wildland fire management plan
environmental assessment

June 1987

VOYAGEURS NATIONAL PARK / MINNESOTA
WILDLAND FIRE MANAGEMENT PLAN
ENVIRONMENTAL ASSESSMENT

Prepared By:

U. S. Department of the Interior
National Park Service
Voyageurs National Park
Minnesota

June 1987
FINDING OF NO SIGNIFICANT IMPACT
ENVIRONMENTAL ASSESSMENT
WILDLAND FIRE MANAGEMENT PLAN

Voyageurs National Park
Minnesota

The National Park Service has prepared an environmental assessment addressing the impacts of implementing a Wildland Fire Management Plan at Voyageurs National Park, which includes resources listed on the National Register of Historic Places. The proposed action is described as Alternative D of the attached environmental assessment; its implementation depends on approval of a fire management plan. The draft Fire Management Plan is included with the environmental assessment by reference.

Compliance with Section 106 of the National Historic Preservation Act (16 U.S.C. 470, as amended) will be completed for the proposed action prior to plan implementation. It has been determined in consultation with the U.S. Fish and Wildlife Service that the proposed plan will have no adverse effects on any Federally listed or proposed endangered or threatened species or their critical habitat. This satisfies the requirements of the Endangered Species Act, as amended (16 U.S.C. 1531-1543).

The assessment has been reviewed, resulting in the following conclusions.

1. The proposals, individually or cumulatively, do not constitute actions which normally require preparation of an Environmental Impact Statement (40 CFR 1502.3; 516 DM 6, Appendix 7.3). The action is not a categorical exclusion under the contemplation of 40 CFR 1501.4 and 1508.4.

2. The proposal will not have a significant (40 CFR 1508.27b) effect on the human environment. Negative environmental impacts which could occur are minor and temporary in effect. There are no adverse impacts on public health, public safety, rare or endangered species, or other unique characteristics of the region. No highly uncertain or controversial impacts, unique or unknown risks, cumulative effects, or elements of precedence were identified. Implementation of the actions will not violate any Federal, State, or local law.

Based on the foregoing, it has been determined that implementation of the proposal will not constitute a major Federal action which will significantly affect the quality of the human environment and that an environmental impact statement is not required and will not be prepared.

[Signature]
Regional Director, Midwest Region

8/17/83
Date
Summary. The National Park Service proposes to allow lightning-caused fires to burn within designated areas in Voyageurs National Park when they can be contained within park boundaries, except when this would endanger visitor safety, private or leased lands or structures. Prescribed burning would be used to create and maintain a mosaic of burned and unburned areas that will approximate natural conditions in areas where the risk of fire escape beyond park boundaries in the spring, summer and fall is high. All unplanned human-caused fires in the park would continue to be routinely suppressed. Wood fires would be permitted only at developed tent, houseboat and day use sites in metal firegrills in order to minimize the threat of wildfires.

Fire has been no less important than rain, sun and frost in shaping Voyageurs' ecosystem through evolutionary periods of time. All of the park's vegetation and wildlife evolved over millions of years in response to periodic lightning-caused fires. Lightning fires in combination with aboriginal burning during the last 10,000 years shaped the northwoods landscape that was an integral part of the lives of the Chippewa, voyageurs and early European settlers. Effective fire suppression and prevention programs since the 1940's, in conjunction with large scale logging and market and subsistence hunting, have dramatically altered Voyageurs' terrestrial ecosystem from its original pre-European conditions.

The exclusion of fire from Voyageurs' fire-maintained ecosystem is gradually shifting the composition and structure of the park's plant communities away from jack, red and white pine, black spruce, aspen and paper birch dominated communities to white spruce and balsam fir dominated communities. The park's progressively maturing forests have severely limited the availability of critical winter habitat for white-tailed deer and moose. Consequently, the size of the park's deer population has declined dramatically in recent years while the moose population has been unable to recover from low numbers. The extirpation of caribou and elk from the park, the low moose population, and the recent dramatic decline in white-tailed deer numbers have resulted in a 66 percent reduction in the park's pre-1890 overwinter ungulate biomass. This severe reduction in the overwinter food supply has dramatically reduced the size and diversity of the park's predator and scavenger populations.

The effects of our present policy of suppressing all fires immediately, as described above, are incompatible with Voyageurs National Park's purpose: "to conserve the scenery and the natural and historic objects and the wildlife
therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." The National Park Service's Wildland Fire Management Guideline (NPS-18) requires that all parks which contain vegetation that can support fire will develop fire management plans and programs reflecting NPS policies and relating to ecological characteristics specific to the area.

The specialized fire management terms used in this environmental assessment are defined in Appendix B.

Address Comments to:
Superintendent
National Park Service
Voyageurs National Park
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Purpose and Need


Lightning fires in combination with aboriginal burning during the last 10,000 years shaped the northwoods landscape that was an integral part of the lives of the Chippewa, Voyageurs and early European settlers (Poltzger 1953, Craig 1972, Swain 1973, 1981). Loggers came to the northwoods in the 1890's to exploit the forests of pine and spruce that had been created by fire or the lack of it. Effective fire suppression and prevention programs since the 1940's, in conjunction with large scale logging and market and subsistence hunting, have dramatically altered Voyageurs' terrestrial ecosystem from its original pre-European conditions (Kurmis et al. 1980, Coffman et al. 1980, U.S. NPS 1981b, Cole 1982, 1987).

The exclusion of fire from Voyageurs' fire-maintained ecosystem is gradually shifting the composition and structure of the park's plant communities away from jack, red and white pine, black spruce, aspen and paper birch dominated communities to white spruce and balsam fir dominated communities (Kurmis et al. 1980, Coffman et al. 1980, Cole 1982, 1987). Periodic lightning-caused fires created openings in the forest canopy, exposed mineral soil and increased light and nutrient availability that favored the regeneration and growth of pines, black spruce, aspen and birch. High grade and clearcut logging increased the proportion of aspen-birch forest in the park by removing large quantities of red and white pine, spruce and fir. Logging thus removed a significant proportion of the stock of red and white pine seed sources in some areas of the park.

Fuel accumulations, spruce budworm outbreaks, blowdowns, and other disturbances related to time since last fire or logging increase the probability that old stands will burn. Given the frequency of severe drought in the region, it is inevitable that all vegetation in the park will eventually burn due to lightning or human-caused fires. Our present policy of fire suppression, therefore, only increases the interval between successive burns on any given acre. The environmental and economic costs of such a policy are: increased fire intensity due to fuels buildup; increased fire size; reduction in the total area of early successional stages and fire-maintained communities; reduced nutrient cycling; increased risk of fire-caused injury or death and property loss for park visitors, employees and neighbors; and dramatically increased costs for fire suppression during large, project fires that may be as high as $100,000 per day in personnel, equipment and other support costs.
The exclusion of fire from Voyageurs' fire-maintained ecosystem, in conjunction with logging, market and subsistence hunting, and trapping, has dramatically altered the composition, distribution and abundance of the park's wildlife communities (Cole 1982, 1987). Hunting eliminated woodland caribou and elk from the park, and severely reduced the size of the moose population. The park's progressively maturing forests have severely limited the availability of critical winter habitat for white-tailed deer and moose (Cowan et al. 1950, Irwin 1975). Consequently, the size of the park's deer population has declined dramatically in recent years while the moose population has been unable to recover from low numbers.

Periodic lightning-caused fires created openings in the forest canopy, exposed mineral soil and increased light and nutrient availability that favored the establishment of grasses, forbs, shrubs and trees that are key forage and browse species for moose, deer, woodland caribou and elk (Cringan 1957, Tefler 1970, Hansen et al. 1973, Krefting 1974, Irwin 1975, Wetzel et al. 1975, Peek et al. 1976, Seal et al. 1978, Boonstra and Sinclair 1984, Darby and Pruitt 1984, Potter 1985). Fifteen to 20 years after a fire, canopy closure and the growth of trees and shrubs beyond the reach of deer, caribou, elk and moose reduce the capacity of these burned areas to support these species. Although the moose brainworm, Parelaphostrongylus tenuis, is regarded as a major factor limiting moose population increases if a deer population is also present (Karns 1967), the moose population on the Little Sioux Burn was able to increase five-fold in the presence of a significant population of white-tailed deer (Peek 1974, Irwin 1975, Cole 1981). Also, densities of about 3 moose and 20 deer per square mile coexist in the Agassiz National Wildlife Refuge which is about 130 miles west of the park.

The elimination of caribou and elk, the low moose population, and the recent dramatic decline in white-tailed deer numbers have resulted in a 66 percent reduction in the park's pre-1890 overwinter ungulate biomass (Cole 1982, 1987). This severe reduction in the overwinter food supply has dramatically reduced the size of the park's predator and scavenger populations. Predators and scavengers that were once abundant are now absent (wolverine), exist in remnant numbers (Canada lynx, bobcat,), or are less abundant than previously (threatened gray wolf and bald eagle, coyote, red fox, pine marten, raven) (Mech 1973, Van Ballenberghe et al. 1975, Peterson 1976, Mech 1977, Hardwig 1978, Mech and Karns 1978). To date, wolves have been less adversely affected than smaller carnivores that mainly scavenge on ungulate carrion, but they have slowly declined from 41 individuals in 1976 to 25 in 1986 (Cole 1982, and unpublished data). Bald eagles that nest in the park area have low reproductive success in comparison to other Lake States areas where they may be less dependent on ungulate carrion in the late winter and early spring (Grim, unpublished data).

Although adequate habitat for woodland caribou exists in the park (Wetmore, 1980), its reintroduction to the park (U.S. NPS 1977) would only increase Voyageurs' overwinter ungulate biomass by an estimated 19,200 pounds to 42,800 pounds, which is still only 62 percent of the park's pre-1890 level of 69,120 pounds (Cole 1982, 1987). Since they utilize early successional stage plant communities extensively, programs to reintroduce elk and restore moose and deer populations would benefit enormously if the present policy of suppressing all fires is replaced by one that restores fire as a natural ecological
process in the park. Likewise, recovery of the park's depauperate predator and scavenger populations to pre-1890 levels will only occur if reintroductions of caribou and elk are accompanied by a fire management program that creates needed habitat for moose, deer, caribou, elk, moles, deer mice, voles, chipmunks, squirrels, and snowshoe hares.

The effects of our present policy of suppressing all fires immediately, as described above, are incompatible with Voyageurs National Park's purpose: "to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

These effects are also incompatible with National Park Service Management Policies (U.S. NPS 1978) which state that "the occurrence of natural fire within a given ecosystem is recognized as a potent factor stimulating, retarding, or eliminating components of the ecosystem. Most natural fires are lightning-caused and are recognized as natural phenomena which must be permitted to continue to influence the ecosystem if truly natural systems are to be perpetuated."

The National Park Service's Wildland Fire Management Guideline (NPS-18) requires that all parks which contain vegetation that can support fire will develop fire management plans and programs reflecting NPS policies and relating to ecological characteristics specific to the area.

