complex because of several factors: the protection of endangered species (whooping cranes (*Grus americana* L.) and wood bison (*Bison bison athabascae* Rhoads)), commercial logging operations, hydroelectric activities, trapping and some hunting, native land claims, and private recreational lease holdings (cabins, etc.). As a result of a long history (20–30 years) of fire control in the park, reports on fire size, cause, location, etc. and weather records are available. This will facilitate a transition from fire control to fire managment objectives.

15.2.3 Western and Central Canada

Elk Island National Park is part of the boreal mixedwood forest of Alberta (Figure 15.1). Trembling aspen (*Populus tremuloides* Michx.) is the dominant tree species while white spruce is often present under the aspen canopy and is co-dominant on the major islands that have escaped past fires. There is little doubt that fire, either lightning- or man-caused, has significantly influenced the vegetation (G. Thomas, 1976, unpubl. rep.). Historically, the park had been hunted by indigenous peoples and, prior to becoming a national park, much of the area was cleared, logged, and burned by settlers. The present vegetation mosaic of aspen forest and open grassland or shrubland meadows is a reflection of past cultural activities (indigenous peoples and European man) and natural factors (including lightning- and man-caused fires) as well as present management practices.

The size (relatively small), location (adjacent to agricultural lands; 20 km from a large city; bisected by a major highway), the presence of large ungulates (bison, moose, and elk [*Cervus canadensis* Erxleben]) confined to the park by a fence, the absence of effective natural predation, as well as recreational uses and other developments in Elk Island, require that active resource management programmes be conducted to meet park management objectives. Currently, grassland meadows are being invaded by several woody plant species, and although this is a natural process, the loss of these grasslands will mean a decrease in plant community diversity and loss of a major food source for bison and elk. Park managers recognize that random-ignition prescribed fires are not a viable option for management purposes, so, to ensure the maintenance of the grassland meadows, a planned-ignition prescribed fire programme is underway. A 30–40 ha area was burned in May 1979. Additional prescribed fires are planned on the basis of information gained from these initial trials.

Prince Albert National Park lies in the boreal mixedwood forest section of central Saskatchewan (Figure 15.1). Wildfire has strongly influenced the vegetation complex here as in other areas of the boreal forest of western Canada. Kiil *et al.* (1973) reported that about one-third of the total 3874 km^2 park area has burned since 1930. In the southern portions of the park, some remnants of rough fescue (*Festuca scabrella* Torr.) grassland have been described by J.F. Cameron (1975, unpubl. rep.). He determined the importance of fire in the evolution and maintenance of these particular grassland communities. Cameron recognized that these grasslands are presently being encroached upon by aspen forest and shrubs. The potential loss of these grasslands has led to a 5-year (1975–1980) cooperative study to make recommendations for the use of prescribed burning as a management tool (Gunn *et al.*, 1976; Samoil *et al.*, 1977). This prescribed burning information along with a completed fuel type map and fire hazard classification scheme of the entire park completed by Kiil *et al.* (1973) will greatly assist park managers in their fire-resource management planning.

Riding Mountain National Park is situated in southwestern Manitoba on a rolling plateau that forms part of the Manitoba escarpment (Figure 15.1). The 2976 km^2 park embraces three major ecosystems, the northern boreal forest, the central grasslands, and the eastern deciduous forest. Though the past fire history of the park is complex and not easily deciphered, early historical records indicate that fires started by settlers were common. The recent history of the park has been compiled for the period 1930–1978 (Briscol *et al.*, 1979, unpubl. rep.). Prescribed fire has been used on an *ad hoc* basis within bison enclosures for several years, and currently an attempt is being made to formalize fire management planning.

15.2.4 North-central United States

Voyageurs National Park, situated in the forested lake country along Minnesota's northern border (Figure 15.1), is a relatively new addition to the US National Park Service's natural area system. Forest fires have historically been instrumental in altering vegetation in the park; logging operations for sawtimber and pulpwood have also drastically altered forest composition in certain areas. Roughly two-thirds of the land area (887 km^2) shows evidence of being logged and/or burned in modern times. The original vegetation, historic and modern fire patterns, and logging activities have been documented for this park, and the influence of fire and logging as factors affecting forest succession and patterns of vegetational development are being assessed (Rakestraw *et al.*, 1980). Results of the study indicated a dramatic shift in species composition from predominately pine or spruce-fir forests in the past to predominately aspen forests, due to a combination of logging, post-logging fires, and 40 years of fire suppression (Ferris, 1980). Current park policy is to suppress all fires. Potential problems arising from the use of fire as a resource management tool relate to visitor safety, leased properties within the park, and fires extending outside park boundaries.

