ECOLOGICAL ROLE OF FIRE IN THE UNCUT BOREAL MIXEDWOOD FOREST

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Forest fires play a multiple role in the ecology of Ontario's boreal mixedwood forest: this forest is a fire-dependent ecosystem that would lose its character, vigor, and faunal and floral diversity in the absence of fire. The role of fire in land use planning and management, including the judicious use of random and planned ignition prescribed fires, must be considered more fully. Fire ecology research needs and opportunities are suggested.

Les incendies de forêt ont des effets multiples sur l'équilibre de la forêt boréale mélangée de l'Ontario: cette forêt constitue un écosystème qui dépend des incendies pour préserver son caractère, sa vigueur, la richesse de sa faune et de sa flore. En ce qui concerne l'aménagement des sols et la planification de leur utilisation, ce qui suppose notamment la mise à profit des incendies et la planification de brûlages dirigés, le rôle du feu doit être mieux examiné. Les possibilités qu'offrent ces pratiques et les besoins en recherche sur les relations entre les incendies et l'écologie sont présentés.

INTRODUCTION

The boreal mixedwood forests of northern Ontario are a complex quiltwork pattern or collage of pure stands and coniferous/deciduous mixtures of black spruce (*Picea mariana* [Mill.] B.S.P.), white spruce (*P. glauca* [Moench] Voss), balsam fir (*Abies balsamea* [L.] Mill.), trembling aspen (*Populus tremuloides* Michx.) and white birch (*Betula* *papyrifera* Marsh.) which were, and still are to a significant degree, related to the fire history of this area. Paleoecological analysis of charcoal deposits in lake and peat bog sediments in the Great Lakes region indicates that there have been periodic forest fires here for at least 9,000 years (Potzger 1950, Swain 1973, Raymond 1975). The regeneration mechanisms of black spruce, trembling aspen and white birch following fire are, in fact, adaptations that have evolved in a fire environment.

This paper reviews the principles of fire as an ecosystem process (Wright and Heinselman 1973, Heinselman 1978) and provides selected examples pertinent to the boreal mixedwood forests. It is essential for forest managers to understand and appreciate the fundamental roles of fire, as its occurrence in the boreal mixedwood forest is inevitable. They should be aware not only of the short- and long-term effects of fire, including the consequences of attempting to exclude it, but also of the ways in which they can use fire as a management tool.

There is a degree of variability in fire effects which is governed by the *fire regime* (i.e., intensity, recurrence interval, size, season of occurrence, depth of burn) and post-fire influences (e.g., climatic conditions) of a given area. For example, burn size is an important factor in wildlife habitat and seed sources, short-interval repeated fires may reduce site quality, and post-fire precipitation patterns determine conifer seedling survival.

INFLUENCE ON THE PHYSICAL-CHEMICAL ENVIRONMENT

Fire can be an effective decomposer and mineralizing agent. Some or most of the nutrients tied up in organic material are liberated and released as ash. Later they are deposited in the soil in sufficient quantity and in appropriate chemical forms so that surviving plants experience a net improvement in their environment (Ohmann and Grigal 1979). In the absence of fire, nutrient cycles and energy flow can be partially or severely blocked by incomplete decomposition of forest biomass (Heinselman 1978). The physical spalling and exfoliation of granitic and metamorphic rocks by fire may be the most important rock-weathering process contributing to soil formation on the Canadian Precambrian Shield (Wright and Heinselman 1973).

The physical removal, by fire, of certain vegetation components within a stand naturally alters microclimatic conditions. Increased insolation correspondingly results in higher soil temperatures which, in turn, stimulate pin cherry (*Prunus pensylvanica* L.) seeds to germinate (Marks 1974) and create the necessary environment to induce aspen roots to sprout (Horton and Hopkins 1966).

The impact of fire on environmental site quality is often of major concern. There is speculation that released nutrients such as phosphorus might cause eutrophication problems (i.e., algal blooms) in receiving lakes and streams. However, studies by McColl and Grigal (1977) and

Schindler et al. (1980) indicate that, except for an unusually short return interval and late season fires, there are no long-lasting, detrimental effects on water chemistry or biological properties. Post-fire vegetation ties up nutrients rapidly and reduces losses.

On the other hand, fire may expose varying amounts of mineral soil and, in so doing, increase the potential for surface erosion. Severe erosion is normally associated with steep terrain and immediate, heavy post-fire rains (Lutz 1956). Nevertheless, no measurable erosion was observed during two separate surveys of wildfire sites in northwestern Ontario (Armson et al. 1973, Methven et al. 1975). Fire-induced changes in the physical and chemical properties of the forest floor are greatly dependent on the degree of "duff" removal. Generally, a layer of organic material remains over a large portion of the area so that direct heating of the mineral soil is minimal.