The specialized fire management terms used in this environmental assessment are defined in Appendix B.
Voyageurs' natural and cultural environments and resources are fully described in the Final Environmental Statement for the Master Plan (U.S. NPS 1979) and the introductions to the park's Cultural Resources Management Plan (U.S. NPS 1987a) and Natural Resources Management Plan (U.S. NPS 1987b). For the sake of brevity this descriptive material will not be repeated here. Only resource and use considerations which uniquely affect the implementation of a wildland fire management plan will be highlighted in this section.

Voyageurs National Park is located in the forested lake country along Minnesota's northeastern border with Ontario, Canada. The park is contiguous with the 1.2 million acre Boundary Waters Canoe Area Wilderness and the 1.1 million acre Quetico Provincial Park. Encompassing a relatively undisturbed, pristine ecosystem of 2.7 million acres, these three units make up a substantial part of the proposed Boundary Waters Biosphere Reserve, which would also include Isle Royale National Park in Lake Superior. Although all these units have or are developing wildland fire management programs similar to Voyageurs' (Harjula 1984, Joens et al. 1987), all lightning and unplanned human-caused fires burning on other public and private lands adjacent to the park are routinely suppressed. Prescribed burning in the park's vicinity is used for fuel reduction within clearcuts, site preparation for natural or artificial regeneration, wildlife habitat improvement, maintenance of berry patches, agriculture, and highway and railroad right-of-way maintenance.

This stretch of lake country typifies the Canadian shield region: a land surface shaped by glaciation into an endless system of internal waterways, with a sense of vastness, reinforced by a continuous forest mantle. This area is closer to the true arctic than any other part of the United States, except Alaska. Lake Superior "holds back" the arctic influence, and arctic-induced coolness provides a tension zone between the boreal forest and the northern hardwood forest. The forest mantle consists of dense stands of spruce, fir, pine, cedar, aspen, birch, oak, and ash, which is broken only by numerous beaver ponds, bogs, sand beaches, and rocky cliffs. Although total vertical relief in the park is only 300 feet (1108 to 1408), a complex mosaic of seral, subclimax and climax plant communities exists. Plant community composition is controlled by sharp gradients in nutrient availability, moisture regime, and time since last disturbance (Kurmis et al. 1978, 1979, 1980). This complexity contributes to significant differences in fire behavior and effects with only small changes in horizontal and vertical distance.

Voyageurs National Park encompasses some 219,128 acres, of which about 85,506 are water. The park is dominated by four major lakes: Rainy, Kabetogama, Namakan, and Sand Point. These lakes and their associated islands, small bays, secluded coves, and rocky shorelines provide outstanding opportunities for motorboating, canoeing, sailing, fishing, sight-seeing, picnicking, hiking, camping, photography, and nature study. These lakes are major barriers to the spread of lightning and human-caused fires beyond park boundaries except along the south park boundary and in the vicinity of narrows (American Channel, Squirrel Narrows, Namakan Narrows, Harrison Narrows, and
King Williams Narrows). Lack of adequate fuelbreaks and lake barriers on lands to the south of Kabetogama and Namakan Lakes will make containment of prescribed fires and wildfires in that area of the park more difficult than on the Kabetogama Peninsula.

Given the tendency for most fires in the border lakes region to move eastward, northeastward, or southeastward (but not westward) because of the prevailing westward winds during fire weather, opportunities for fires to leave the park will be few. Fires in this region will not burn significant areas under most weather and fuel conditions. Yet to achieve significant burns we must work close to that difficult to identify margin for error where a small increase in burning conditions could trigger rapid fire advances and loss of control. There may always to some risk in our region of having fires behave differently than expected because of fuels, fire weather and terrain interactions. But again, fortunately, the geography of Voyageurs is such that fire excursions beyond park boundaries are unlikely and can be prevented by appropriate suppression actions under nearly all circumstances.

All private and retained use and occupancy cabins, and major developed areas within the park are located on the shores of the park's major lakes. The easy availability of large quantities of lake water should ensure that all these cabins and their occupants, and major developed areas and their visitors and employees can be fully protected during prescribed natural fires, prescribed burns, and the suppression of lightning and unplanned human-caused fires. Since 98 percent of the park's recreational use occurs on these lakes or their shorelines, it should also be relatively easy to protect the public from the hazards of fast moving crown fires.

The park's main landmass is the heavily forested Kabetogama Peninsula. Some 75,000 acres in extent, it is predominantly undeveloped and accessible only by water or air. Rainy, Kabetogama and Namakan Lakes are major barriers to the spread of lightning and human-caused fires beyond the Kabetogama Peninsula except at Gold Portage and in the vicinity of narrows (American Channel and Squirrel Narrows). The interior of the peninsula has a number of lakes. The peninsula offers outstanding opportunities for backpacking, hiking, canoeing, fishing, nature study, and photography. What little recreational use that does occur in the interior of the peninsula is concentrated on two short trail systems, the Cruiser Lake and Locator Lake Trails. Since access and use of the interior of the peninsula is so concentrated, it should be relatively easy to protect the public from the hazards of fast moving crown fires.

Although few visitor facilities are currently available within the park, development of visitor centers and contact stations, boat launching ramps, marinas, docks, tour and shuttleboat systems, trails and campsites, concession facilities, and improved road access was approved in Voyageurs' Master Plan (U.S. NPS 1980). Implementation of these development programs has begun and will continue in the future.
FIRE AND ECOSYSTEM INTERACTIONS

This section of the environmental assessment describes how the physical and biological characteristics of Voyageurs National Park's ecosystem have been affected by fire, the absence of fire, and fire suppression actions. Fire's historic role, the current potential for fire, and the probable effects of present and future fires on Voyageurs' ecosystem are described.

Fire History

In order to perpetuate ecological processes and preserve natural conditions within Voyageurs, the historic role of fire in establishing and perpetuating the park ecosystem must be understood. Evidence for the historic role that fire has played resides in lakebed sediments, fire-scarred trees, stand origin dates, oral histories of aboriginal peoples, historical sources, General Land Office Survey notes, and fire reports.

Postglacial Period. The pollen records from Voyageurs National Park and the surrounding region show that jack, red and white pine, black and white spruce, balsam fir, white birch, and bigtooth and quaking aspen have dominated the upland forest vegetation in the park during the past 1200 years (Potzger 1953, Wright 1968, Craig 1972, Swain 1973, 1981, Coffman et al. 1980). Probably few areas ever attained the postulated fir-spruce-cedar-birch climax in postglacial times. Pollen analysis shows no change or only short-term changes in the relative percentages of major forest species over the past 1200 years. Due to a cooler climate between 550 and 100 years ago (Little Ice Age), spruce and fir have been increasing while the pines have decreased (Potzger 1953, Craig 1972).

The record of charcoal in lake sediments indicates that fire was an important ecological factor in the forest history of northeastern Minnesota and northwestern Ontario before Europeans arrived, and even before aboriginals migrated to North America (Craig 1972, Swain 1973, 1980, 1981, Alexander 1980). A detailed record of the past 1200 years shows that the average interval between fires in the region is approximately 60-70 years, with a range of about 10 to 100 years. This estimate of fire frequency from charcoal analysis is probably very conservative.

Settlement Period. The record of fire-scarred trees, stand origin dates, historical sources and General Land Office Survey notes has yielded a more detailed description of fire history in the region during the last 400 years than is available through the record of charcoal in lake sediments alone. The nearly universal occurrence of charcoal at the base of the litter and humus layers confirms the widespread extent of past fires. Most areas clearly burned several times in the period of record, but it is often possible to document only the last one to three fires (Heinselman 1973).

On an areawide basis, these records show that significant fires occurred in Voyageurs, BWCA, or Quetico at an average interval of 4.3 years, with a range
of about 1 to 8 years between fires (Heinselman 1973, Woods and Day 1977a, Coffman et al. 1980). Major fire years in the BWCA, marked by fires burning more than 100 square miles occurred at an average interval of 26 years, with a range of about 11 to 42 years between major fires (Heinselman 1973). Most of the total area burned by fires occurred during these major fire years. Eighty-three percent of the area burned prior to 1911 in the BWCA resulted from just nine fire periods: 1894, 1875, 1863-4, 1824, 1801, 1755-9, 1727, 1692, and 1681. About 82 percent of the virgin forest burned every 100 years.

Aboriginal Americans have inhabited the park and surrounding region for at least the last 5000 years. The hunting-gathering adaptations of native Americans involve extensive and detailed understandings of natural phenomena (Lewis 1985). Fire use was a significant and integral part of human-environmental relationships for hunting-gathering peoples. Native peoples are cognizant of a wide range of fire effects, both desirable and undesirable; for people to ignore or be indifferent to fire is considered by them to be foolish in the extreme (Lewis 1985). Hunter-gatherer fire regimes are distinguishable from purely natural ones by the seasonality of burning, the frequency with which fires are set, the intensity of fires, and the selection of preferred sites.

The boreal forest supported relatively small populations of Indian hunters and gathers because resources were widely distributed and few in number. Among Indians in northern Alberta, except for a few fires set in late autumn, all burning took place in the first 2 weeks of spring; the period of summer lightning fires, late July through August, was a most dangerous time for burning (Lewis 1977). Within the boreal forest region, burning entailed the maintenance of grassland habitats, such as small prairies, meadows and sloughs, that make up some 2 to 5 percent of the region. Except for firing windfalls of dead and downed trees, efforts were made to exclude fires from forest stands, this being largely accomplished by burning grasslands while surrounding forests remained too wet to burn. With the exception of some isolated stands of white spruce and pine, the combination of human-ignited and lightning fires enabled the boreal forest region to burn at least once every 100 years (Lewis 1985).

**Fire Control Period.** Following logging in the early part of this century, fire suppression has been practiced effectively in most of the region. Only four fire periods, 1917-18, 1923, 1936, and 1980 have seen large fires within the park this century and these are typically associated with extreme drought periods (Coffman et al. 1980). With the exception of these four periods, there has not been any other significant fire activity recorded. In a study of MDNR fire records at the Orr District Office, it was found that of 201 fires recorded between 1933 and 1954 within what is now the park boundary, there were 33 lightning-caused fires (16 percent) and 168 human-caused fires (84 percent). None of the 201 fires, except those already indicated as "major", burned over 70 acres. Most fires were extinguished before reaching even 5 acres.

Native Americans in northern Alberta maintain that the mix of habitat types in the boreal forest has changed in the past 50 years (Lewis 1985). Today, previously more diverse environments are dominated by brush and trees and are less productive of preferred resources. Summer lightning fires are accepted
by them as a natural condition of life but, they add, the scale of these disruptions was formerly reduced by their continued and regular use of low-intensity spring fires.

Fire Potential

Fire potential is an ecosystem's capability for fire. The traditional concepts of fire risk, fire hazard, and fire danger are incorporated within the concept of fire potential. The important determinants of fire potential are probable fire occurrence, the fire environment, and probable fire behavior. Fire environment refers to the conditions, influences, and modifying forces that control fire behavior. The fire environment is composed of three interacting influences: fuels, weather, and topography.

