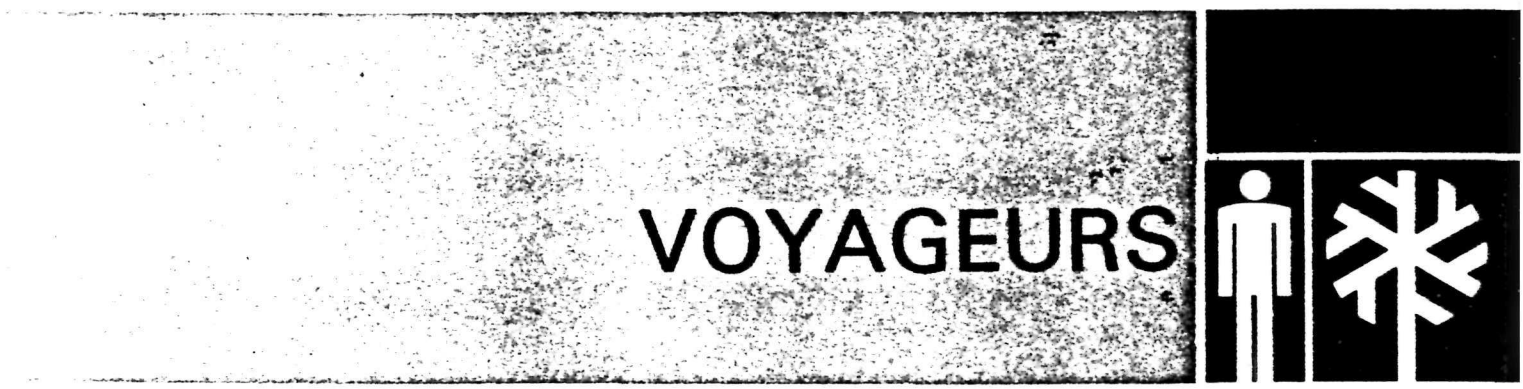
draft natural resources management plan and environmental assessment



NATIONAL PARK / MINNESOTA

D R A F T

N A T U R A L R E S O U R C E S M A N A G E M E N T P L A N

A N D E N V I R O N M E N T A L A S S E S S M E N T

Voyageurs National Park
Minnesota

1989

Recommended by: _____
Superintendent, Voyageurs N.P. Date

Approved by: _____
Regional Director, Midwest Region Date

EXOTIC AND RARE PLANT MANAGEMENT
VOYA-N-004

STATEMENT OF PROBLEM

Exotic and noxious plant species have been introduced and dispersed through most if not all of the nation's wilderness areas (Marion et al. 1986). Voyageurs National Park has at least 36 exotic species that have become naturalized, have invaded and likely displaced some of the park's native vegetation (Munson 1986). However, the park's exotic and noxious species diversity, distribution, and abundance has not been adequately documented or mapped. No systematically applied programs for monitoring or controlling exotic species within the park currently exist. Whether there has been an increase in the number of exotic and noxious plants that have migrated directly into the park since Voyageurs' creation in 1971 is unknown. There are approximately 600 active and abandoned cabin and logging camp sites and 800 campsites in Voyageurs which likely have been invaded by exotic or noxious plant species.

The species diversity, abundance, and parkwide distributions of the park's rare plants have not been adequately documented or mapped. Management of critical habitats for threatened and endangered plants, as well as for the park's rare plants, is an obligation and responsibility of Voyageurs National Park. The park, however, does not have an effective and professionally implemented rare plant and plant community management program. Pronounced human threats to the park's sensitive plant taxa are increased recreational use of the park and construction in the park's developed areas. Minimal efforts have been made to monitor those affects. Voyageurs' inability to effectively protect the park's rare vegetation and plant communities and control exotic and noxious plants in the park is incompatible with existing regulations and requirements of the other Federal and State regulatory agencies and the Endangered Species Act of 1973 as amended. These problems are also incompatible with Voyageurs' legislative purpose and National Park Service policy and guidelines (U.S. NPS 1978: IV-11).