CONTROLLER OF VEGETATION COMPOSITION, STRUCTURE AND SUCCESSION

Plant community composition is determined largely by the fire regime and the composition and nature of the pre-fire community. Other environmental factors are less important because of the relatively narrow range of climatic conditions and the broad range of plant tolerances (Grigal and Ohmann 1973, Ohmann and Grigal 1979). The autecological characteristics of the mixedwood tree species in relation to fire are well known*(Lutz 1956, Rowe and Scotter 1973, Ahlgren 1974, Viereck and Schandelmeier 1980). The mode of reproduction following fire is either by seed (conifers and hardwoods) or by vegetative means (hardwoods). MacLean (1960) states that "Fires create conditions that are usually favourable to reproducing white spruce, and unfavourable to balsam fir." Van Wagner (1979b) notes that "...black spruce...trembling aspen, and white birch--are ecologically equipped to spring back even after complete mortality over a wide area." The semiserotinous cones of fire-killed black spruce stems retain viable seeds for several years so that a live overhead seed source is not necessary (LeBarron 1939, Vincent 1965). White spruce and balsam fir, on the other hand, generally require "live seed trees" in the refugia of unburned areas within or adjacent to the burn (Rowe 1955, Bakuzis and Hansen 1965). Trembling aspen root suckering (Horton and Hopkins 1966) and the characteristic white birch whorls which originate from buds at the stem base are the usual means of recovery but both can reproduce by seed (Archibold 1980). Birch sprouting is more common in younger stands than in middle-aged and older stands (Lutz 1956).

Little duff removal by fire tends to favor the hardwoods since their regeneration mechanisms are not as dependent on the resulting seedbed conditions. Because of the preference of black spruce (and to some extent white spruce) for mineral soil, density and pattern following fire will vary in suceeding generations according to depth of burn.

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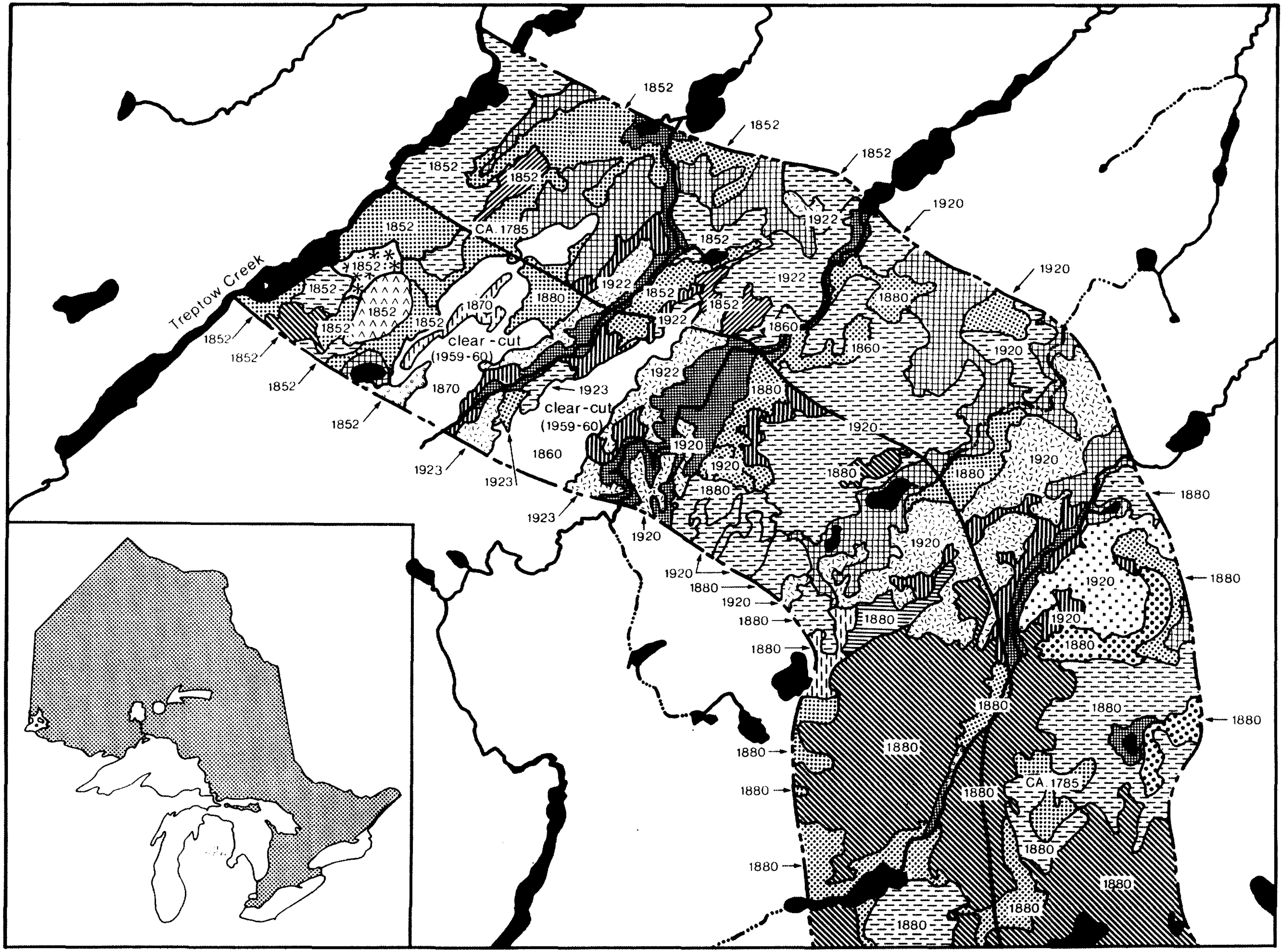
*See previous paper in these proceedings.