Fire Occurrence. Fires within the park are ignited by either lightning or humans. Almost all of the park's human-caused fires occur during the peak visitor use season (mid-May through early September) and result from abandoned cooking and/or warming fires that escape into the trees. Thunderstorms occur about 25 days per year over northeastern Minnesota, chiefly between April and October. They are usually more frequent in midsummer than in spring or fall, although yearly patterns vary greatly. Duff layers and dry snags are often ignited by lightning strikes, but most such fires are extinguished by rains that accompany the storm, and consequently are never detected by fire control personnel. Occasional storms with little or no precipitation that coincide with drought conditions do ignite fires that grow to significant size. All such fires are quickly extinguished by fire control crews.

Review of fire records since establishment of Voyageurs National Park, reveals that since 1974 a total of 80 fires burned 406.3 acres within park boundaries; 69 percent were human-caused while 31 percent were caused by lightning (Table 1). Twenty-five fires were lightning-caused and burned 355.9 acres. One lightning-caused fire in 1980 is responsible for 81 percent of the total acreage burned by all fires during this 13 year period. The remaining 55 fires were human-caused and burned 50.4 acres. Lightning-caused fire occurrences ranged from 0 to 7 in a year, averaging 1.9 fires per year. Human-caused fire occurrences ranged from 0 to 14 in a year, averaging 4.2 fires per year. The maximum number of fires and acreage burned occurred in 1980 when 21 fires burned 349 acres. The year with the least fire activity was 1985 when 1 fire burned less than 0.1 acre.

Fire Environment. Because the park's gently rolling to moderately rugged topography is broken by many lakes, cliffs, rock outcrops, and interspersed bogs and peatlands, the primary mechanism for large fire development is long distance spotting (Roussopoulos 1978). Large fires normally "hop" from ridge-top to ridge-top, sometimes coalescing in the low areas, but often leaving the interjacent lowlands entirely unburned. Lakes are often insufficient barriers to fires of this nature. Spotting distances of one to several miles across water bodies have been observed. Furthermore, the abundance of forested islands on many lakes offers a pathway for consecutive spotting across yet larger waterbodies.

The lack of topographic relief within the park eliminates many of the fire behavior characteristics associated with orographic lifting of air masses,
TABLE 1. Number and causes of wildland fires, and acreages burned in Voyageurs National Park, 1974-1986.

<table>
<thead>
<tr>
<th>YEAR</th>
<th>Human-caused</th>
<th>Lightning-caused</th>
<th>Total Fires</th>
<th>Human-caused</th>
<th>Lightning-caused</th>
<th>Total Acres</th>
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</tbody>
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upslope and downslope winds, head fires on steep slopes, and elevational zonation of vegetative communities. Wind direction in the region is determined more by synoptic weather than by topographic features, so definite seasonal wind patterns do occur that have a pronounced effect on fire behavior in the park (Sando 1969). The number of days since significant rainfall also has a pronounced effect on fire behavior. Periods of long duration without rain seldom occur in this region but lesser periods of dry weather occur frequently (Sando 1969). Slope aspect affects local microclimates and associated plant communities. South and southwest aspects are snow-free earlier and dry out sooner in the spring and after rainfall than north and northeast aspects. Small local differences in elevation are responsible for significant differences in soil moisture and nutrient levels that are reflected in plant community composition.

Plant communities types, stand age classes, and successional stages, time since last disturbance, and lack of topographic relief in Voyageurs combine to create a vegetation/fuel mosaic that is extremely heterogeneous. Time elapsed since last major disturbance and the type of vegetation present at the time of that disturbance are more important in determining the composition and structure of the park's upland plant communities than differences in local environmental parameters (Ohmann and Ream 1971, Ohmann et al. 1973). Fuel accumulations, spruce budworm outbreaks, blowdowns, and other disturbances related to time since last fire or logging increase the probability that old stands will burn.

Many factors linked to stand maturation and senescence increase the probability that older stands will burn (Heinselman 1973). Total above-ground biomass in living plants increases with stand age, up to some maximum for each first generation postfire forest type. Following crown fires, the fuelbed arrangement is not conducive to fire spread until 100 to 300 years after fire when first generation trees begin to deteriorate and die. Within 50 to 100 years after fire an understory of fir, spruce, or cedar commonly develops beneath the pioneer forest, introducing ladder fuels capable of carrying fire into the crowns of the overstory. These understory species have very flammable foliage. Within 100 to 150 years after fire, balsam fir may increase enough to sustain a spruce-budworm outbreak; once fir mortality from defoliation commences, dead fir adds to fuels.

As the pioneer forest ages, the first generation overstory trees become increasingly susceptible to wind breakage and uprooting; individual trees are felled or, rarely, most of the stand is blown down and adds to fuels. Many pioneer stands contain paper birch which develops loose scrolls and strips of highly flammable bark 50 to 150 years after establishment; wind blown birch bark causes spot fires. Tree diseases, such as heart-rotting fungi and black spruce dwarf-mistletoe, increase with stand age, eventually causing direct mortality and increased susceptibility of living trees to fire. There is a gradual accumulation of litter, duff, and humus on the forest floor as postfire forests mature. All of these factors and others tend to increase available fuels and flammability of forest stands with advancing age.

As first generation stands reach maturity and senescence, the probability of ignition and of a high intensity fire generally increases. Given the frequency of drought in the region, it is inevitable that all vegetation in
the park will eventually be burned by lightning or human-caused fires. Lightning alone is an adequate source of ignitions to guarantee that all flammable stands will eventually burn (Heinselman 1973). If fire managers burned a stand in the spring, summer, or fall they would be simply substituting a prescribed burn for a lightning fire that would eventually occur in any case (Heinselman 1973).

Fire Behavior. Fire history records for Voyageurs, BWCA and Quetico indicate that without fire control measures, large acreages of virgin forest were burned at rather long intervals when weather and fuels combined to yield optimum burning conditions (Heinselman 1973). Many fires also burn in years not marked by a prolonged regional drought. Numerous short-term spring, summer, or fall droughts occur locally on a regular basis in the park and vicinity. Today, lightning fires continue to occur during regional or local droughts on days with high winds. Some of these rather brief droughts set the stage for fairly large burns. In this non-mountainous terrain, intense ground fires and crown fires can run many miles and jump large water bodies by spotting. Once such fires become large, control is difficult, and wind shifts can threaten lives and/or property in the park and vicinity.

Following a period of dry weather, spring and fall fires burn readily and spread quickly (Heinselman 1973). This is because the low vegetation is cured and the fallen needles of conifers and dried leaves of deciduous trees and shrubs add to surface fuels. The succulent green vegetation of summer is also absent, eliminating a critical energy absorbing heat sink. Under these conditions, fires can be spectacular. Crowning in conifers and total kill of the overstory over large areas are possible if fuels are dry (10-hr time lag moisture below 9 percent), humidity is below 30 percent and wind speeds exceed 15-20 miles per hour (Haines and Sando 1969, Roussopoulos 1978). The Little Sioux fire in 1971 was the most recent such fire and approached within about 16 miles southeast of the park near Crane Lake (Sando and Haines 1972). In mid-May, the Little Sioux fire burned 14,628 acres during a three day period. Spotting occurred up to 3/4 mile ahead of the flame front.

In spring, wet, frozen soils and organic layers as well as moisture in heavy fuels usually prevent thorough consumption of organic layers, snags, and fallen trees. Spring burning conditions may occur between mid-April and early June. Fall burning conditions can develop early in September or even in late August in exceptionally dry years. Fall fires have the potential both to move rapidly and to consume heavy fuels and organic layers. Light surface fires, causing little injury to fire resistant red and white pines, are also possible under spring or fall conditions if it is not too dry and the wind not excessive (Buckman 1964).

Summer fires in most vegetation types require a longer period of dry weather, and more severe fire weather than spring or fall fires to achieve similar intensities and rates of spread (Heinselman 1973). But in prolonged drought, evaporation dries out the litter and humus layers, and these become part of the fuel. Snags, fallen trees, and other heavy fuels also dry out and may be consumed. Summer fires are smoldering and slow-moving as these heavy fuels and organic layers burn with the retardent effect of green undervegetation. Without control, such fires could burn large areas during prolonged droughts. Some summer fires will burn into the fall when more rapid fire spread is likely.
Such a fire began about a half mile west of the end of Mica Bay on July 1, 1936, and eventually burned a total of 18,000 acres of timber on the Kabetogama Peninsula. The summer was unusually hot and dry. In July, temperatures reached over 100 degrees Fahrenheit daily for a week. Civilian Conservation Corps crews tried unsuccessfully all summer to control the fires that had originated from the single ignition on July 1. The fire was not completely extinguished until September 28 when about four inches of rain fell and put the fires out. Altogether, about 200 men fought the fires. Changes in wind direction and spotting frustrated control efforts. The fire consumed all vegetation and soil down to bedrock in some places. Jack pine and aspen quickly recolonized the burned area (Coffman et al. 1980).

Some nearly pure conifer stands with only lichen, moss, and heath-shrub undervegetation, such as black spruce-feathermoss, jack pine-black spruce, or red pine types, may burn much the same in spring, summer, or fall because there is little seasonal change in fuel moisture.

The ecological effects of these various types of burns seem to depend on two results of the fire: the extent of crowning and direct overstory kill, and the depth of humus layer consumption, which affects the survival and regeneration of many trees, shrubs, and herbs and determines seedbed characteristics (Heinselman 1973).

Fire Effects on Vegetation

Voyageurs National Park and the surrounding region have a natural fire rotation or fire cycle of about 100 years (Heinselman 1973). This was the average time required for fire to burn the total park area prior to the era of fire suppression. While some portions of the park may have experienced a shorter average fire return interval (13 to 38 years), other areas were missed by fire for fairly long periods (400 to 500 years).

The effects of fire on Voyageurs' fire dependent ecosystem are determined by the average fire return interval for a particular plant community. For convenience, the park's vegetation has been subdivided into seven community type fire groups (Ohmann and Ream 1971, Coffman et al. 1980, Kurmis et al. 1980). Each fire group contains forest stands with ground flora, shrub and tree strata similarities, a similar response of tree species to fire, and a similar postfire succession. The fire groups, summarized below, range from exposed bedrock and very dry, thin soil, pine types to very wet, swamp sites with deep, organic soils.

Upland Shrub-Lichen Fire Group. Plant communities in this fire group grow on very dry sites with poor nutrient availability. This fire group is a distinctive mosaic of exposed rock outcrops and intervening patches of shrubs, such as dwarf juniper, Juneberry, bush honeysuckle, mountain maple, willow and blueberry. Bare rock outcrops and rock surfaces painted with crustose lichens and fruticose reindeer mosses cover most of the ground, and higher plants grow only in crevasses and depressions where a very thin layer of sandy soil has managed to accumulate. About 50 years are required for lichen regrowth after fire. The average fire return interval for this fire group is determined primarily by the return interval of the dominant vegetation with which it forms a mosaic.
The upland shrub-lichen fire group is vulnerable to fire because it is exposed and dry. After a fire burns off the vegetation on a rock outcrop, what little soil that remains may be eroded by rain and wind, and the site must once again be colonized by pioneer species. Such a cycle maintains this fire group indefinitely on these sites, as long as fire exerts its influence. However, if soil loss does not accompany fire, a fire-climax community of scrub oak or jack pine may develop.