Munson (1986) identified 602 species of vascular plants (distributed in 277 genera in 89 families) occurring in Voyageurs National Park. Currently 36 exotic plant species (Table 4-2), approximately 70 species of rare plants (Tables 4-1 and 4-5), and 10 rare and endangered plant communities have been identified within the park (Tables 4-4). The Koochiching and St. Louis County Agriculture Control Specialists have identified 13 noxious weed species (classified by the Minnesota Department of Agriculture) that have become established in the vicinity of the park (Table 4-3). Although considerable plant research has occurred at Voyageurs (Kurmis et al. 1978, 1979, and 1980, Munson 1986, Wetmore 1979, Lakela 1965) much additional research is essential to bring Voyageurs into full compliance with existing county, state, and federal mandates and policies concerning exotic, noxious and rare plant management. Therefore comprehensive exotic and noxious species control and rare species protection programs cannot be conducted until the appropriate plant research is completed.

Exotic Plant Species. The National Park Service defines exotic species as those that occur in a given place, area, or region as the result of direct or indirect, deliberate or accidental introduction of the species by humans (U.S. NPS 1978: IV-11). This definition allows for entry of new species into the native flora of an area through natural dispersal. It also allows for the control or eradication of species that are native to the flora outside the park area, but which, through the activities of humans, have become established within the area.

The main management concern with exotic plants is to avoid or compensate for disruption of natural ecosystems by exotics. National Park System lands have been set aside for preservation of examples of the natural or historic features characteristic of the United States. Such exotics species are not natural components of the ecological systems characteristic of the given location, and as a result, have not evolved in concert with the evolution of those species that are native to the location, The native species are species which presently occur, or once did occur prior to some human influence, in a given place, area, or region as the result of ecological processes that operate and have operated without significant direct or indirect, deliberate or accidental alteration by humans. Introductions of exotics by humans are ones that have permitted species to cross natural barriers to their dispersal capabilities thus giving those species opportunities to become established in areas previously inaccessible to them because of natural forces.

Exotic species in Voyageurs National Park are of special management concern for three reasons: (1) when they invade and displace native plant species they could alter park plant successional processes, plant community productivity, diversity and stability; (2) they are not indigenous and represent deviations from natural ecosystem conditions present during the era of the Voyageurs; and (3) their presence provides the visitor with a skewed impression of the park's natural vegetation (Marion et al. 1986).

There are two major sources of exotics plants in the park: (1) those remaining from logging and agricultural practices or habitations prior to the establishment of the park, and (2) those brought in more recently through human activities. Dispersal of exotics in the park occurs by natural means (wind, water, animals, etc.) as well as through human activities (vehicles, recreation, pets, etc.). Exotic plants most often become established and persist where the native vegetation has been disturbed or destroyed by either natural or human activities, such as on construction sites, road shoulders, areas trampled by heavy human use, campsites, trailways, burned areas, and water level fluctuations. If the disturbance is temporary, plant succession may lead to the reestablishment of the native vegetation and exclusion of exotics. The persistence of exotics is enhanced on sites where disturbance recurs.

Studies of the composition, abundance, and distribution of Voyageurs' plant communities were conducted by Munson (1986) and Kurmis et al. (1980). They documented the presence of exotics and noxious weeds within the park but did not verify the abundance and distribution of Voyageurs' exotic and noxious plants. Likewise, they did not discuss their ecological significance or make recommendations for their control in the park.

Perpetuation of exotics in the park's flora is variable. Some are eventually excluded by their inability to compete with native vegetation. Most spread to

FISHERIES MANAGEMENT
VOYA-N-008

STATEMENT OF PROBLEM

Voyageurs occupies a unique place in the National Park System in that over one-third of its area is water-covered and over 95 percent of it is accessible only by air or water. The park is dominated by four major lakes: Rainy, Kabetogama, Namakan, and Sand Point. In addition, numerous small lakes dot the interior of the park's main landmass, the Kabetogama Peninsula. Together these lakes support a fish community resource which is a vital link in the ecological food chain of the area. Fish provide food for some of the park's wildlife. Osprey, bald eagles, loons, otters, bears and other birds and mammals scavenge or prey on fish. The fisheries is also one of the main attractions of the park to visitors. Sport fishing has been and continues to be the principal visitor activity in Voyageurs with approximately seventy percent of the visitors fishing while in the park (Cole 1985a).