A short fire interval may promote aspen-birch or shrubs over spruce-fir because of the ability of the deciduous species to sprout/sucker at an earlier age than that at which conifers are able to produce abundant seed. A long fire interval may promote spruce over the hardwoods because of the greater longevity of conifers and the pathologically induced short rotations inherent in aspen and birch. Ahlgren (1974) points out that since fire frequently destroys the seed crop of young black spruce trees, natural selection may have favored genetic strains with the most vigorous height growth. Failures in conifer regeneration following fire are often attributed to unsatisfactory seedbed conditions, inadequate seed source or a combination of these factors. In such cases, trembling aspen and white birch may fulfill an important role in colonizing a site. For spruce seedling establishment, deeper burns temporarily reduce competition from lesser vegetation.

The minor flora indigenous to the mixedwood forest have regeneration mechanisms (i.e., wind dispersed seed, buried roots and rhizomes, stored seed) which ensure their survival (Marks 1974, Flinn and Wein 1977, Ahlgren 1979, Archibold 1979, 1980). Their response is dependent largely on the depth of burn, although fire frequency can also be a selective force (Methven 1978).

The patterns created by fire and physiography provide for a variety of stand ages, vegetation types and successional stages over the forest landscape (Fig. 1). The vegetation mosaic as a whole changes little over time; the fire-initiated patches "...like the pieces in a kaleidoscope--are periodically rearranged by fire and succession" (Heinselman 1978). The average number of years required to burn an area equivalent to the region as a whole is regarded as the *natural fire rotation* (Heinselman 1973) or *fire cycle* (Van Wagner 1978b). Van Wagner (ibid.) has shown that the stand age-class distribution in a natural fire-controlled forest should in theory fit a negative exponential function. The average stand age would be the same as the fire cycle; two-thirds of an area would have stands younger than the fire cycle and one-third would have stands that are older. Fire cycles prior to the initiation of fire protection have not been worked out for any boreal forest area in northern Ontario, although a study is in progress (Alexander 1978). Estimates of fire cycles for near-boreal conditions are 50-100 years (Heinselman 1973, Woods and Day 1977, Van Wagner 1978b). The scarcity of forest stands older than 150-200 years (e.g., MacLean 1960, Lynn and Zoltai 1965) is simply a reflection of the cyclic nature of fire. Upland areas burn more often than do lowland areas, simply because conditions conducive to fire spread occur more frequently on uplands.

Site conditions, fire variability, and the large variety of stand compositions and conditions provide for a number of possible courses of forest succession. A simplified case is illustrated in Figure 2. Vegetational changes after fire are changes in relative abundance and dominance rather than changes in species composition. The process is