To the east of Voyageurs National Park lies the Boundary Waters Canoe Area (BWCA), a 4170 km^2 unit of the US National Wilderness Preservation System within the Superior National Forest (Figure 15.1). Probably more is known about the fire history and ecology of the BWCA than any other area in the northern circumpolar environment. Charcoal stratigraphy in annually laminated lake sediments indicated that periodic fires have occurred in the area for at least 9300 years (Swain, 1973, 1980; Wright, 1974). Heinselman's (1969, 1971, 1973a,b) dendrochronological dating and mapping of forest fire patterns is very complete for nearly the last 400 years. Phytosociological studies of the upland plant communities have indicated that present forest structure and composition is closely related to the length of time and character of the last fire, and the age and composition of the former stand (Ohmann and Ream, 1969, 1971a,b; Grigal and Ohmann, 1973, 1975; Ohmann *et al.*, 1973). A programme of fire effects studies (see Rudd, 1971; Books, 1972; Peek, 1972) following a 6000-ha fire in 1971 (Sando and Haines, 1972) has yielded a considerable amount of knowledge (e.g. Ohmann and Grigal, 1979). A much smaller-scale programme involving a 1368-ha fire in 1976 has also been initiated (Ahlgren, 1976; Buech *et al.*, 1977).

In 1976, planning commenced on introducing random-ignition prescribed fires, on a pilot basis within a contiguous 400-km^2 study area of the BWCA (Gibson, 1976). The remoteness, light visitor use, and lack of development allows BWCA fire managers to focus on the potential for uncontrollable fire growth outside the study area as a criterion for initiating suppression action. Detailed fuel inventories were conducted in the study area during the summer of 1976 and the data were related to potential fire behaviour (i.e., spread, intensity, crowning, spotting) utilizing mathematical models (Roussopoulos, 1978a,b). Predicted fire behaviour compared favourably with actual conditions on three wildfires in or near the study area, suggesting that the modelling results, coupled with experience and judgement, could be used in writing fire management prescriptions. A fire-related information base has been assembled including the preparation of a vegetation/fuel type map (Roussopoulos, 1978b) and a draft environmental analysis report prepared. Pre-attack planning for the area has been completed and accommodations made for ensuring visitor safety. The pilot study area project has not been implemented since the completion of the land management planning process on the Superior National Forest is a necessary prerequisite before reintroducing fire into the BWCA ecosystems.

In the western portion of Lake Superior lies its largest island, Isle Royale, a 544 km^2 archipelago managed by the US National Park Service as a National

Park (Figure 15.1). Cooper (1913) carried out a study of Isle Royale vegetation succession and concluded that 'It is nearly certain that fire has played a part in the vegetational history of almost all if not the entire forested areas of the island'. Charcoal analysis of sediment cores from inland lakes has indicated that fire has been an important ecological factor in the island's forest history for at least 1000 years (Raymond, 1975). Fire ecology studies, particularly those regarding fire–moose–wolf (*Canis lupus* L.) relationships associated with a 10 000-ha fire in 1936 (Krefting, 1974; Allen, 1974, 1979), have clearly shown the significant role of fire in the island's ecology (Hansen *et al.*, 1973; Janke *et al.*, 1978; Janke, 1979; Janke and Lowther, 1980). Approval for allowing random-ignition lightning-caused fires to run their course (USDI National Park Service, 1977) was granted in 1976, pending final acceptance of a fire-management plan. Six fires have been classed and monitored as random-ignition prescribed fires between 1976 and 1979. The largest of these, the 1976 Card Point Fire, burned 2 ha over an 80-day period (Miller, 1978). Although no planned-ignition prescribed fires have been conducted to date, it is still considered an option available to park managers. A vegetation/fuel type map of the island was recently prepared (Steigerwaldt and Meyer, 1979).