**Scrub Oak and Jack Pine Fire Group.** Plant communities in this fire group grow on very dry to dry sites with poor to medium nutrient availability. Scrub oak communities are dominated by an overstory of stunted red oak and red maple, with quaking aspen and paper birch present in some stands. Once established, scrub oak communities should be able to perpetuate themselves in the absence of disturbance because red oak and red maple germinate best in soil covered by a thin layer of leaf litter. Fire can remove red maple from such communities but red oak readily resprouts from the base after fire and, once established, will probably persist indefinitely.

Jack pine communities are nearly always found in pure, even-aged stands or occasionally as a codominant with black spruce in stands that regenerated after fire. Although some jack pine stands may persist for as long as 250 years without fire, the average fire return interval for most stands is 50 to 100 years. Besides triggering seed release, fire eliminates shady conditions which jack pine seedlings are intolerant of, burns off litter and humus, and exposes mineral soil which forms an ideal seed bed for conifer seedlings. Jack pine stands in the park originated after major fires in 1864, 1894, 1910 and 1936. In the absence of disturbance, these jack pine communities will be replaced by more shade tolerant tree species, such as black spruce, white spruce, balsam fir and paper birch. Regular, natural disturbance prevents stands from ever becoming fir-spruce-birch and black spruce-feather moss communities.

**Red and White Pine Fire Group.** Plant communities in this fire group grow on dry to medium moisture sites with poor to medium nutrient availability. Some red and white pine stands often survive intact 200 to 300 years, with a possible maximum for single trees or small groups of 400 to 500 years. Surface fires that scarred trees occurred with an average fire return interval of 23 years (range 13 to 38 years) (Frissel 1973).

Communities in this fire group have been most affected by past fires and logging in the park. Fire climax pine types during the pre-settlement period occupied about 46 percent of the park's total forest area, while today they occupy only about 15 percent of the total area (Coffman et al. 1980). Red and white pine communities are not regenerating in the park due to their exacting silvical requirements (Ahlgren 1959, 1960, 1976, Coffman et al. 1980, Kurmis et al. 1980). Although these communities are of fire origin, reintroduction of fire alone into the park ecosystem may not be able to restore the extensive and stately stands of red and white pine, which were a major portion of the northwoods virgin forest in pre-settlement times.

Red pine communities in the park are characterized by a structured, two-layer canopy of mature pines (150 to 250 years old) and younger trees of various species, such as balsam fir, red maple and paper birch. Without future
periodic surface fires, as these stands break down 200 years hence, they will be replaced by trees that can germinate on the duff-covered soil and moss, and under the shady conditions that exclude red pine reproduction. Balsam fir, white spruce, and red maple, and possibly some white pine will increase in importance as the red pine canopy breaks down. Even with the presence of periodic fires, red pine communities may continue to deteriorate because: normal seed production begins at about 20 to 25 years of age; the probability of good seed years coinciding with desirable postfire seedbeds is low; trees more than 100 to 200 feet apart experience poor seed production and dispersal; they are shade intolerant and must compete with herbs and shrubs; and extensive areas that served as seed reservoirs in the past have been markedly reduced by logging (Ahlgren 1976).

Like red pine communities, white pine communities are uncommon today, remaining primarily along lakeshores and on islands, where regulations limited timber harvesting, and elsewhere in scattered stands that would have been too young for logging in the early 1900's. White pine germinates more successfully than red pine on very thin litter and is more tolerant of shade, especially in the first few years of development. However, white pine is rarely able to move into existing forest stands, and this slow-growing tree, like red pine, depends on fire to eliminate faster-growing trees competing for light. White pine is further limited by browsing by white-tailed deer and white pine blister rust. Without fire, new stands of white pine are not becoming established in the park and a form of fir-spruce-birch community will eventually succeed white pine in many areas.

**Aspen-Birch Fire Group.** This is the major fire group in the park. Plant communities in this fire group grow on all but the driest and wettest sites with medium to high nutrient availability. While this fire group occupied only about 20 percent of the park's pre-settlement forest area, today it comprises about 57 percent of the total forest area (Coffman et al. 1980). Past wildfires and logging of pine, spruce and fir created ideal conditions for the establishment of quaking and bigtooth aspens and paper birch by either seeds or suckers following disturbance. After years of timber harvesting, an extensive network of aspen rhizomes has developed in northern Minnesota (Ahlgren 1976), increasing the likelihood that aspen would regenerate disturbed sites. Many of the aspen-birch stands will be deteriorating within the next 20 to 30 years. The average fire return interval for this fire group is between 50 and 100 years. Eventually, in the absence of fire or other major disturbance, these sites will be dominated by a fir-spruce-birch climax. With fire, aspen, birch and pine will be important associates in this fire group.

**Fir-Spruce-Birch Fire Group.** The balsam fir-spruce-birch community is often considered the climatic climax community in northern Minnesota. It is able to perpetuate itself over many generations in the absence of disturbance because of its shade tolerance. This community also succeeds many kinds of forest in the park on moist, nutrient medium sites when fire, logging and other disturbances are excluded. This community typically has a dense canopy of balsam fir that includes scattered but ever-present white spruce, paper birch and quaking aspen. Undergrowth may be completely shaded out, leaving only a carpet of balsam fir needles on the ground. More open portions of such stands support balsam fir and white spruce seedlings, and occasional patches of herbs
and shrubs, such as mountain maple and beaked hazel. In stands from which fire has been excluded, wind and spruce budworm create openings where fast-growing aspen and birch regenerate and potentially take over entire stands when large areas are disturbed.

White and black spruce, balsam fir, and northern white-cedar are common understory elements beneath the pines, aspen, or birch (Heinselman 1973). In many cases, however, many individuals of these four species are really not much younger than the pioneer overstory species they associate with. These species usually perish in the same fires that destroy the overstory pioneers, in these cases at least, they are caught up in the same fire rotations.

**Swamp Hardwoods Fire Group.** The uplands hardwood, ash-elm, and black ash communities grow on moist to wet, nutrient rich sites. The uplands hardwood community is rare in the park and is dominated by American basswood and ironwood. The ash-elm community is not common in the park and is dominated by black and green ash and American elm. Black ash communities are found in swales and creek floodplains where the water table is high and soils are organic and poorly drained. Seasonal standing water is normal, but water movements prevent stagnation and ensures a continuous input of nutrients. Black ash forms a pure, uneven-aged canopy with a few scattered white cedar, American elm and tamarack trees in the canopy.

In the absence of disturbance, members of this fire group are climax communities on moist to wet, rich sites. One generation of long-lived black ash may stand for 300 years. Disturbances such as fire, windstorm, drought, or water-logging caused by beaver activity, frequently trigger temporary conversion of a such communities to aspen-birch forest.

**Swamp Conifers and Bogs Fire Group.** This fire group contains the park's white-cedar, black spruce, leatherleaf bog, shrub carr, and marsh communities. The white-cedar community is rare in the park. This community is most often found on flat floodplains and in depressions where conditions are wet and intermediate in nutrients. White-cedar forms almost pure stands with an occasional black ash or balsam poplar in the canopy. The dense shade cast by this overstory reduces undergrowth density and diversity. White-cedar is very fire-sensitive and has almost literally been driven to the lakeshores by fire. It is so uncommon on uplands that it is often considered a species requiring high soil moisture and mobile groundwater. But the proof that it can cope with dry sites is that it is sometimes abundant on ridges on certain islands and other sites where fires have been infrequent (Heinselman 1973).

The black spruce community is found in low, wet places where nutrient levels are low due to isolation from groundwater. Black spruce seeds require moisture and a seedbed of mineral soil or moss. On lowlands, the sphagnum moss of nutrient deficient bogs forms a favorable seedbed if conditions are not overly wet. Many black spruce stands in the park originate when seedlings invade treeless leatherleaf bogs, or tamarack bogs as accumulating plant remains provide increasingly dry conditions. The black spruce is the climax community on such wet, poor sites. Crown and surface fires readily kill black spruce. Following low intensity fires, black spruce regenerates from seed in undestroyed, semi-serotinous cones.
Leatherleaf bog communities occupy sites substantially wetter than black spruce bogs; they are too wet for germination of black spruce and other trees. Leatherleaf and bog birch dominate these sphagnum moss bogs. Ground fires readily kill these halfshrubs and sphagnum moss. As site conditions become drier, this community may be invaded by black spruce and tall shrubs.

The shrub carr community occurs on flat lowlands that are substantially richer in nutrients than leatherleaf and spruce bogs. The shrub carr originates when tall shrubs, such as speckled alder and willow, colonize sedge and cattail marshes. Eventually, these sites may succeed to black ash or white-cedar communities. Fire readily removes the above ground biomass of these tall shrubs, and sedges and grasses.

Marshes are semi-aquatic communities and are found in the park's lakes and beaver ponds. Conditions are very wet and nutrient levels are intermediate. The marsh community lacks trees and shrubs and is dominated by continuous growth of cattails, sedges and wild rice except where standing water is deep. Marsh vegetation is readily removed by fire outside the growing season after the plants have dried out.

**Fire Effects on Wildlife**

An understanding of the role of fire in Voyageurs' ecosystem requires at least a brief look at the interactions between vegetative successions and wildlife habitat. Most of the park's native mammals and birds have habitat requirements that correspond with niches in various postfire successional stages. Wholesale succession of the forest due to fire exclusion is now restructuring the entire system, and gradually eliminating the niches of many formerly abundant wildlife species. The removal of fire from the park would eventually cause a significant loss of wildlife diversity and an overall decrease in wildlife abundance (Heinselman 1973, Apfelbaum and Haney 1986, Cole 1987).

**Moose.** Large quantities of nutritious browse are required by moose during the long northern Minnesota winter. Proliferation of palatable forage following fire is often responsible for increased moose populations. Postfire sprouters, such as aspen, birch, willow, red maple and pincherry, are heavily used (Hansen et al. 1973, Peek 1974a, 1974b, Irwin 1975, Peek et al. 1976). Large burns are suitable feeding areas unless the snow is more than 20 inches deep. Two or three years after fire, the regrowth protrudes above the deepest snows, and moose can then forage most of the winter. Moose can utilize larger saplings than can white-tailed deer or elk. Their height of reach is 8 feet and they will break down saplings up to 4 inches in diameter to reach higher browse. Consequently, moose can make better use of the large quantities of browse available within large burns than deer or elk. Moose also benefit from the overhead cover of conifer forests on cold winter nights and browse the foliage of sapling balsam fir. Thus, a combination of recent burns and adjacent maturing forest near waterways for summer range make a very productive habitat complex for moose.

A widely dispersed, low density moose population is capable of rapidly colonizing the favorable habitats associated with a burn (Peek 1974a). Substantial immigrations of yearling males to burned areas occur within 6
months after a fire (Peek 1974a). Increased levels of nutrition on burns also increase the rate of twinning in moose populations (Franzen and Schwartz 1985). This capability serves an important function as an adaptation to survival in the boreal forest, where mature spruce-fir and jack pine communities produce very little forage for moose, and fires create an abundance of woody browse quite rapidly.