Treptow Creek
1852
CA. 1785
1870
1880
clear-cut
(1959-60)
1922
1923
1860
1920

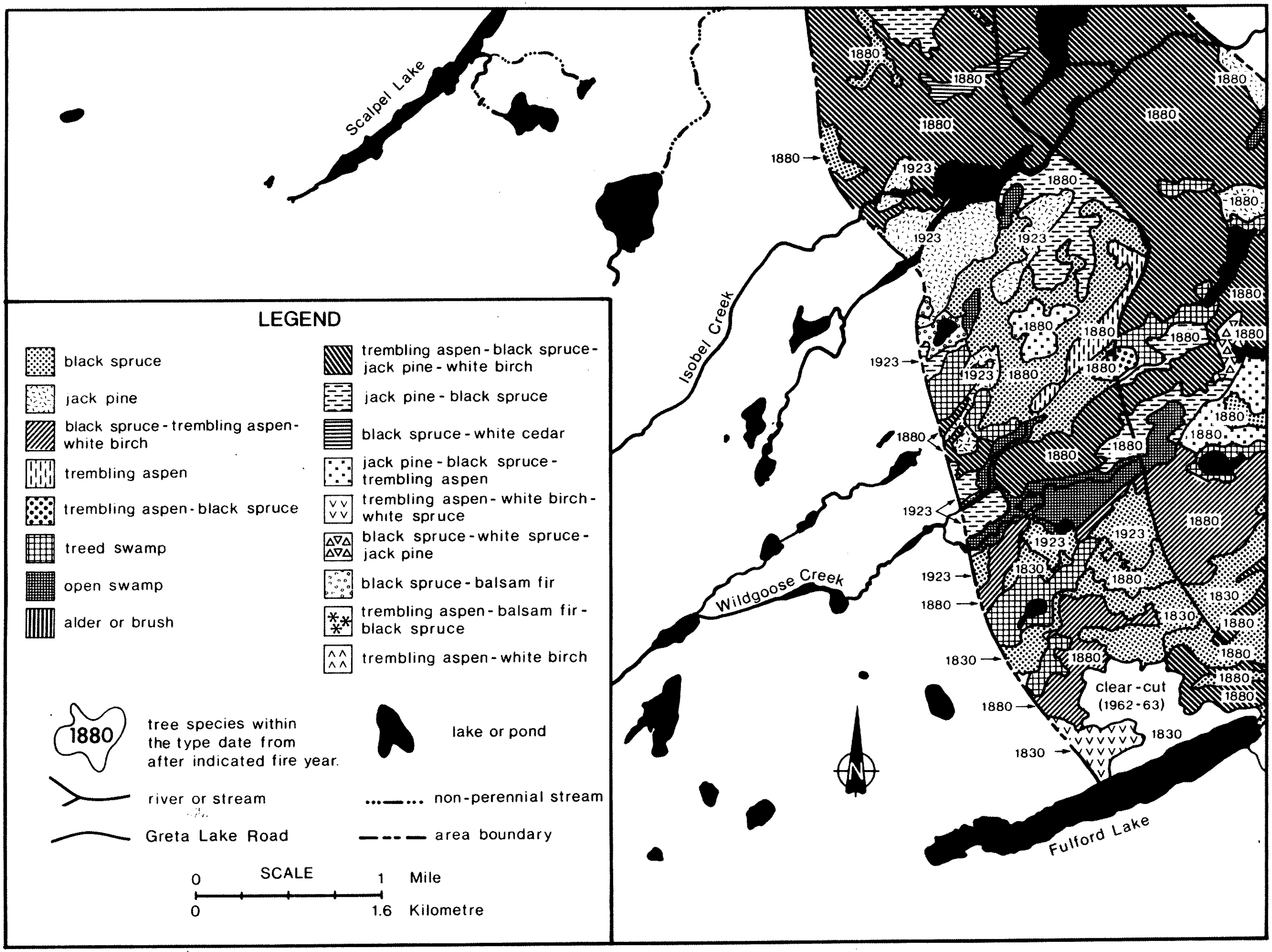


Figure 1. Composite stand fire origin and overstory vegetation map for a 54.4 km^2 area in the Geraldton Site District (5) - Lake Nipigon Site (3W) Region (49°56'N, 87°07'W) of north-central Ontario (adapted from Lynn and Zoltai 1965).

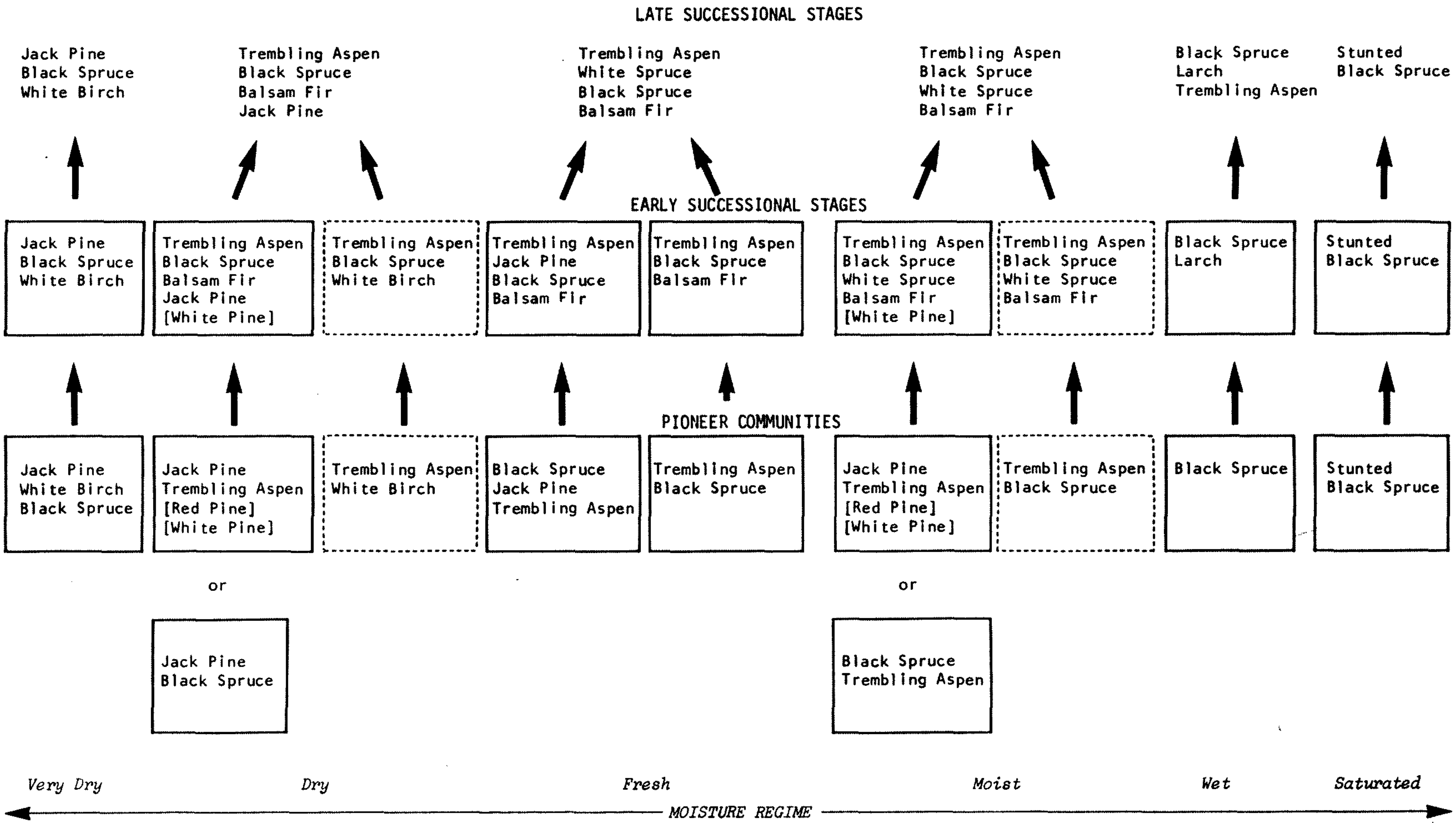


Figure 2. Observed and speculated successional trends in forest cover types by broad site classes associated with a normal ecoclimate in the Wabigoon Lake (4S) Site Region of northwestern Ontario (adapted from Zoltai 1965). Types within solid and dashed blocks indicate, respectively, conifer ("severe" burn) and hardwood ("moderate" burn) dominance following fire. Species within brackets are those which occur occasionally. The proportion of each species in each type can vary considerably. This diagrammatic model of forest succession averages the nutrient regimes in each of the moisture situations.