The Seney National Wildlife Refuge, located in Michigan's Upper Peninsula (Figure 15.1) is a 386-km^2 component of the federal Fish and Wildlife Service refuge system. As of July 1976, its fire plan had not been up-dated since part of the Refuge received wilderness status, refuge personnel had no system of monitoring fire-danger conditions, and there was a lack of experienced fire personnel on the refuge. On 30 July 1976 the Walsh Ditch Fire was ignited by lightning. The fire was allowed to burn freely to 4900 ha in size before suppression action was initiated on 11 August. Aided by worsening drought conditions (Johnson, 1976), the fire spread to a final size of 29 000 ha on 21 September including 7000 ha of state and private lands. Suppression costs amounted to approximately $8 million. The lack of information on fuel and weather conditions, coupled with a fire management plan that did not cover the refuge's wilderness lands, resulted in severe criticism of the agency's decision to delay suppression. We cite this example, not to draw undue attention to this one particular situation and the people or agency involved, but to emphasize the importance of technically sound management plans and staff capable of fulfilling plans. Failure to do so might result in the loss of public and political acceptance of fire use as a tool in natural area management.

15.2.5 Eastern Canada

Quetico Provincial Park is a 4655-km^2 wilderness–lake ecosystem in north western Ontario (Figure 15.1). As a prerequisite to the implementation of a fire management versus fire exclusion programme in Quetico, a 2½ year fire ecology study of the park was undertaken between 1975 and 1977 (Woods and Day, 1977d). The species composition and stand structure of Quetico's forests were examined photogrammetrically (Woods and Day, 1976) and a fire history map was prepared showing recent fires and as many older burns as possible (Woods and Day, 1977a). Stand case histories and analysis of relevant literature were used to determine the specific ecological role of fire in four of the Park's major forest communities (Day and Woods, 1977; Woods and Day, 1977b,c): jack pine (*Pinus banksiana* Lamb.), red pine (*P. resinosa* Ait.), poplar (*Populus* spp.), and black spruce (*Picea mariana* [Mill.] B.S.P.). An 'ecological burn zone' (Woods and Day, 1977d) map was reconstructed showing three zone classes based on a forest stand's life cycle where fire use should not (regenerative phase), could (immature–mature phase), and should (overmature phase) be employed. In 1978, a 250-km^2 pilot fire management study area was proposed by the Ontario Ministry of Natural Resources that would involve the use of planned- and random-ignition prescribed fires to allow for the application of fire to be tested on an operational basis over a 2-year period. The proposed pilot study area, oriented in a southwest–northeast direction, has been subdivided into 'start' and 'spread' zones to account for typical fire spread due to topographic features and prevailing winds in an effort to limit potential for escapes. However, the project has not yet been initiated. Although logging operations have been discontinued in Quetico since 1971, the local forest industry is likely to oppose a fire management programme. An appropriate public education programme is recognized as an essential ingredient to successful implementation of the project. An analysis of Quetico's fire weather and fire danger climatological characteristics is in progress (Alexander and Woods, 1977).

On the northeastern shore of Lake Superior lies the Province of Ontario's largest National Park, Pukaskwa (Figure 15.1), a 1860-km^2 parcel of rugged Canadian Shield country (Gimbarzevsky *et al.*, 1978). The need for baseline information to guide fire management direction and for landscape interpretation was recognized early in the park's planning activities. Commencing in 1977, a 3-year investigation into the historical, ecological, and managerial role of fire was undertaken (Alexander, 1978). From a fire history standpoint, emphasis is being placed on construction of stand origin and fire history maps through field sampling and existing vegetation maps. Elucidation of the area's fire ecology centres on the review and synthesis of applicable literature and photograph (aerial and ground) comparisons. An assessment of the Park's 'fire environment' in terms of fuel types, climatic and meteorological characteristics, and terrain features is being undertaken (e.g., Street and Alexander, 1980). From the knowledge gained and information assembled, recommendations will be made regarding an appropriate fire management strategy for the Park. The Ontario Ministry of Natural Resources is currently responsible for fire detection and suppression in Pukaskwa under an existing 10-year agreement (until 1988) between provincial and federal governments. All fires are to be suppressed within a 8-km buffer zone between the boundary and interior of the Park. The woodland caribou (*Rangifer tarandus caribou* Gmelin) habitat within the Park and commercial timberlands adjacent to the Park are two examples of concern to implementing a more liberal fire management programme in Pukaskwa.