**White-tailed Deer.** White-tailed deer were less abundant in northeastern Minnesota in primeval times than they are today. A large population increase came with the less intensive logging and increased fire protection that followed the early 1900's (Irwin 1975). Peak populations came between 1930 and 1950. With decreased timber cutting, plus fire exclusion, deer populations have since declined sharply as the forest has matured in the park and vicinity (Cole 1982, 1987). Deer diets are much more highly variable than those of moose; deer will eat grasses, herbs, shrubs, and trees. Deer populations will increase somewhat in response to the large quantities of food available on recent burns. Due to relatively small home range size and limited dispersal of yearlings, deer are not as well adapted to utilize recent large burns as moose. Deer prefer denser cover and lesser snow depth than moose. Although favored browse plants occur on recent burns, deer cannot use large burns effectively because of deep snow and increased chances of predation by the eastern timber wolf. Deer, consequently, feed near the edges of forest openings and do not utilize the forage more than 75 yards from cover. Thus, a combination of recent small burns and adjacent maturing forest make a very productive habitat complex for deer.

**Woodland Caribou.** Woodland caribou were common in the park and vicinity until 1900 but disappeared by about 1925 (Cole 1982, 1987). Excessive hunting and a regional decrease in the proportion of old stands supporting tree lichens were involved in the elimination of caribou (Heinselman 1973). In winter, caribou subsist on a diet of tree lichens, ground lichens and browse. Some browse plants used by caribou are found in old forests as well as on recent burns (mountain maple, mountain ash, red-osier dogwood, willows, and highbush cranberry). Ground lichens are most abundant on open bedrock ridges which become well covered by lichens 60 to 100 years after fire. Caribou utilize mature coniferous upland habitat more than any other available habitat, except during October, December and January when semi-open and open bogs are used more (Darby and Pruitt 1984). Favored use of bogs continues until mid-February when snow cover thickness and hardness restrict foraging. Caribou then switch back to sites with more favorable snow cover conditions in mature coniferous uplands, especially rocky ridges with jack pine. Thus, a combination of mature coniferous uplands bisected by semi-open and open bogs make a very productive habitat complex for caribou.

**Elk.** Elk were present in the park and vicinity until 1900 but disappeared soon after due to excessive market and subsistence hunting (Cole 1982, 1987). Elk are very general feeders that prefer grassland, shrubland, and recent burns over the mixed forest community. In winter, highest population densities occur on sites that have burned during the past century while lowest densities occur in mature forest (Martinka 1974). They choose aspen-birch over coniferous communities in summer and winter, although conifers may be used for hiding and thermal cover during times of harassment or severe weather. Proliferation of palatable forage following fire is responsible for
increased elk populations. Frequent fires that set back succession and retain grasses, herbs, shrubs and aspen will benefit any elk that are reintroduced into the park. Thus, a combination of recent burns and adjacent maturing forest make a very productive habitat complex for elk.

**Ruffed Grouse.** In northeastern Minnesota the ruffed grouse depends heavily on the buds of aspen for winter food, especially on the staminate flower buds of quaking aspen (Svoboda and Gullion 1972). A patchwork of aspen stands of different ages, interspersed with conifers, provides good feeding habitat plus winter shelter. This was the character of the primeval forest. Succession due to fire exclusion is now gradually reducing ruffed grouse habitat in the park, although there is still much good habitat in the younger aspen stands being managed for pulpwood outside the park (Sharp 1970, Heinselman 1973).

**Other Birdlife.** The primeval mosaic of forest age classes and successional stages created by fire provided niches for all native land birds (Heinselman 1973). Early communities, the first 23 years after fire, had as high a bird diversity but half the bird density as mature plant communities that developed 100 to 200 years after fire (Apfelbaum and Haney 1986). Intermediate communities developed within 50 years as jack pine and aspen canopies matured and had a third less species, but comparable bird density as early communities. Old-growth communities, 300 or more years after fire, had lower diversity and density than mature communities. Bird species and communities in this region are adapted to fire and in the long-term absence of fire, communities begin to fragment (Apfelbaum and Haney 1986).

**Small Mammals.** Most species of smaller mammals (redbacked and rock vole, deer mouse, masked shrew, least chipmunk and red squirrel) are well adapted to survival during and after fires. Variable topography, low fuel loadings and high moisture contents permit some portions of an area to escape burning entirely or to burn only lightly, especially in depressions and lowland areas. Small mammals either survive within the confines of the burn in unburned areas or in burrows more than 3 inches below the soil surface; escape the fire by emigrating to unburned areas; or die as a result of the fire (Buech et al. 1977). Although fire will not reduce the species diversity of small mammals within a burn, populations are frequently only 15 percent of prefire populations for one or two growing seasons after the burn. As grasses, herbs and shrubs, and trees becomes reestablished on the burned area, small mammal populations will gradually increase to preburn levels. The red squirrel, however, is temporarily displaced by fire because its niche is maturing jack pine, black spruce, and red and white pine stands - all late successional stage communities.

**Snowshoe Hare.** In natural ecosystems, snowshoe hares attain peak populations in young postfire stands, especially of aspen and birch, because of their need for thin-barked woody stems for winter food. Five to thirty years after fire are the best years for hares (Grange 1965). In recent decades, hares have been nearly absent from the park because of the severe lack of recently burned areas (Cole 1982, 1987). Small, irregularly shaped openings created by fire within 200 to 400 yards of dense conifer cover or shrub thickets provide maximum snowshoe hare habitat in aspen-birch forest communities (Conroy et al. 1979, Wolff 1980).
**Beaver.** Past logging and wildfires in Voyageurs created ideal habitat for beaver that now supports maximum densities. Stands of deciduous trees and shrubs within a few hundred feet of lakes and streams are required by beaver, as well as aquatic roots and tubers. Aspen, paper birch, and willow are favored foods. Cuttings from these trees and shrubs are used for dams, lodges, and winter food caches. In the primeval system, these species were found on burns, but within 70 to 100 years after a fire beaver often fell all of the aspen and birch within reach of waterways and canals (Heinselman 1973). They must then move on to a more recent burn. Fire exclusion is now preventing the regrowth of many aspen-birch stands in the park and a beaver population decline is expected (Heinselman 1973, Kurmis et al. 1980).

**Eastern Timber Wolf.** This threatened species is the largest carnivore in the park ecosystem. Its principal prey are white-tailed deer, moose, beaver, and formerly woodland caribou and elk (Van Ballenberghe et al. 1975, Cole 1982, 1987). Enough area of early postfire plant communities must exist within a wolf pack's territory to sustain a surplus of the prey species that depend on such communities (deer, moose, beaver, and formerly elk) (Heinselman 1973, Cole 1982, 1987). Formerly caribou were common in mature forests, thereby giving the wolf available prey in both old and young stands. But today, old stands contain few prey animals, and the wolf is not as common as it was prior to 1890 (Mech 1973, 1977, Mech and Karns 1978, Cole 1982, 1987). Pack sizes are also decreasing. Further declines in the park's wolf population will continue if fire exclusion continues, especially if caribou and elk are not soon reestablished within the park and vicinity.

**Other Predators and Scavengers.** As with the park's wolf population, the sizes of the remainder of the park's predator and scavenger populations (coyote, red fox, wolverine, Canada lynx, bobcat, fisher, pine marten, raven, jays, chickadees, and bald eagle) have been dramatically reduced below pre-1890 levels by human intervention into Voyageurs' ecosystem (Cole 1982, 1987). An inadequate area of early postfire plant communities exists to sustain a surplus of the prey species that depend on such communities (ruffed grouse, snowshoe hare, beaver, deer, moose, and formerly elk). In the past, these predators and scavengers were sustained through the winter by scavenging on wolf kills (Mech 1966, 1970).

Whenever wolves leave a large carcass, either temporarily to go off and rest or permanently upon abandoning the kill, a wealth of food becomes available to smaller birds and mammals. Some of these animals, such as crows, ravens, jays, and red squirrels, are poorly adapted for killing other animals themselves. Thus, it becomes more efficient for them to spend most of their time gleaning bits and pieces of leftovers from the abandoned kills of predators. Other species, such as foxes, coyotes, bobcats, fishers, and bald eagles, are only part-time scavengers. Most of the time they prey on other animals themselves, but they do rely on scavenging on wolf kills to hold them over while their own prey is scarce or unavailable. But today, old stands contain few prey animals for wolf packs to kill, and those animals that are killed are fully consumed by the pack, leaving little food for scavengers. Further declines in the park's predator and scavenger populations will occur if fire exclusion continues, especially if caribou and elk are not soon reestablished within the park and vicinity.
Black Bear. The black bear is omnivorous and thus can find food in many habitats in the park and vicinity. Fruit producing plants are important to the long-term population health, reproduction, and survival of black bears in northeastern Minnesota (Rogers 1976, 1977). But the important berry producing shrubs, such as blueberries, raspberry, juneberries, and cherries are most abundant 2 to 20 years after fire (Heinselman 1973). Thus, recent burns are important habitats for bear. In primeval times, bears undoubtedly frequented burns during berry season, but today there are no recent burns within the park. Raspberries are an exception because they also abound in openings in spruce budworm killed fir stands. As with most species, optimum habitat for bears is a mosaic of early successional and mature plant communities (Irwin and Hammond 1985). Advancing forest succession and continued fire exclusion will eventually result in a reduction in the park's black bear population.
ALTERNATIVE ACTIONS AND THEIR PROBABLE ENVIRONMENTAL CONSEQUENCES

The following subsections of this environmental assessment describe four alternatives for managing wildland fires in Voyageurs' ecosystem. These alternatives are: (A) No Action, Continue to Suppress all Fires; (B) Allow all Natural Fires to Burn; (C) Parkwide Prescribed Burning Program; and (D) Implement Wildland Fire Management Plan (Preferred Alternative). The environmental consequences of implementing Alternatives A, B, C, or D are also evaluated below. The effects of each alternative on preservation and maintenance of park vegetation and wildlife, public safety, air quality, and program costs are evaluated in terms of Voyageurs National Park's legislative purpose and National Park Service policy and guidelines.

A. No Action, Continue to Suppress all Fires. All lightning and human-caused fires originating within or from outside Voyageurs National Park would continue to be routinely suppressed. Prescribed burning would not be used to simulate natural ecological processes and conditions, as in Alternatives C and D. Although forest stands in park developed areas would be manipulated to maintain specific communities and reduce fuel loadings, such practices would not be applied to vegetation parkwide. All cooking and warming fires would be restricted to metal firegrills located in developed campsites and day use sites. A variety of media would be used to sensitize park visitors, neighbors, and employees to the needs to prevent all human-caused fires and report all fires to the park.

Given the frequency of severe drought in the region, it is inevitable that all vegetation in the park would eventually burn due to lightning or human-caused fires. Continuation of our present policy of fire suppression, therefore, would only increase the interval between successive burns on any given acre. Decreases in fire frequency would decrease the total area of fire-dependent and early successional stage plant and animal communities parkwide. Consequently, the total area of fire intolerant and late successional stage plant and animal communities would increase to an unnatural level within this southern boreal forest park. The loss of fire-dependent and early successional stage plant and animal communities could be prevented by parkwide prescribed burning and/or forest products harvesting programs. While prescribed burning is not included in this alternative, harvesting of trees as a vegetation management technique on a parkwide basis is contrary to National Park Service policy and guidelines.