During the last 100 years man's activities have considerably influenced the fisheries resources in the area now comprising the park. Evaluation of present resources is made difficult by the absence or incompleteness of early records, but it is apparent that sport and commercial fishing, stocking of native and introduced species, and habitat degradation and manipulation have affected the fisheries, altering species composition and community structure. Lake sturgeon, once abundant, were nearly extirpated by the commercial fishery at the turn of the century. Walleye, the area's most valuable commercial and game species, experienced a severe population decline in Rainy Lake in recent decades because of overexploitation and habitat manipulation. The building of dams for flood control and power generation has resulted in an artificial regime of annual lake levels which reduces spawning habitat for certain species during crucial spring reproductive periods. The erosion, run-off, and materials spillage associated with logging, construction, and human habitation has reduced water quality and physically altered the environment in some areas. Deposition of mercury, from human-caused atmospheric pollution, has contaminated the aquatic system, entering the food chain and creating the need for a fish consumption advisory.

Thus the park occupies an area which has been and is still being considerably used and changed by man. The National Park Service has overall responsibility for the health of the fisheries populations in Voyageurs the state administers recreational and commercial fishing within the park. The Ontario Ministry of Natural Resources (OMNR) regulates fisheries in Ontario waters, some of which are contiguous with park waters along the international boundary in Rainy, Namakan and Sand Point Lakes. Both of these agencies have fisheries resources management objectives and methods which conflict with Service policy.

NPS Fisheries Management Policies and Guidelines. The consumptive use of game fish is permitted in most national parks, including Voyageurs. Management policy concerning this activity is as follows:

"Fishing has been traditionally permitted in the National Park System since the establishment of Yellowstone. The Service will continue this practice, but, in so doing, it affirms that:

> Waters may be closed to fishing to protect rare, threatened or endangered plant and animal species in the waters or in adjacent habitat.
>
> Portions of park waters may be closed to fishing when the fish life and other aquatic life has greater value to greater numbers of visitors for the appreciation of plant and animal life, for scientific study, interpretation, or environmental education.
>
> Fishing may be prohibited in certain waters and at certain times when necessary to protect spawning groups of endemic fish species or to maintain natural distributions or densities of native wildlife species that use fish for food.

Where fishing is permitted, such fishing shall be carried out in accordance with applicable state and federal laws and regulations. Park regulations may be different for native and non-native species and may be modified for specific waters. Commercial fishing is permitted only where authorized by law" (U.S. NPS 1978: IV-8).

The policy also differentiates between various land management zones of national parks and establishes different management objectives for them. In natural zones (98.96 percent of Voyageurs' total area), fisheries management shall be specifically aimed towards preservation or restoration of the full spectrum of native species, including fish, and regulated for native species so that mortality is compensated by natural reproduction (ibid.). In addition, "no artificial stocking of exotic fish species will occur; artificial stocking of fish may be employed only to re-establish native species" (ibid.).

The 1971 legislation authorizing the establishment of Voyageurs National Park specifies that the area will be administered in the following ways:

> The Secretary shall permit recreational fishing on lands and waters under his jurisdiction within the boundaries of the park in accordance with applicable laws of the United States and the State of Minnesota, except that the Secretary may designate zones where and establish periods when no fishing shall be permitted for reasons of public safety, administration, fish and wildlife management, or public use and enjoyment. Except in emergencies, any regulations of the Secretary pursuant to this section shall be put into effect only after consultation with the appropriate agency of the State of Minnesota (Section 302(a)).
>
> The seining of fish at Shoepack Lake by the State of Minnesota to secure eggs for propagation purposes shall be continued in accordance with plans mutually acceptable to the State and Secretary (302(b)).