15.2.6 Fennoscandia and USSR

Norway, Sweden, and Finland comprise a total land area of 1 110 535 km^2, and nature reserves are generally smaller than their North American counterparts. Forest fires are generally not recognized as an important or positive historical–ecological factor as in North America; however, Finnish legislation on nature conservation is being revised and will include considerations of fire in the management of parks and reserves.

Norway has 13 national parks with a total area of 5000 km^2 and approximately 200 smaller reserves (Holt-Jensen, 1978). Very little local information is available on the natural role of fire. Management agencies are relying on results from other countries where Scots pine (*Pinus sylvestris* L.) and Norway spruce (*Picea abies* [L.] Karst.) are dominant species for basic management information.

Sweden's 16 national parks and some 500 nature reserves have a total area of approximately 9600 km^2 and 1750 km^2, respectively (Esping, 1972). Forest fire history investigations in northern Sweden by Zackrisson (1976, 1977) have led him to conclude that there is an over-representation of old-growth forests, due to fire suppression measures. If suppression is continued, forests that have scarcely existed for 600 years will result (Zackrisson, 1981). He suggests that fire should be reintroduced into some of the larger forest reserves and national parks. A project to assess fire management needs in Swedish parks and reserves was started in July 1979 by Zackrisson to reconstruct the fire history of Muddus National Park (Figure 15.2), one of the largest virgin forest areas in northern Sweden (492 km^2). The historical data on fire incidence coupled with Uggla's (1974) studies of post-fire regeneration of trees and understorey flora on wildfire sites in the park will assist in clarifying the specific role of fire.

Finland's nine national parks and 15 nature reserves have a combined total area of 3247 km^2 (Kalliola, 1970; Anon., 1975). The first step in considering fire in the management of Finnish parks and reserves was the initiation of a project in 1972 by the Department of Environmental Conservation at the University of Helsinki to investigate the fire ecology and history of six selected study areas. Four parks and two reserves were selected as being