really one of forest development (Methven et al. 1975, Methven 1978, Janke and Lowther 1980). Contrary to Drexler's (1941) observations, many spruce-fir-aspen-birch stands are really of direct post-fire origin, for what appears to be succession is really just suppression (Heinselman 1973). Hughes (1967) dated a late successional stage mixedwood stand near Manitouwadge that contained remnant individuals dating from their fire origin in ca. 1761. Kendeigh (1947) describes a similar situation for a stand south of Black Sturgeon Lake originating after fire in ca. 1772.

Forests that experience little or no fire, termed "fire-independent" or "non-fire-dependent", are able to perpetuate themselves without periodic renewal by fire because other natural recycling mechanisms are involved. The role of fire as an agent that terminates and renews succession is ensured by setting up the proper conditions for the regeneration of a new stand. Recycling by insects and wind activity (e.g., Ghent 1958, Fye and Thomas 1963, Hughes 1967) in the boreal mixedwood forest seems far from complete because community succession is not set back as far as is the case with fire. What vegetation might develop in the absence of fire? Because of its shade tolerance, balsam fir is the only tree species apparently capable of continual establishment in the boreal mixedwood forest (MacLean 1960, Dix and Swan 1971, Grigal and Ohmann 1975, Carleton and Maycock 1978). Hence, extensive stands dominated by balsam fir in the tree stratum, and ultimately perpetuated by spruce budworm, would be the likely outcome.

DETERMINANT OF WILDLIFE HABITAT PATTERNS AND POPULATIONS

Although the popular image suggests that forest fires leave charred animal bodies littering the landscape, in reality there is very little evidence that fires kill substantial numbers of wildlife. Most animals are capable of avoiding fires by burrowing, running away, flying away, or escaping into water. Except for nests containing young or new-born mammals and birds which are not yet very mobile, wild animals are not particularly vulnerable to fires. In Alaska, for example, Hakala et al. (1971) reported that two large fires covering over 30,000 ha did not cause the animals in the area to panic. A family of swans (*Olor* spp.) and a moose (*Alces alces*) moved and fed in a small lake while the surrounding forest burned to the shore. A small group of woodland caribou (*Rangifer tarandus*) rested, were encircled by the fire, then moved away. Ruffed grouse (*Bonasa umbellus*) were heard drumming in unburned pockets of trembling aspen a week after the 6,000 ha Little Sioux Fire of May 1971 in northeastern Minnesota (Stenlund 1971). The fact that forest fires kill individuals cannot be disputed, but it is questionable whether fires depress whole populations (Cringan 1958, Buech et al. 1977).

The long-term habitat conditions created by recurrent fire are often excellent for wildlife. Some animals react to very specific conditions created by fire while others exploit the general pattern or mosaic of vegetation. For example, the sharp-tailed grouse (*Pedioecetes phasianellus*) of northern Ontario is particularly drawn to open and semi-open areas such as those that have been recently burned over (Hansen et al. 1973, Euler 1977). Birds that nest in tree holes or cavities take advantage of the snag patches produced by fire (Niemi 1978). At the other end of the spectrum are generalists like white-tailed deer (*Odocoileus virginianus*) and moose which use all successional stages and inhabit a wide variety of vegetation types. When the various habitat types are interspersed in close proximity, the value to these animals is enhanced. The fire mosaic, which is predominant throughout the boreal forest, benefits both specialists and generalists. Specialists benefit because through periodic fire the probability is enhanced that the particular set of conditions the species requires will exist. Generalists benefit because the mosaic contains a variety of conditions usually relatively well dispersed throughout the area.

In Ontario, moose are probably the most obvious example of animals exploiting recently burned areas (Cumming 1972). This relationship has been explored in numerous studies and the overwhelming evidence is that burned areas are beneficial to moose populations (Peterson 1953, Cringan 1958, Peek 1972, 1974, Hansen et al. 1973, Krefting 1974, Irwin 1975). As was noted in the editorial of the Winter 1978 issue of the *Ontario Fish and Wildlife Review* "...moose seem particularly drawn to openings created by fire. This may be a result of nutrient cycling caused by burning, but we don't really understand it." A fivefold increase in moose following the 1971 Little Sioux Fire was attributable initially to immigration of yearlings into the area but was subsequently sustained by increased productivity and survival.[1] Preferences for the fire-created mosaic have also been noted in a number of operational surveys in Ontario. A portion of the 1941 Gogama Fire area which, apparently, was excellent moose range was described by Vozeh and Cumming[2] with the aid of a forest resources inventory map. It consisted of 354 ha and supported 1.7 moose/km^2 in winter. Eighty-two percent of the area was composed of a stand that had reproduced following the burn 19 years earlier. It contained a mixture of tree species, 4-9 m tall, with a dense understory of shrubs and tree saplings. The remainder of the study area consisted of five rather long and narrow patches of mature conifers which constituted 18% of the total area. These stands contained patches of dense cover (8%) and were distributed around the edges of the study area. No part of the area was more than 0.5 km from a patch of mature coniferous cover.