Neither the enabling legislation or any subsequent legislation pertaining to the park provide for commercial fishing as a legitimate use within the authorized boundaries of the park though testimony in the hearings for the establishment of the park indicated that commercial fishing could be allowed

to continue The U.S. Supreme Court (No. 85-1561) recently upheld a court of appeals decision in Organized Fishermen of Florida vs. Watt (590 F.Supp. 805-816 (1984)) that upheld the National Park Service's ban on commercial fishing in Everglades National Park. The court noted that where Congress has intended to permit commercial fishing in a national park it has said so explicitly in the park's enabling legislation, such as for Glacier Bay and Wrangell-St. Elias National Parks and Preserves. Public statements by NPS administrators that commercial fishing would not one day be prohibited in Everglades N.P. were found to not compromise this congressional intent.

Fishing in Voyageurs is carried out under Minnesota regulations and fisheries management goals and objectives that "provide for optimal use of the fisheries resource of the waters within the park" (MDNR 1983). Waters in the park are managed under the following goals: (a) preserve, protect and improve fish habitat to maintain the fisheries resources; (b) maintain and restore fishing opportunities in lakes and streams by stocking where appropriate; (c) encourage adequate facilities for public sport fishing opportunities; (d) obtain information on chemical, biological, physical and use characteristics of all bodies of water to formulate fisheries management plans; (e) conduct investigations to understand and develop the fisheries resource; (f) provide a public informational program; and (g) provide for coordination of fisheries management activities statewide and internationally (MDNR 1983).

Management of the fishery resource in Voyageurs is complicated by the fact that the park lies along the international border between the U.S. and Canada (Province of Ontario). Kabetogama Lake is wholly within park boundaries, but Rainy, Namakan, and Sand Point Lakes are under the joint jurisdiction of the U.S. and Canada. Regulations regarding the fishery differ between the two jurisdictions. The OMNR and MDNR, however, are attempting to standardize fishing regulations for all international boundary waters.

The National Park Service has the authority, consistent with existing law and the Department of the Interior Fish and Wildlife Policy, 43 CFR Part 24, to phase out fish stocking or other fisheries management programs within Voyageurs National Park upon a finding that such activities are not consistent with the purposes and values for which that unit of the National Park System was established. The United States Supreme Court decided in Hughes vs. Oklahoma (1979) that the various States did not "own" the wildlife within their individual states. Although a state may regulate the taking and possession of wildlife, its authority is always subject to the paramount power of the United States. In Kleppe vs. New Mexico (1976) the Supreme Court unanimously ruled that the property clause of the U.S. Constitution gives Congress the power to protect wildlife on the public lands, state law notwithstanding.

When creating the National Park Service, Congress specifically provided that the Service "shall promote and regulate the use of the Federal areas known as national parks" for the purpose for which they were established and "to conserve...the wildlife therein." Congress has explicitly charged the Secretary of the Interior and the National Park Service with the obligation to manage the wildlife, including fisheries, within National Park System units. Although Voyageurs' enabling legislation specifically allows for recreational fishing, fisheries management activities within the park must be conducted in a manner consistent with the 1916 National Park Service Organic Act.

The park's enabling legislation also states that while fishing will be permitted, the Secretary may designate zones where and establish periods when no fishing shall be permitted for reasons of public safety, administration, fish and wildlife management, or public use and enjoyment. Although such actions by the Secretary are to be taken in accordance with the applicable laws of the State of Minnesota and after consultation with the MDNR, authority for such action is solely with the Secretary. Consultation with the state is advisory only. Congress and the Supreme Court have therefore provided the Service with a broad mandate for actively managing the fisheries resource in Voyageurs National Park.

Native Fishes. The major lakes of Voyageurs are interconnected with each other and with the Rainy Lake watershed system, and thus reflect the diversity found in the area. There are approximately 48 species in 16 families of fish in Voyageurs (Table 8-1). Fish species composition is similar throughout the system, with the Percidae (i.e., walleye, perch, sauger) dominating the highest trophic level. Northern pike of the family Esocidae is also an important large predator. The Cyprinidae is the most abundant family, with members of the Centrachidae and the Catastomidae families being well represented.