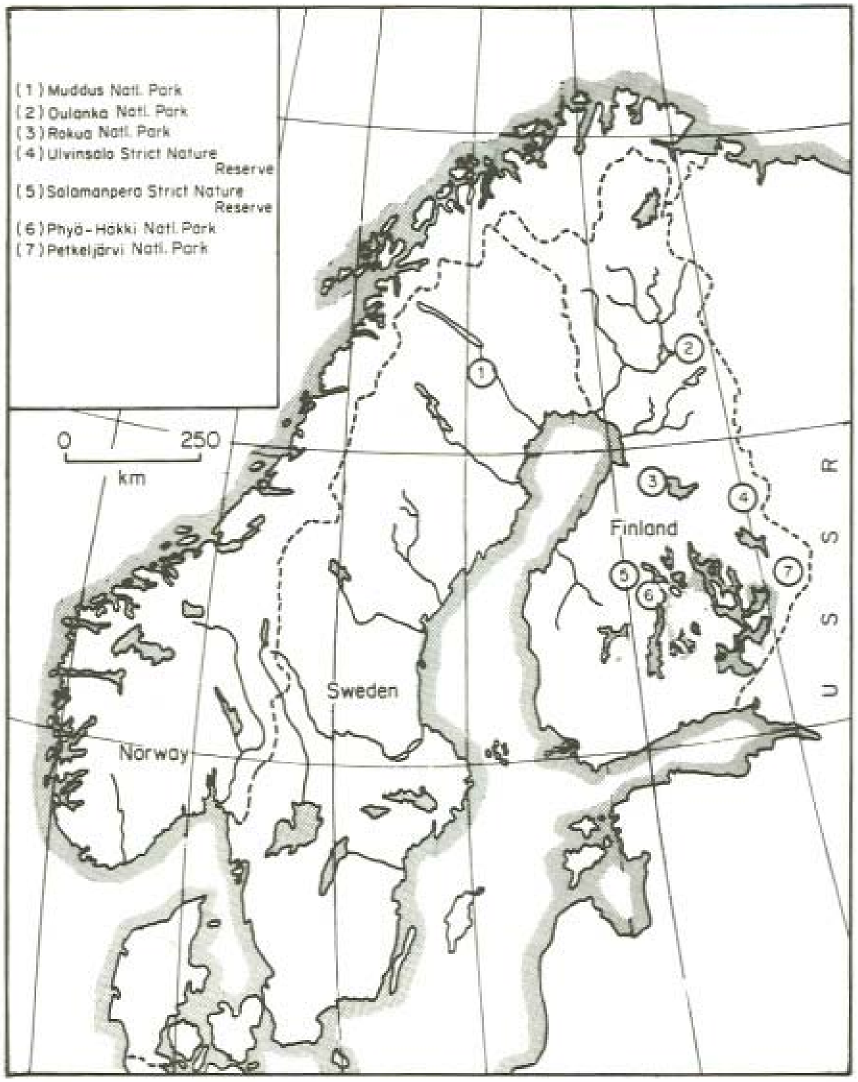

Figure 15.2 Geographical location of parks and nature reserves in Fennoscandia referred to in the text

representative of the Finnish boreal forest (Figure 15.2): Oulanka National Park (107 km^2), Rokua National Park (4.2 km^2), Phyä-Häkki National Park (10 km^2), Petkeljärvi National Park (6.3 km^2), Salamanperä Strict Nature Reserve (12.7 km^2), and Ulvinsalo Strict Nature Reserve (25 km^2). Field surveys for the project have been completed and the first report, on the Ulvinsalo Strict Nature Reserve, issued (Haapanen and Siitonen, 1978). The

Ulvinsalo landscape is a mosaic of upland and lowland sites. These effective fuel discontinuities may assist the application of prescribed fire planning by serving as natural barriers to surface fire spread. A phytosociological analysis and distribution map of the vegetation types in Oulanka National Park has been completed (Söyrinki *et al.*, 1977).

The main type of nature reserve in the Soviet Union is termed a *zapovednik* or State natural preserve (Pryde, 1972, 1978) although a variety of protected areas exist. These areas are specified as being 'forever withdrawn from economic utilization for scientific-research and cultural-education purposes'. Each preserve has its own scientific staff and supporting research facilities. A large portion of the research carried out in the preserves has direct application to the national economy. The importance of *zapovedniki* as outdoor laboratories for biological and ecological research represents one of the main justifications for withdrawing such areas from economic development, although biosphere preservation cannot be understated. Fire has had an important historical-ecological role in the northern forest ecosystems of the Soviet Union, for example, in northern European Russia (Vakurov, 1975) and northeastern Siberia (Shcherbakov, 1975). However, the Soviet attitude to fire in the *zapovedniki* is perhaps best illustrated by the case of the Mari *zapovednik*. Much of the preserve was swept by fire in 1972. As a result, in 1973 a decision was made to abolish Mari. Although the study of fire effects could have been conducted whether the area was officially designated as a *zapovednik* or not, lacking this status it was easier to place it in some economic activity (Pryde, 1978).

15.3 DISCUSSION

A number of broad generalizations can be made regarding the above survey of fire management in natural areas. The crusade for fire management in North American wilderness areas, parks, and other nature reserves is largely over. Policies have been formulated that give a legal basis for more than just fire control. This is not the case in other circumpolar countries.

Area specific historical research and assessment of plant and animal communities in relation to fire is becoming available. There has been some experimentation but no long-term programmes with planned-ignition prescribed fires. Experience with random-ignition prescribed fires is limited. Pilot study areas have been proposed for the use of random and planned-ignition prescribed fires, but in only a couple of instances are there operational programmes, and these have not been critically tested.

Generally, fire suppression is the only aspect of fire management that is currently being practised in nature reserves. The stated objective of nature reserves, namely the preservation of natural conditions, is clearly not being accomplished under a policy of almost total fire suppresssion. Fire exclusion carries two major risks if pursued indefinitely: (1) fuel accumulation to the point that widespread, high-intensity fires will result in spite of protective measures, and (2) loss of floral and faunal diversity. Attempted fire exclusion is a defensible 'holding action' until the necessary expertise can be developed to implement fire management plans.