The total moose population in Ontario is also a mosaic of population densities which expands and contracts as environmental conditions change. Moose populations have probably always fluctuated as fires

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[1] Peek, J.M., Professor, Coll. For., Wildl. and Range Sci., Univ. Idaho, Moscow. (personal communication, 29 September 1979).

[2] Vozeh, G.E. and Cumming, H.G. 1960. A moose population census and winter browse survey in Gogama District, Ontario. Ont. Min. Nat. Resour., Gogama District. 31 p. (unpublished report)

disturbed various areas and as vegetation changed following those disturbances. Moose and fire have evolved together in the boreal forest and if fire were eliminated entirely, populations would certainly decrease drastically.

A dominant relationship between fire and wildlife in the boreal mixedwood forest is achieved through the particular conditions created when trembling aspen stands are favored by fire. Aspen is certainly the champion of several "phoenix" tree species in the boreal forest and would not exist in the same quantity without fire. The relationship between wildlife and aspen is clear; several wildlife species find aspen stands excellent habitat (Sharp 1971, Gullion and Svoboda 1972, Peek 1972, 1974).

Fire can influence predator-prey relationships since carnivores are dependent on herbivores and therefore on the fire-created vegetative mosaic. The story of the 1936 fire-moose-timber wolf (*Canis lupus*) association on Isle Royale is a classic example (Allen 1974, Krefting 1974). Fox's (1978) analysis suggests that forest fires are at least partially responsible for the cyclic nature of snowshoe hare (*Lepus americanus*) and associated Canada lynx (*Lynx canadensis*) populations.

Some animal species have been viewed as "climax species", adapted to and dependent on late successional stages of vegetation. Woodland caribou and pine marten (*Martes americana*), for example, are usually viewed as animals associated with the mature boreal forest. For them, the hypothesis suggests, fire is detrimental because it destroys their habitat (Devos 1948, 1952, Cringan 1957, 1958). More recent studies, however, illustrate that the relationship is more complex than was once thought. Woodland caribou have been shown to survive very well in early successional areas (Bergerud 1974, Euler et al. 1976, Davis and Franzmann 1979) and pine marten require some form of disturbance to produce the food items they need. Koehler and Hornocker (1977) concluded that fire was an important agent in establishing and maintaining a diversity of forest communities useful to marten.

CONTROLLER OF FOREST INSECTS AND DISEASE

Although there are a number of fire/disease and fire/insect interactions in the boreal mixedwood forest, the association of fire with spruce budworm (*Choristoneura fumiferana* [Clem.]) is paramount. When extensive stands of balsam fir-white spruce reach a susceptible stage, outbreaks of the budworm eventually lead to tree mortality and create fuel concentrations that make large-scale fires possible[3]. Such fires then eliminate the host trees and advanced balsam fir reproduction over sizable areas, thus terminating the outbreak and lessening the chance of

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[3] Alexander, M.E. and Stocks, B.J. 1981. Fire and spruce budworm interactions in eastern North American spruce-fir forests. Dep. Environ., Can. For. Serv., Sault Ste. Marie, Ont. (in preparation)

future outbreaks. This may be a self-perpetuating mechanism ensuring that boreal mixedwood stands do eventually burn. Wood boring beetles which colonize fire-killed stems (Richmond and Lejeune 1945) provide an important food source for woodpeckers, nuthatches and other species which use the insect fauna of dead trees. We have observed that northern three-toed woodpeckers (*Picoides tridactylus*) thrive in recently burned areas.

The fact that black spruce dwarf mistletoe (*Arceuthobium pusillum* Peck) in Ontario is most commonly found in lowland areas is probably a reflection of higher fire intensities and "cleaner" burns on adjacent uplands (Alexander and Hawksworth 1976). The laboratory studies of Parmeter and Uhrenholdt (1976) suggest that forest fire smoke could inhibit germination of rusts and other fungi far beyond a fire's perimeter.

REGULATOR OF DRY-MATTER ACCUMULATION

Consumption of downed woody fuels, tree foliage, shrubs, etc., and reduction in organic mantle depth is an obvious and desirable feature of forest fires. Production of plant biomass generally exceeds decomposition as time elapses following fire in northern forests. The net result is that live and dead forest fuels gradually accumulate (e.g., "duff" depth increases with time since fire). The cyclic nature of fire causes a continual fluctuation between a very low and a persistent maximum biomass (Van Wagner and Methven 1980). An increase in potential fire intensity is not necessarily associated with fuel accumulation because fuel availability does not parallel an increase in forest biomass (Van Wagner 1979b). Flammability peaks early in stand development, falls as the stand matures and rises again as the stand begins to deteriorate.