The lakes of the park formed relatively recently with the receding of glacial Lake Agassiz about 10,000 years ago (Teller and Clayton 1983). Perhaps the largest freshwater lake that ever existed on the North American continent, Lake Agassiz formed at the edge of the Wisconsin ice sheet 12,000 to 13,000 years ago. The lake initially drained south into the Mississippi watershed, allowing the northward movement of fish from the Mississippi glacial refugium. Most species of fish in Voyageurs are believed to be derived from this immigration. At various times Lake Agassiz had connections with the Superior basin and the Hudson Bay system, dispersing fish over a vast area. Eventually most of Lake Agassiz drained into Lake Superior. The connection between the two was severed by glacial rebound and the lakes left by Agassiz's recession drained to the north. Fish were segregated and scattered with the lake's retreat, as new watersheds were formed, including the Rainy River watershed of which Voyageurs is a part (Baily and Smith 1981, Crossman and McAllister 1986, Treuer 1979).

Evidence of this segregation of species into discrete local populations exists in the park's interior lakes on the Kabetogama peninsula. Shoepack and Little Shoepack Lakes support a strain of muskellunge which appears to be morphologically dissimilar to muskellunge found elsewhere in the area. Genetic studies could possibly verify this distinction. Cruiser, Little Trout and Mukooda Lakes support small populations of lake trout, a species not found in the other interior lakes. Stocking of nonnative genotypes of lake trout into these lakes has made it difficult to assess the present condition of the native population. Observers have noted two morphologically distinct types of trout in the lakes, however, supporting the theory that they are genetically distinct. In order to respond to the Service's mandate to restore and preserve native fish populations, such problems must be adequately evaluated.

Introduced Fishes. Around the turn of the century, as the commercial fishery of the area was intensively developed, much stocking was undertaken (MDNR files, International Falls, Mn). Because of the lack or incompleteness of records at that time, it is difficult in some cases to determine with

certainty which species now present are native or were introduced. For instance, smallmouth bass were stocked, but there may have been a natural population prior to stocking (Phillips et al. 1982, Eddy and Underhill 1974). Largemouth bass, bluegill, pumpkinseed and black crappie were possibly introduced.

Often non-native species and genotypes are not adapted to the particular ecosystem into which they are introduced and survive only if the natural populations have to some extent been displaced. The introduction of non-native species at a time when native fish populations were under severe pressure from commercial exploitation may have allowed certain changes in species composition to occur. Most introduced species have been predators, thus having the potential to cause disruptions of predator-prey interrelationships. It is also uncertain what effect the stocking of non-native genotypes of native species has had on native gene pools of some species.

Fish Stocking. Because of the past importance of the commercial fishery and the continued importance of the sport fishery, stocking of fish has been done in the waters in and around Voyageurs since 1917. In that year, in response to the rapidly expanding walleye fishery, a hatchery was established at the western end of Rainy Lake at Ranier, Minnesota. The state of Minnesota assumed management of the hatchery in 1919. Later the hatchery was moved to International Falls, Minnesota, where it operated until 1943, supplying walleye fry to area lakes. Since 1917 extensive stocking has occurred on Rainy, Kabetogama and Sand Point Lakes and the numerous interior lakes of the Kabetogama Peninsula, and continues due to pressure from local sportfishing clubs. Table 8-2 lists stocking activities administered by the MDNR. It is probable that very early records are incomplete or absent. Also unknown are the origins of fish stocks used in early plantings.

Walleye is the major stocked species in the large lakes of Voyageurs . Since 1937 over one-half billion walleye fry have been introduced into Rainy Lake with over 12.5 million fry having been added in the first five months of 1987. In Kabetogama Lake almost 80 million walleye were stocked from 1918-1986, with most stocked prior to 1943. Later plants have been done with stocks native to the Rainy River watershed, but earlier plants may have been done with transplants from other watersheds, and thus from genotypically different populations. Other native and exotic species have also been stocked, including sunfish, crappie, largemouth bass, smallmouth bass, northern pike, yellow perch, muskellunge and catfish.