Implementation of this alternative would also: severely reduce nutrient cycling; severely reduce the availability of critical winter habitat for white-tailed deer and moose; continue to reduce the overwinter food supply for the park's depauperate predators and scavengers, particularly the threatened eastern timber wolf and bald eagle; dramatically increase wildfire intensity and size due to fuels buildup and increased vegetation/fuel continuity; increase the risk of fire-caused injury or death and property lose for park visitors, employees and neighbors; and dramatically increase costs for fire suppression during large, project fires that may
be as high as $100,000 per day in personnel, equipment and other support costs. Temporary decreases in smoke production resulting from the suppression of all lightning and human-caused fires in the park would eventually be offset by the tremendous volume of smoke generated by the inevitable, catastrophic wildfires that would result from continuation of this policy. Implementation of this alternative would also reduce the number of wildfires caused by escaped campfires by over 90 percent.

Exclusion from the park's ecosystem of one of the evolutionary forces that has shaped it for millions of years would fail to adequately protect, preserve and maintain Voyageurs for the enjoyment of present and future generations. Implementation of this alternative would be contrary to Voyageurs' legislative purpose and National Park Service policies and guidelines because it would allow continued and progressive unnatural changes in the park's ecosystem.

B. Allow all Natural Fires to Burn. All lightning-caused fires originating within or from outside Voyageurs would be allowed to burn at any time of the year and under any weather conditions unless they threaten human life, private property, private or retained use and occupancy cabin sites, major park developed areas, developed campsites and day use sites, trailheads, cultural or archeological resources, endangered or threatened species, to escape from the park, to violate air pollution control laws and regulations, or to violate other resources management objectives. All natural fires would be monitored frequently in order to maintain current information on fire size, location, rate of spread, intensity, and potential threats which might require suppression action.

Prescribed burning would not be used to simulate natural ecological processes and conditions in areas where the threat of fire escape beyond park boundaries is unacceptably high, as in Alternatives C and D. Forest stands in park developed areas would be manipulated to maintain red and white pine stands that would act as firebreaks under some burning conditions. All human-caused fires originating within or from outside Voyageurs would continue to be routinely suppressed. All cooking and warming fires would be restricted to metal firegrills located in developed campsites and day use sites. A variety of media would be used to sensitize park visitors, neighbors, and employees to the natural role of fire in Voyageurs' ecosystem, and the needs to prevent all human-caused fires and report all fires to the park.

Implementation of this alternative would restore the natural frequency and intensity of fire in almost 100 percent of Voyageurs. Increases in fire frequency would dramatically increase the total area of fire-dependent and early successional stage plant and animal communities parkwide. Consequently, the total area of fire intolerant and late successional stage plant and animal communities would be restored to a natural level within this southern boreal forest park.

Implementation of this alternative would also: dramatically increase nutrient cycling; dramatically increase the availability of critical winter habitat for white-tailed deer and moose; increase the overwinter
food supply for the park’s depauperate predators and scavengers, particularly the threatened eastern timber wolf and bald eagle; reduce wildfire intensity and size due to fuel reductions and decreased vegetation/fuel continuity; increase visibility reduction due to smoke production during long burning fires; dramatically increase the risk of fire-caused injury or death and property lose for park visitors, employees and neighbors; and dramatically increase costs for fire suppression during large, project fires that may be as high as $100,000 per day in personnel, equipment and other support costs. Implementation of this alternative would also reduce the number of wildfires caused by escaped campfires by over 90 percent.

Permitting lightning fires to burn in areas of Voyageurs where inadequate fuelbreaks exist and/or continuous vegetation/fuels extend beyond park boundaries would increase the risk of fire escape outside the park. During severe burning conditions, fire control forces in such areas would very likely be ineffective in containing fires within park boundaries. Escaped fires would, therefore, threaten lives and property, and timber resources on lands adjacent to the park. Although the use of prescribed burning in these areas, as in Alternatives C and D, would greatly reduce such risks, such a program is not included in this alternative.

Reintroduction of lightning fire to Voyageurs' ecosystem would preserve and maintain it for the enjoyment of present and future generations. The risk of fire escape beyond Voyageurs' boundaries, however, would remain at an unacceptable level in many areas of the park. Implementation of this alternative would be contrary to Voyageurs' legislative purpose and National Park Service policies and guidelines because it would permit fires burning near park boundaries to periodically escape to adjacent lands and threaten human lives and property, and timber resources.

C. Parkwide Prescribed Burning Program. In order to minimize the risk of fire threatening human life and property within and beyond Voyageurs' boundaries, prescribed burning would be used to simulate the natural fire process and to reestablish, to the extent possible, what are judged to be pristine or natural conditions throughout the park. Under this program, management fires would be ignited in designated burn units within specified weather, fuel moisture, and fire behavior parameters. Burn units would be delineated based on the presence of large expanses of open water, interior lakes, beaver ponds, wetlands, stream channels, major changes in vegetation/fuel types, and roads that will contain fires within unit boundaries. Prescribed burning would be carried out from early April through late October or early November. Priorities for burning would be determined by the length of time since previous burn, current fuel loading and vegetative conditions, topographic advantage, and by personnel and logistical requirements.

Forest stands in park developed areas would be manipulated to maintain red and white pine stands that would act as firebreaks under some burning conditions. All lightning and unplanned human-caused fires originating within or from outside Voyageurs would continue to be routinely suppressed. All cooking and warming fires would be restricted to metal firegrills
located in developed campsites and day use sites. A variety of media would be used to sensitize park visitors, neighbors, and employees to the natural role of fire in Voyageurs' ecosystem, and the needs to prevent all human-caused fires and report all fires to the park.

Implementation of this alternative would simulate in almost 100 percent of Voyageurs the natural range of fire frequencies but not the natural range of fire intensities. Increases in fire frequency would dramatically increase the total area of fire-dependent and early successional stage plant and animal communities parkwide. Consequently, the total area of fire intolerant and late successional stage plant and animal communities would be restored to a natural level within this southern boreal forest park.

Although the objective of this prescribed burning program would be to duplicate the frequency and severity of lightning fires on the park's plant and animal communities during times and in places where safety and control would be assured, the resulting vegetative mosaic created and maintained by this program would be very different from that which would result from a natural fire management regime alone. Since prescribed burns would be conducted under less extreme burning conditions than occurs naturally, species favored by less intense fires, short dispersal distances, and small openings would come to dominate an ecosystem where intense fires, long dispersal distances, and large openings were once the norm. Also, the element of randomness in the timing and location of ignitions would be significantly reduced by a prescribed burning program, with the result that the park's plant communities would become more uniform in age and structure than under natural conditions.

Implementation of this alternative would also: dramatically increase nutrient cycling; dramatically increase the availability of critical winter habitat for white-tailed deer and moose; increase the overwinter food supply for the park's depauperate predators and scavengers, particularly the threatened eastern timber wolf and bald eagle; reduce wildfire intensity and size due to fuel reductions and decreased vegetation/fuel continuity; increase visibility impairment due to smoke production during prescribed burns; reduce the risk of fire-caused injury or death and property lose for park visitors, employees and neighbors; dramatically increase costs for prescribed burning; and decrease costs for wildfire suppression during large, project fires that may be as high as $100,000 per day in personnel, equipment and other support costs. Implementation of this alternative would also reduce the number of wildfires caused by escaped campfires by over 90 percent.

The risk of fire escape beyond Voyageurs' boundaries and fire's potential threats to human life and property would be minimized by this alternative. Use of prescribed burning to simulate the effects of a lightning fire regime on Voyageurs' ecosystem, however, would not adequately preserve and maintain it for the enjoyment of present and future generations. Implementation of this alternative would not be fully consistent with Voyageurs' legislative purpose and National Park Service policies and guidelines.
D. Implement Wildland Fire Management Plan (Preferred Alternative). This alternative would implement Voyageurs’ Wildland Fire Management Plan (U.S. NPS 1987d) and incorporate elements from Alternatives A, B, and C. This alternative would: (1) allow fire to achieve its natural role; (2) use fire to accomplish desired resource management objectives; (3) protect life, property, and resources from unwanted fire; and (4) avoid unacceptable effects of fire and fire suppression. The Wildland Fire Management Plan divides the park into three units: fire suppression, and prescribed natural and conditional fire management units (Figure 1).

Voyageurs' fire suppression units would provide intensive protection for human life and property within and outside park boundaries. Such units would surround the park's development zones, developed campsites and day use sites, docks and bulletin boards at trailheads, private lands, and all private and retained use and occupancy cabin sites. All lightning and human-caused wildfires originating from within or threatening a fire suppression unit from outside will be suppressed (confined, contained, controlled, or a combination). Mechanical fuel manipulation and prescribed burning would be used to reduce fuels, and maintain vegetative mosaics and wildlife habitats that approximate natural conditions and ecosystem processes within fire suppression units. Where appropriate, stands of red and white pine would be maintained in the vicinity of park developed areas to create fuelbreaks that would reduce the intensity of some fires entering these areas. Periodic prescribed understory burning and planting of red and white pine would reduce the volume of ladder fuels in the understory and promote the establishment and maintenance of open stands of red and white pine.

All lightning-caused fires originating within or from outside Voyageurs' prescribed natural fire management unit would be allowed to burn at any time of the year and under almost all weather conditions unless they threaten human life, private property, private or retained use and occupancy cabin sites, major park developed areas, developed campsites and day use sites, trailheads, cultural or archeological resources, endangered or threatened species, to escape from the management unit, to violate air pollution control laws and regulations, or to violate other resources management objectives. All natural fires would be monitored frequently in order to maintain current information on fire size, location, rate of spread, intensity, and potential threats which might require suppression action.

No fires would be ignited by management in the prescribed natural fire management unit, with the following exceptions. Certain fires may be ignited in conjunction with suppression efforts. Should continued research and monitoring demonstrate that this program is not encouraging the regeneration of red and white pine stands, or creating critically needed winter habitat for moose, deer and elk, then active steps may be taken to regenerate these stands or habitat through a combination of prescribed burning and/or tree planting. If it is determined that any threatened or endangered species is critically fire-dependent and that fire exclusion has so adversely affected the critical habitat of any species so as to endanger its existence, then active steps may be taken to restore that habitat through prescribed burning.
Voyageurs' conditional fire management units attempt to strike a balance between restoring and perpetuating a fire-dependent ecosystem and protecting life and property within and beyond park boundaries. Ecologically, the conditional and prescribed natural fire management units are identical. The conditional units, however, are located in areas where the risk of fire escape beyond park boundaries in the spring, summer and fall is unacceptably high. Both lightning-caused fires and prescribed burns would be allowed to burn within a pre-determined set of parameters. When conditions are not within these parameters, fires would be suppressed or contained.