Heinselman (1978) stated that fire management programmes are really only needed if there is concern about public safety or about unnatural ecosystem effects due to prior fire exclusion. Unfortunately, one or both concerns are often justified. The guiding principle in choosing between random-ignition or planned-ignition prescribed fires should be that random-ignitions are preferable, if not precluded by safety or ecological concerns (Heinselman, 1978). Safety concerns might dictate that only planned-ignitions be used near boundaries, near structures, in very small reserves, and in high visitor use areas. Prescribed fire, especially random-ignition, carries the risk of potential danger to human safety, but as noted earlier, fire exclusion policies have similar risks. Forest fires are dangerous, and thus the manager should never allow his enthusiasm for initiating or restoring fire to the ecosystem to override safety considerations. Park visitors can be given pre-entry instructions, directed away from fire areas and evacuated if necessary, closures to fire areas can be initiated, and announcements issued or messages dropped from aircraft to back-country users. However, the responsibility of preventing uncontrollable fire growth outside a reserve is paramount and requires an ability to manage fire on the scale required.

Some managers have suggested that the public will not accept prescribed fire management programmes in nature reserves. Stankey (1976) has pointed out how dramatic the shift from high-cost fire suppression to the active use of fire might appear to the public.

The problems of prescribed fire capability and public support are immediate concerns that hamper the implementation of more liberal fire management programmes. We would like to suggest partial solutions to problems and to identify specific research and management needs. Forest fire smoke is generally not a problem from the standpoint of health concerns and aesthetics, but it can severely hamper aerial fire intelligence and suppression operations under certain meteorological conditions.

The need to promote understanding and support for ecologically sound prescribed fire programmes is not an insurmountable problem if the public receives factual information about 'natural' ecosystems, and about the measures that will be needed to maintain and/or restore these ecosystems. Efforts to gain public support for technically sound programmes, in the absence of concomitant programmes to educate, inform, and involve the public, seemed doomed to failure (Stankey, 1976).

There may be a problem with understanding the need for reintroducing fire which is a legacy of intensive fire prevention campaigns. To overcome this incomplete story told to the public, with posters, slogans, etc., new and innovative eductional work with the media, schools, clubs, etc. is needed. Careful distinctions must be made between unwanted fires, which still must be suppressed in all cases, and wanted fires (Barrows, 1977). Persons who understand little about fire are more likely to endorse stringent suppression statements than those who are better informed. The findings of Stankey (1976) and Rauw (1980) suggested that the public will respond positively as the factual knowledge of fire's natural role increases.

Management actions that would enhance public support for fire management programmes have been outlined by Stankey (1976): (1) educate and involve all segments of the public and (2) avoid sudden changes in policy-implementation. Rauw (1980) has shown that a slide-tape presentation can be an effective means of increasing and assessing visitor knowledge of fire's natural role and attitudes towards fire management policies and practices.

There are legitimate concerns about our ability to implement fire management plans that consider random- and/or planned-ignition prescribed fires. Such programmes involve risks, not the least of which is public safety and damage to adjacent lands (Flanagan, 1972). Barrows (1977) cautions that managers are still incapable of coping with wildfires under all conditions. Although risks cannot be entirely eliminated, they can be minimized to within acceptable limits through management plans that are professionally prepared, technically sound, and expertly executed (Moore, 1976).

Two problems unique to using random-ignitions in northern ecosystems are lack of defensible boundaries and typical fire behaviour. Many northern ecosystems are characterized by flat terrain with continuous fuels. Low-lying areas (e.g., bogs) and water-bodies (e.g., lakes, rivers) inhibit firespread but short- and long-range spotting is common. Fires of any real ecological significance in North America and Siberia are most often stand-replacing, high-intensity surface fires or crown fires. In Fennoscandia and northern European Russia, low- to medium-intensity surface fires are more prevalent.

Nature reserve managers are understandably apprehensive of high-intensity fires, not only because the fire-killed stems alter aesthetics but because of the potential for escape beyond the limits of an area. In many northern forests such fires were the natural agents of periodic stand renewal and must somehow be provided for if the natural system is to survive.

Planned-ignitions generally present far fewer problems, but techniques, experience, and confidence must be acquired for handling random-ignitions. Much of our experience and knowledge in the application of prescribed fire in other ecosystems is only partially applicable, so a manager is forced to apply existing and new technology while at the same time avoiding mistakes which are caused by poor application of widely known and proven practices (Moore, 1976).

A major problem encountered with random-ignition prescribed fires is that they are inevitably associated with periods of extreme fire weather which coincide with conditions when fire suppression resources are already committed. Once such fires become large, control is difficult and wind shifts could threaten lives or property in and/or outside a reserve.