CONTROLLER OF MAJOR ECOSYSTEM PROCESSES AND CHARACTERISTICS

Fire's role in regulating biotic productivity and maintenance of long-term ecosystem diversity and stability in northern forests has been the focus of much discussion in the ecological literature of late (e.g., Mutch 1970, Dix and Swan 1971, Heinselman 1973, 1978, Wright and Heinselman 1973, Bormann and Likens 1979, Van Wagner and Methven 1981). Productivity is almost always higher in early than in late stages of forest development (Hansen et al. 1973, Rowe and Scotter 1973). Fire can stimulate an increase in net primary production through changes in the physical-chemical environment (Ohmann and Grigal 1979). Dix and Swan (1971) felt that most areas in the boreal forest have "...undergone an infinite number of fire disturbances through time followed by an equivalent number of vegetational readjustments." The forest and its environment are linked in an irregular "pulse" strategy of alternating fire disturbance and regrowth that repeatedly rejuvenates the growing stock.

The fire-created vegetative mosaic provides for a variety of habitats--recent burns, newly regenerating stands, healthy maturity, decadence. This in turn determines plant and animal system diversity on a landscape scale. In the absence of fire we would expect ecosystem-wide progression to species-impoverished stands consisting principally of balsam fir. A significant end result of recurring fires is often expressed in terms of ecosystem stability (i.e., general long-term persistence). The stabilizing function of fire is effected through halting development and/or succession before instability becomes irreversible, i.e., before the community is radically altered (Van Wagner and Methven 1980).

MANAGEMENT IMPLICATIONS

Mutch (1970) advanced the hypothesis that *fire-dependent* plant communities had, through evolution, developed characteristics which made them more flammable. The extraordinarily high energy content (Hough 1969) and firebrand potential of white birch bark might be regarded as such an adaptation in the boreal mixedwood forest. However, we feel that the definition advocated by Kelsall et al. (1977) is more applicable to the boreal mixedwood forest--*it is a fire-dependent system that would lose its character, vigor, and faunal and floral diversity in the absence of fire.*

Certain forest/vegetation management practices can duplicate fire effects and even create habitat suitable for wildlife (Telfer 1974, Dolgaard et al. 1976, Euler 1977). The ecological rationale for broadcast burning of logging slash centres on the premise that natural conditions can be approximated (e.g., Tucker and Jarvis 1967, Robinson 1970, Perala 1974). Lower planting costs and fire hazard reduction are added benefits (Kiil 1971, Vyse and Muraro 1973).

Logging and slash burning may indeed be adequate substitutes for fire but what effect has fire protection had in the uncut portions of the boreal mixedwood forest? On the basis of percent mean annual area burned for 1920-1979, calculated fire cycles vary from 200 to 1,000 years (avg 500 years) in northern Ontario (Alexander 1980). There are, of course, no 500-year-old stands in northern Ontario but the present fire cycle is indicative of the increasing effectiveness of fire suppression. Logging has helped fill the gap between the burned area that would have occurred without fire protection and the area burned with fire protection. However, we may be seeing the consequences of fire exclusion already. For example, is the continuing spruce budworm outbreak being perpetuated by the existence--attributable to fire exclusion--of extensive areas of susceptible balsam fir? Are our parks becoming biologically quite different from the types of areas we planned to perpetuate?

On the other hand, one has to wonder about the economic wisdom of aggressive fire suppression. Forest fires are controlled more by weather than by fire control forces and suppression equipment. Some 75 years ago James Douglas[4] wrote:

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[4] Douglas, J. ca. 1905. The Conservation of Canada's Natural Resources (a lecture given at McGill College). Public Archives of Canada, M.G. 29, File B15, Vol. 54.

"It is a question whether there could be much wisdom in spending large sums of money in a vain effort to preserve tracts of forest, only to meet their fate by fire. These conflagrations seem irresistible and the cost of preparing for a possibility of stopping them may exceed the value of the chance. Small forest fires may sometimes be influenced or partially controlled, but no way has been found to stop great conflagrations and I do not think they can be stopped."

In spite of a marked increase in suppression capability (and even with new technology) it seems that complete fire exclusion is impractical, if not physically and financially impossible, even for those areas under active management, in view of the fire environment (multiple fire starts, fuel complexes, fire climate, terrain) and inaccessibility of much of northern Ontario. Fire control forces can easily handle fires of low or moderate intensity but very likely the frequency of large-scale, high-intensity fires will increase with a continued policy of fire exclusion. Certainly logging companies cannot tolerate random fire in areas scheduled for cutting, but buying more hose or larger planes is not the answer. Obviously an ecologic-economic compromise is in order. Van Wagner (1978a, 1979a) and Martell (1978, 1980) have advocated a number of economic principles as a basis for considering fire in concert with land management in the boreal mixedwood forest. In addition, Euler (1975) has outlined a method by which the economic benefits of prescribed burning for creating favorable moose range can be judged.

Fire is a resource no less than the physical and biological components of the environment: without fire, the ecosystems that today characterize regions such as the boreal mixedwood forest would be something different. Fire should be considered from both an ecological and a protection point of view by those developing land and resource management objectives. Furthermore, once the objectives have been set, fire-related activities should be designed specifically to meet them, and not as an afterthought when all other planning has been completed.

The most commonly cited potential use of prescribed fires in the uncut boreal mixedwood forest has been associated with the renewal of overmature and decadent stands (e.g., Millar 1936, Larsson 1948). Other opportunities or possibilities for using "chance or random" (e.g., lightning) and/or "planned" ignition prescribed fires in standing timber include: wildlife habitat management (Gibson 1971, Steward[5]); hazard reduction and stand conversion in spruce budworm-killed areas (Alexander and Stocks[3]); park management (Woods and Day 1977, Alexander

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[5] Steward, R.W. 1975. A proposal for the evaluation of controlled burns as a moose management tool in the Cochrane District. Ont. Min. Nat. Resour., Cochrane District. 20 p. (unpublished report)

and Dubé 1979); and modified suppression programs on non-commercial timberlands (Harrison[6]).