Many lightning-caused fires originating within or from outside the conditional fire management unit would be allowed to burn at any time of the year when they remain within prescription unless they threaten human life, private property, private or retained use and occupancy cabin sites, major park developed areas, developed campsites and day use sites, trailheads, cultural or archeological resources, endangered or threatened species, to escape from the management unit, to violate air pollution control laws and regulations, or to violate other resources management objectives. Those lightning-caused fires originating within or from outside this unit that are outside of prescription would be suppressed except where such fires pose no risk to the resource or public safety and where the environmental impacts of suppression would not be commensurate with the adverse effects of the fire.

A prescribed burning program would be implemented within fire suppression and conditional fire management units to encourage regeneration of red and white pine stands and restore critically needed winter habitat for moose, deer and elk. To the maximum extent possible, this program would simulate the effects of the park's natural fire rotation or cycle on plant communities within unit boundaries. The objective of this program would be to duplicate the frequency and severity of natural fires in times and places when safety and control can be assured. Management fires would be ignited in designated burn units within specified weather, fuel moisture, and fire behavior parameters. Burn units would be delineated based on the presence of large expanses of open water, interior lakes, beaver ponds, wetlands, stream channels, major changes in vegetation/fuel types, and roads that would contain fires within unit boundaries. Prescribed burning would be carried out from early April through late October or early November. Priorities for burning would be determined by the length of time since previous burn, current fuel loading and vegetative conditions, topographic advantage, and by personnel and logistical requirements.

All unplanned human-caused fires originating within or from outside Voyageurs would continue to be routinely suppressed. All cooking and warming fires would be restricted to metal firegrills located in developed campsites and day use sites. A variety of media would be used to sensitize park visitors, neighbors, and employees to the natural role of fire in Voyageurs' ecosystem, and the needs to prevent all human-caused fires and report all fires to the park.

Implementation of this alternative would restore the natural frequency and intensity of fire in about 85 percent of Voyageurs. Implementation of this
alternative would also simulate in about 15 percent of the park the natural range of fire frequencies but not the natural range of fire intensities. Increases in fire frequency would dramatically increase the total area of fire-dependent and early successional stage plant and animal communities parkwide. Consequently, the total area of fire intolerant and late successional stage plant and animal communities would be restored to a natural level within this southern boreal forest park.

Although the objective of prescribed burning in Voyageurs' fire suppression and conditional fire management units (15 percent of the park) would be to duplicate the frequency and severity of lightning fires on the park's plant and animal communities during times and in places where safety and control would be assured, the resulting vegetative mosaic created and maintained by this program would be very different from that which would result from a natural fire management regime alone. Since prescribed burns would be conducted under less extreme burning conditions than occurs naturally, species favored by less intense fires, short dispersal distances, and small openings would come to dominate an ecosystem where intense fires, long dispersal distances, and large openings were once the norm. Also, the element of randomness in the timing and location of ignitions would be significantly reduced by such a prescribed burning program, with the result that the park's plant communities would become more uniform in age and structure than under natural conditions.

Implementation of this alternative would also: dramatically increase nutrient cycling; dramatically increase the availability of critical winter habitat for white-tailed deer and moose; increase the overwinter food supply for the park's depauperate predators and scavengers, particularly the threatened eastern timber wolf and bald eagle; reduce wildfire intensity and size due to fuel reductions and decreased vegetation/fuel continuity; increase visibility impairment due to smoke production during prescribed burns and long-burning prescribed natural fires; reduce the risk of fire-caused injury or death and property lose for park visitors, employees and neighbors; increase costs for prescribed burning; and reduce costs for wildfire suppression during large, project fires that may be as high as $100,000 per day in personnel, equipment and other support costs. Implementation of this alternative would also reduce the number of wildfires caused by escaped campfires by over 90 percent.

Reintroduction of fire to Voyageurs' ecosystem would preserve and maintain it for the enjoyment of present and future generations. Voyageurs' prescribed natural fire management unit would maximize the area within the park in which natural fire is a critical ecological process that perpetuates and maintains a fire-dependent ecosystem. Voyageurs' conditional fire management units, on the other hand, would strike a balance between restoring and perpetuating a fire-dependent ecosystem and protecting life and property within and beyond park boundaries. Voyageurs' fire suppression units would provide intensive protection for human life and property within and outside park boundaries. Implementation of this alternative would be fully consistent with Voyageurs' legislative purpose and National Park Service policies and guidelines.
RECOMMENDED COURSE OF ACTION

The recommended course of action is the adoption of Alternative D, Implement Wildland Fire Management Plan. All of the activities identified in Alternative D would be implemented as follows.

A. Resource Management Actions.

VOYA-N-024-01: Increase Public Information. Ecological concepts upon which the wildland fire management program is based would be incorporated into information handouts, selected books written about the park, and wayside and visitor center exhibits. Information handouts explaining the fire management program would be prepared and periodically updated. Information about the fire management program would be incorporated into interpretative talks, walks, automatic slide and/or videotaped programs, and the park newspaper, safety brochure, and camping and hiking brochure. During ongoing fires, news articles would be written and released to local newspapers, radio, and television stations. Signs notifying the public about ongoing prescribed natural fires, prescribed burns, or fire suppression efforts, area closures, dense smoke, or other special situations would be placed along roadways, and at visitor centers, boat launching ramps, trailheads, campsites, day use sites, and resorts.

VOYA-N-024-02: Increase Public Safety. Consistent, accurate monitoring and evaluation of fire behavior in the park would provide the basis for developing contingency plans, contacts, and briefings that ensure public and personnel safety. A fire safety brochure would be developed for distribution to park visitors and neighbors. Visitor use would be limited or prevented near wildland fires and potentially affected areas. Park personnel would enforce visitor compliance with area closures.

VOYA-N-024-03: Increase Training. All employees working on suppression or prescribed fire assignments within or outside of Voyageurs National Park would be qualified under the NPS Wildland Fire Qualification System to at least the Firefighter level. Fire Monitoring Teams working on suppression or prescribed fire monitoring assignments inside Voyageurs would have at least one person with a rating of Firefighter or higher, in addition to a Weather and Fire Behavior Specialist (Fire Monitor) II rating. Priority in fire training would be given to those employees who have wildfire and prescribed fire responsibilities as part of their position function. The park would develop in employees fire behavior management skills, with fire behavior coursework through S-390. The park would have a goal of maintaining one individual on the park's fire staff trained to the Fire Behavior for Managers...
(prescribed fire applications) or Fire Behavior Analyst (suppression fire applications) level, even though current red carding may not be required. The park would develop to the Single Resource Boss (Crew Boss) qualifications, sufficient permanent park personnel to meet park fire staffing needs for both suppression and prescribed fire applications. The park would develop and maintain as qualified at least one Prescribed Fire Burn Boss II.

VOYA-N-024-04: Increase Seasonal Personnel. Implementation of Voyageurs' wildland fire program would require the employment and training of additional seasonal personnel during the park's fire season to suppress wildfires, take limited suppression actions on prescribed natural fires, prepare and conduct prescribed burns, mechanically treat fuels in the vicinity of developed areas, and monitor fire behavior and effects.

VOYA-N-024-05: Increase Equipment and Supplies. Implementation of Voyageurs' wildland fire program would require the acquisition of additional equipment and supplies to meet the park's needs for suppressing wildfires, taking limited suppression actions on prescribed natural fires, preparing and conducting prescribed burns, mechanically treating fuels in the vicinity of developed areas, and monitoring fire behavior and effects.

VOYA-N-024-06: Increase Aerial Detection and Fire Monitoring Flights. Due to limited visibility from the ground, aerial flights would be the primary means of detecting lightning and human-caused fires in the park and vicinity. Two aerial fixed-wing flights would be flown each day when the park's Manning Class was IV or higher, or during and after lightning activity or any other fire emergency. In instances where fires are inaccessible from the ground, cursory monitoring would also be done from an aircraft.

VOYA-N-024-07: Increase Cooperation with State Agencies Responsible for Smoke Management during Prescribed Natural Fires and Prescribed Burns. The Minnesota Pollution Control Agency's air quality/smoke management regulations would be complied with when making decisions about the use of prescribed natural fires and prescribed burns in Voyageurs.

VOYA-N-024-08: Increase Protection of Archeological and Historical Resources during Wildland Fires. Fire management activities that disturb the ground in Voyageurs in any way, such as fireline construction using hand tools or heavy equipment, would use para-professional and professional archeologists working in cooperation with firefighters and prescribed burn preparation crews to prevent needless cultural resource destruction. The park's Cultural Resource Management Specialist would also be a member of the Fire Management Overhead Team in order to protect Voyageurs' cultural resources during fire management activities.

VOYA-N-024-09: Acquire Remaining Private Land within Voyageurs. All remaining private land within the authorized boundaries of the park
would be acquired through the procedures outlined in Voyageurs' approved Land Protection Plan (U.S. NPS 1986a). Highest priority would be given to acquiring those tracts that currently do not have structures on them.

**VOYA-N-024-10: Survey South Park Boundary.** In order to minimize the possibility of fire management actions being mistakenly taken outside the park boundary on prescribed natural fires and/or prescribed burns thought to be within a fire suppression or conditional fire management unit, the south park boundary from Crane Lake to Black Bay would be surveyed.

**VOYA-N-024-11: Increase Interagency Cooperation.** As agencies whose lands are contiguous with the park implement wildland fire management programs, the National Park Service would promote interagency cooperation that will allow fires to burn from one jurisdiction into another, even across the international boundary. When planning a large or complex prescribed burn in Voyageurs, the park would consider the use of a MNICS overhead team to manage the burn. This practice would enhance training and experience opportunities while promoting increased interagency coordination and cooperation.

**VOYA-N-024-12: Protect Nesting Bald Eagles during Prescribed Fires.** When prescribed fires occur or are planned for areas containing active or suitable unoccupied bald eagle nesting territories, precautionary measures would be taken to protect nest trees. Such things as a firebreak around nest trees or the scheduling of a proposed burn in late summer/early fall when eaglets have fledged and dispersed the natal area would minimize impacts to nest territories.

**B. Monitoring Actions.**

**VOYA-N-024-20: Increase Monitoring of Fire Weather.** Fire weather would be continue to be collected daily between 1300 and 1400 hours at the Kabetogama Lake Visitor Center base station from April 1 through November 1. Fire weather for prescribed burns would be recorded at a dummy weather station established within each unit to be burned. All daily weather records from Voyageurs would be entered into AFFIRMS by 1400 hours each day in order to predict burning conditions and fire behavior.

**VOYA-N-024-21: Increase Monitoring of Fire Behavior and Effects.** All prescribed natural fires, prescribed burns, and wildfires would be monitored by a Fire Monitoring Team. Information gathered during fire monitoring would be used to keep fires within predetermined criteria, know when to take suppression action, and protect human life and/or property. Monitoring would include documenting the fire environment (weather, fuels, topography), fire behavior (manner and rate of spread, flame length, etc.), and fire effects (percent of fuels consumed, changes in plant community composition and structure, etc.). Photographs would also be taken for the historical record.
VOYA-N-024-22: Continue to Monitor Fire Effects on Air Quality and Visibility. The instrumentation at the park's Black Bay Air Quality Monitoring Site would document carbon monoxide, nitrogen dioxide, sulfur dioxide, lead, ozone, and particulate matter levels prior to, during, and after prescribed natural fires and prescribed burns. The automatic 35mm single lens reflex and 8mm movie photographic systems located at the Kabetogama Lake Visitor Center site would document visibility in the park prior to, during, and after prescribed fires. A transmissometer would be added to this visibility monitoring system in the summer of 1987.