The extensive experience in fire fighting technology that has been acquired over the decades is still required for fire management objectives. Managers must have the option of suppressing certain perimeters, or even the entire fire, if they anticipate unacceptable safety problems. There is a fine line between a wildfire and a random-ignition prescribed fire. The prescription for a random-ignition may call for partial containment or suppression and a wildfire might be "herded". An assessment of fire potential (e.g., fire growth) and a knowledge of the threshold conditions for severe fire behaviour (crowning, high rate of fire spread, spotting) is absolutely essential.

Assessing potential fire behaviour encompasses at least four interrelated facets: (1) an adequate fire weather and climatic station network; (2) a system to integrate past and present weather effects on fire danger conditions; (3) fire behaviour prediction schemes with appropriate fuel and terrain map data; and (4) short- and long-term fire weather forecasting. Much of the thought and analysis that goes into evaluating fire potential can be incorporated and organized into decision making flowcharts (e.g., Devet, 1976; Chapman, 1977; Fischer, 1980) such as are found in the Fortymile Interim Fire Management Plan (Anon., 1979). Remote weather stations offer a solution to the problems of manned observation units and vast, remote areas (e.g., Harrington, 1978). Sophisticated fire danger rating systems have been developed, at least in North America (Deeming *et al.*, 1977; Turner and Lawson, 1978).

Quantitative fire behaviour prediction is still inexact, fragmented, and often incomplete, although useful schemes are becoming available (Van Wagner, Chapter 4, this volume). Thus the fire manager must rely on (1) case studies and analyses of past fires (e.g., Street and Alexander, 1980); (2) information from wildfires (e.g., Sando and Haines, 1972) and experimental prescribed fires; (3) mathematical modelling (e.g., Roussopoulos, 1978a,b); and (4) experienced judgement. Perhaps we can learn about the management of high-intensity fires by studying free spreading fires. In northern North America many such opportunities exist where there are no economic reasons for suppression.

In spite of the fact that empirical techniques and mathematical models for predicting fire behaviour are slowly becoming available there is still the need for professional judgement and practical experience (Moore, 1976). North American nature reserve managers are gaining experience with fire, but in Fennoscandia, attrition through retirements is taking its toll of personnel involved with prescribed fire during the 1950s and the 1960s. The necessary expertise to fill this void might be acquired through an international exchange programme of short-term visits between North American and Fennoscandia fire specialists.

The development of a close working relationship between the fire manager and area fire weather forecaster is absolutely essential. The forecaster must be aware of and appreciate the manager's objectives and the manager should understand the forecaster's limitations in predicting weather accurately. The variability in synoptic weather patterns does not permit a reliable weather forecast much beyond three days. Historic weather records reveal patterns which can be used by fire managers in developing intelligent fire management prescriptions (e.g., number of days suitable for planned-ignition prescribed fires and when they might occur). We cannot determine which specific weather occurrences from the past will be repeated at any given time in the future. Instead, we examine the records from the last two or three decades and assume the occurrences will have the same frequency in the future (Furman, 1979). Statistical climatological analysis might be of assistance in determining the probability of below-normal precipitation or meteorological drought (Furman, 1978).

15.4 CONCLUDING REMARKS

The basic objective of fire management programmes in nature reserves is to restore or maintain fire's natural role as an environmental factor. If we were to let nature choose the time, the place, and fuels (i.e., allow all lightning fires to burn regardless), then supposedly a natural system should result. This is unrealistic because of socio–economic–political factors. Plant and animal communities in some reserves have been altered by fire exclusion and/or prior land use, and many reserves are really only a fragment of the primeval system. What managers really desire is not the natural fire regime *per se*, but rather the vegetation complex that the natural fire regime would have created (Van Wagner and Methven, 1980). The objective would be to emulate the long-term historic pattern as nearly as possible considering safety and ecosystem size.

Fire managers for nature reserves should have clear, specific, and biologically attainable objectives. Action plans or statements must spell out the philosophy of ecosystem management and the biological nature of the ecosystem to be maintained or restored (e.g., vegetation types and successional stages to be encouraged, the approximate proportions of the area that might be occupied by each type and stage at any one time, the native fauna to be encouraged, etc). Historical research and inventory will allow judgements about the degree to which present ecosystems should be managed. The proportion of area to be occupied by various successional stages is a key issue and should be based on the forest age–class structure. The negative

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