Fire prevention posters, messages, and literature have an important influence on public attitudes and therefore we should consider carefully the messages they communicate (Stankey 1976). Unless the public is kept informed of the natural role of fire and the beneficial uses of fire, it is liable to continue to insist on total fire suppression.

RESEARCH NEEDS AND OPPORTUNITIES

The science of predicting fire behavior and effects is in its infancy and the many ramifications of continued fire exclusion are not fully understood. Nevertheless, we cannot wait until we have all the facts and figures in hand. We must assemble and synthesize available information and prepare guidelines in support of fire/land management. Research conducted in other parts of the boreal forest (Alaska to Newfoundland) can provide an additional source of information. Managers may be forced to make qualitative predictions. Computer simulation may prove to be the most useful tool for analyzing the effects of current and forecasted levels of fire protection on forest resources (e.g., Van Wagner 1978b).

The following specific research needs are deemed worthy of future study. The applicability of the results and the likelihood of problem solution were the main factors in the selection process.

1. Quantification of fire characteristics vs. possibilities for post-fire development (e.g., depth of burn vs. seedbed and understory flora; fire intensity vs. available seed).

2. Relationship between organic mantle thickness and stand fire history, site type, etc.

3. Resulting vegetative mosaic, given potential fire behavior and physiographic features.

The importance of fire behavior relationships, from the standpoint of fire effects and fire growth predictions, cannot be overemphasized. Some progress is being made in this research area for other northern Ontario fuel complexes (Stocks and Alexander 1980).

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[6] Harrison, R.J. 1979. Fire Management Scheme for the Islands of Lake Nipigon and Black Bay Peninsula. Oral presentation at the Ontario Ministry of Natural Resources State of the Art Fire Management Seminar (Feb. 19-22, Geneva Park, Ont.).

What is the best approach to organizing a program that will address these specific needs? It would be overly optimistic to expect a single research unit to handle the entire program. A committee (perhaps under COJFRC sanction) is needed to serve as a catalyst, promoting research in specific areas, and as a coordinator. Representattives from OMNR, the CFS, universities and industry should be included in the membership. Field staff should begin their own monitoring programs.

Wildfire sites serve as ready-made study areas and present a number of possibilities for investigation. Ahlgren (1974) has, since 1950, established and monitored vegetational development on permanent plots in a number of areas in the Quetico-Superior region. Similar work was initiated in 1976 by the Great Lakes Forest Research Centre in northwestern Ontario (Stocks and Alexander 1980). An excellent example of initiative at the field level is the Chabbie Lake Burn Study Area (49°35'N, 79°46'W) in OMNR's Cochrane District which was established to monitor vegetation development and changes in moose utilization following a 325 ha wildfire in 1975.[7] The project has continued in spite of changes in personnel. Permanent plots established on recent wildfire sites have several advantages over survey efforts (e.g., fire behavior and pre-fire stand structure are more easily reconstructed since the "evidence" is still fresh).

Planned ignition prescribed fires afford many more opportunities for data collection. A prescribed fire on the southern half of Geikie Island (1100 ha) in Lake Nipigon was first proposed in 1977 by OMNR Nipigon District fish and wildlife staff.[8] A moose browse and pellet group survey was undertaken so that the effect of the burn in terms of browse creation and subsequent changes in moose utilization after the fire could be better evaluated.

The mapping of patterns resulting from wildfires (burned vs. unburned) would eventually result in a library of "case studies". This should be common practice for all moderate and large fires (say > 1,000 ha).

The possibility of relocating and redoing previous surveys (e.g., Hosie 1953) is worth investigating. Reconstructing old photographs and establishing permanent photo points may provide a valuable record of forest development following fire for use in public education programs.

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[7] Armstrong, E. 1980. Forest successional changes in the Chabbie Lake Burn Moose Browse Study Area, 1975-1979. Ont. Min. Nat. Resour., Cochrane District. 23 p. (unpublished report)

[8] Beange, D.B., Conserv. Off. Coord., Ont. Min. Nat. Resour., Nipigon District. (Personal communication 22 August 1977)

CONCLUDING REMARKS

Is fire a destructive menace or a natural process? Forest fires pose a difficult problem to land managers--should they try to exclude fire and face unwanted ecological change, or tolerate fire and risk resource damage and public condemnation? Fire in the boreal mixedwood forest is neither good nor bad except in terms of the degree to which it promotes or hinders land management objectives. The fact that we have acquired conditioned attitudes regarding fire complicates matters because managers, planners, policy analysts and the general public may be suggesting solutions to land management problems that disregard the long-term environmental significance of fire. Many managers view fire simply as a silvicultural tool (Sloane 1960). As developed earlier, the post-fire transformation of a site is essential for the survival and rejuvenation of the forest. The long-term effects of fire may sometimes offset the initial inconvenience and direct impact. What appears to be an aesthetic and economic disaster is really a normal and necessary process. Fire management programs will be effective only when the ecological role of fire is appreciated and integrated into land use planning and management.

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