C. Research Actions.

VOYA-N-024-30: Refine Prescriptions for Fire Management. A problem oriented research program would provide park managers with refined prescriptions for prescribed fire management. Results from this research would permit fire managers to make more refined predictions of the effects of different fire intensities on the park's plant and animal communities. It would also permit fire managers to improve fire behavior prediction by adjusting and adapting the stylized fuel models in the Northern Forest Fire Laboratory Fire Behavior System to the park's vegetation/fuel complexes.

VOYA-N-024-31: Long-term Research on Fire Effects. A few prescribed natural fires and prescribed burns would be intensively studied for several decades to provide detailed information on fire's effects in the park's major vegetation/fuel types. This program would expand upon the monitoring described above by documenting vegetation structure and fuel loading on permanent plots prior to, immediately after, and in subsequent years.

VOYA-N-024-32: Reestablish Red and White Pine Stands. A problem oriented research program would provide park managers with factual knowledge for evaluating whether restoration of fire alone to park ecosystems is adequate to increase regeneration and survival of red and white pine stands or whether other cultural techniques, such as tree planting, are also necessary for their successful reestablishment.

VOYA-N-024-33: Restore Absent and Declining Native Wildlife. A problem oriented research program would provide park managers with factual knowledge for evaluating if restoration of fire alone to park ecosystems would increase overwinter ungulate biomass to pre-settlement levels and thereby restore the park's depauperate predator and scavenger populations, or whether other measures, such as reintroduction of woodland caribou and elk, are necessary for successful restoration of Voyageurs' native wildlife. Once caribou and elk are reintroduced, the focus of the research would be to determine if the restoration of fire and extirpated ungulates to park ecosystems would increase overwinter ungulate biomass to pre-settlement levels and thereby restore the park's depauperate predator and scavenger populations.
CONSULTATION AND COORDINATION

The following agencies, organizations and individuals were consulted in preparing this environmental assessment and the Wildland Fire Management Plan.

Steve Botti, Resource Management Specialist, NPS, Yosemite N.P., CA
Citizens' Council on Voyageurs National Park, International Falls
Crane Lake Volunteer Fire Department
Dr. Miron Heinselman, Adjunct Professor, University of Minnesota, Minneapolis
International Boundary Waters Fire Committee, Thunder Bay and Duluth
International Rainy Lake Board of Control, Hull, Quebec
Island View Volunteer Fire Department
Kabetogama Lake Volunteer Fire Department, Ray
Koochiching County Land and Forestry Department, International Falls
Minnesota Department of Natural Resources; State, Region II, and International Falls Offices, and the Kabetogama and Pine Island State Forests
Minnesota Incident Command System (MNICS) Task Force Coordinator, St. Cloud
Minnesota Pollution Control Agency, Duluth
Minnesota State Historic Preservation Office, St. Paul
Ontario Ministry of Natural Resources; Atikokan and Fort Frances Districts
St. Louis County Land Department, Duluth
U. S. Army Corps of Engineers, St. Paul
U. S. Fish and Wildlife Service, St. Paul
U. S. Forest Service, Superior National Forest; Forest Supervisor's Office and LaCroix Ranger District
U. S. National Park Service; Voyageurs N.P., Midwest Regional Office, and Washington Office Branch of Fire Management Staffs
Voyageurs Region National Park Association, Minneapolis
Dr. Jan van Wagendonk, Research Scientist, NPS, Yosemite N.P., CA
The following comments from the MPCA, MSHPO, and USFWS were incorporated into this environmental assessment and the Wildland Fire Management Plan.

**Minnesota Pollution Control Agency**

The Minnesota Pollution Control Agency (MPCA) expressed some concern about potential visibility impairment and air pollution during prescribed natural fires and prescribed burns in Voyageurs, a class I area. MPCA requested that we obtain permits for prescribed burning and inform them when natural prescribed fires were burning in the park.

The preferred alternative (D) and the fire plan's air quality/smoke management guidelines require Voyageurs' fire management program to be coordinated with the MPCA. The National Park Service will inform MPCA Pollution Control Specialists in Duluth of all fire management activities in the park, as outlined below:

**Prescribed Burns** - An objectives-oriented prescribed burn will be conducted with the following required measures:

A. A copy of the park's annual prescribed burn program will be sent to the MPCA office prior to the burning season.

B. An MPCA open burning permit will be obtained for each prescribed burn in the park. The National Park Service will comply with all the limitations to burning contained on the back of the permit.

C. Notification shall be given to the MPCA office no more than 24 hours prior to, and preferably on the day of, the ignition of the burn.

D. Notification shall be given to the MPCA office when the burn is declared out.

**Prescribed Natural Fires** - In the event of a prescribed natural fire, the MPCA office will be notified during the office hours of the first full day of burning. The office will then be notified every second day while the fire is burning and when the fire is declared out.

The impacts of Voyageurs' fire management program on air quality and visibility will be monitored continuously by the National Park Service. The instrumentation at the park's Black Bay Air Quality Monitoring Site will document carbon monoxide, nitrogen dioxide, sulfur dioxide, lead, ozone, and particulate matter levels prior to, during, and after prescribed natural fires and prescribed burns. The automatic 35mm single lens reflex and 8mm movie photographic systems located at the Kabetogama Lake Visitor Center site will document visibility in the park prior to, during, and after prescribed natural fires and prescribed burns. Eventually, in addition to the photographic
systems, the visual resource prior to, during, and after burns will be documented with a transmissometer that measures atmospheric extinction.

**Minnesota State Historic Preservation Office**

The Minnesota State Historic Preservation Office (MSHPO) believes that "activities associated with controlling fires in Voyageurs has the potential to affect historical and archeological resources. Clearly a distinction can be made between the potential impacts of prescribed burns and wildfires. There should be no reason why effects on historical and archeological properties cannot be completely avoided through proper pre-burn survey and planning. In the case of wildfires considerations of public safety are more important."

The preferred alternative (D) and the fire plan both give high priority to protecting historical and archeological resources during fire management activities in Voyageurs. Ongoing archeological and historical site surveys in the park are providing information vital to the protection of cultural resources during prescribed fires and wildfires. Fire management activities that disturb the ground would use paraprofessional and professional archeologists working in cooperation with firefighters and prescribed burn preparation crews to prevent needless cultural resource destruction. The park's Cultural Resource Management Specialist would also be a member of the park's Fire Management Overhead Team in order to protect Voyageurs' cultural resources during fire management activities.

**U.S. Fish and Wildlife Service**

The U.S. Fish and Wildlife Service (USFWS) encouraged implementation of the fire plan because it would diversify and manage vegetative communities within Voyageurs that are important to the threatened bald eagle and gray wolf. The USFWS, however, wanted to see a more explicit statement in the plan about the protection of active and suitable unoccupied bald eagle nests during prescribed fires. It also wanted additional conditional fire management units established on the Kabetogama Peninsula to enhance habitat for wolf prey species, such as deer, moose, and beaver.

The USFWS comments on bald eagle nesting habitat were incorporated into the assessment's preferred alternative (D) and the fire plan. However, additional conditional fire management units were not established on the Kabetogama Peninsula. We believe that the use of natural ignitions alone will be sufficient to restore fire-dependent and early successional stage plant communities and their associated wildlife species on the peninsula. The preferred alternative and fire plan, however, would permit increased prescribed burning on the peninsula if fire monitoring and research reveal that natural ignitions alone are not accomplishing these objectives.

**Preparer**

Jim Benedict, Natural Resource Management Specialist, Voyageurs National Park
APPENDIX A: REFERENCES CITED


Cole, G. F. 1981. Alternative hypotheses on ecological effects of meningeal


APPENDIX B: DEFINITIONS

Aggressive attack - usually follows fire discovery immediately and with sufficient force to effect control at the earliest possible time with minimum acres burned.

Confine - to restrict a fire within boundaries that are either predetermined (pre-attack planning) or determined during the fire.

Contain - to surround a fire with a fireline, or firelines if spot fires exist, for the purpose of checking the fire's spread.

Control - to put a fire out by fireline construction, burning out, cooling hot spots, and other actions that remove any threat of subsequent fire escape.

Delayed attack - attack does not immediately follow discovery.

Escaped fire - wildfires that cannot be successfully controlled by initial attack forces and prescribed fires that escape prescription and burn as wildfires.

Escaped fire situation analysis - an analysis of alternative suppression strategies for either confining, containing or controlling a wildfire.

Fire management unit - a distinct part of park or wilderness that can be recognized and mapped from its external features.

Fire dependent or fire maintained ecosystems - an ecosystem can be called fire dependent or fire maintained if periodic perturbations by fire are essential to the functioning of the system.

Fire evaluation - the process of examining and appraising fire monitoring information.

Fire monitoring - the act of observing a fire to obtain information about its environment, behavior, and effects for the purpose of evaluating the fire and its prescription.

Fire prescription - a written statement defining the objectives to be attained, and the conditions of temperature, humidity, wind direction and speed, and fuel moisture, under which a fire will be allowed to burn. Generally expressed as an acceptable range of the various indices, and the limit of the geographic area to be covered.

Modified attack - is less than aggressive attack.

Natural - in accordance with and determined by nature; untouched by the influences of aborigines or pre-Europeans, and modern civilization and society.
Natural fire - any fire of natural origin, i.e. caused by lightning or volcanic activity. In a broader context, the role fire played in the evolution of an ecosystem. This means fire has influenced natural selection, ecosystem structure, and distribution of plant and animal populations.

Prescribed burn - a fire deliberately ignited by land managers within a fire prescription in order to achieve predetermined resource management objectives; a form of prescribed fire.

Prescribed fire - skillful application of fire to natural fuels under conditions of weather, fuel moisture, etc., that will allow confinement of a fire to a predetermined area and at the same time will produce the intensity of heat and rate of spread required to accomplish certain planned benefits to one or objectives of silviculture, wildlife management, grazing, hazard reduction, etc. Its objective is to employ fire scientifically to realize maximum net benefits at minimum damage and acceptable cost.

Prescribed natural fire - fire of natural origin, i.e., caused by lightning or volcanic activity, which is allowed to burn under prescribed conditions; a form of prescribed fire.

Scheduled prescribed fire or planned ignition - a fire ignited by the manager at a predetermined time.

Unscheduled prescribed fire or unplanned ignition - a fire that is ignited as a result of an act of God or unauthorized human activity. The time of such ignition is not known in advance.

Wildfire - a free-burning fire; all fire other than prescribed fire that occurs on wildlands.

Wildland fire management - all activities related to the prevention, control or use of fire burning through vegetation under specific prescriptions for the purpose of achieving fire management objectives.
As the nation's principal conservation agency, the Department of the Interior has basic responsibilities to protect and conserve our land and water, energy and minerals, fish and wildlife, and parks and recreation areas, and to ensure the wise use of all these resources. The department also has major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.