The park's numerous interior lakes have also been stocked with game fish since the early 1900's. Largemouth bass, smallmouth bass, crappies, bluegill and pumpkinseed were stocked in many of the lakes. Cruiser, Little Trout and Mukooda Lakes are believed to have contained small native populations of lake trout. Lake trout of a nonnative genotype have been introduced into these lakes for many years, and it is unknown whether the native genotype is still present. Rainbow trout, an exotic species, was introduced into Beast and O'Leary Lakes in 1964, after the lakes were treated in 1961 with the biocide Toxaphene. This stocking program continued until 1980.

At present, stocking programs in park waters include the annual introduction of thousand of walleye fry and fingerlings into Rainy and Kabetogama Lakes and

thousands of yearling lake trout into Cruiser, Little Trout and Mukooda Lakes. This program is administered by the MDNR, and has substantial support from local sportfishing organizations. Service policy states "no artificial stocking of exotic fish species will occur; artificial stocking of fish may be employed only to re-establish native species" (U.S. NPS 1978). In the case of the walleye stocking program, a viable reproducing population already exists in the lakes being stocked.

Commercial Fishing. Commercial fishing began in the area now known as Voyageurs National Park in 1885 with a pound-net fishery for lake sturgeon.

Table 8-1. Native and introduced fishes in Voyageurs National Park*. Species possibly introduced indicated by +++ (Phillips et al. 1982, Eddy and Underhill 1974)

Family Petromyzontidae - lampreys	
Silver lamprey	*Ichthyomyzon unicuspis* Hubbs and Trautman
Family Acipenseridae - sturgeons	
Lake sturgeon	*Acipenser fulvescens* Rafinesque
Family Hiodontidae - mooneyes	
Mooneye	*Hiodon tergisus* Lesueur
Family Salmonidae - trouts	
Cisco	*Coregonus artedii* Lesueur
Lake whitefish	*Coregonus clupeaformis* (Mitchill)
Lake trout +++	*Salvelinus namayoush* (Walbaum)
Family Umbridae - mudminnows	
Central mudminnow	*Umbra limi* (Kirtland)
Family Esocidae - pikes	
Muskellunge	*Esox masquinongy* Mitchill
Northern pike	*Esox lucius* Linnaeus
Family Cyprinidae - minnows	
Lake chub	*Couesius plumbeus* (Agassiz)
Brassy minnow	*Hybognathus hankinsoni* Hubbs
Golden shiner	*Notemigonus crysoleucas* (Mitchill)
Emerald shiner	*Notropis atherinoides* Rafinesque
Common shiner	*Notropis cornutus* (Mitchill)
Blackchin shiner	*Notropis heterodon* (Cope)
Blacknose shiner	*Notropis heterolepis* Eigenmann and Eigenmann
Spottail shiner	*Notropis hudsonius* (Clinton)
Mimic shiner	*Notropis volucellus* (Cope)
Northern redbelly dace	*Chrosomus eos* Cope
Finescale dace	*Chrosomus neogaeus* (Cope)
Bluntnose minnow	*Pimephales notatus* (Rafinesque)
Fathead minnow	*Pimephales promelas* Rafinesque
Blacknose dace	*Rhinichthys atratulus* (Hermann)
Longnose dace	*Rhinichthys cataractae* (Valenciennes)

The lake sturgeon was fished to commercial extinction and the sturgeon fishery in Minnesota was closed in 1922. Because of the good economic return on walleye, commercial fishermen began to concentrate their efforts on this species in the 1920's. In 1924, when annual harvest yields were first reliably recorded, the walleye harvest was 330,000 pounds. By the early 1970's, the yield had precipitously declined to 41,800 pounds. Although total species yield had also decreased, the percentage contribution of walleye to the total had declined from 30 to less than 10 while the catch per unit effort (CUE) also had decreased. At the same time the growth rate of walleye increased, probably as a compensatory response to decreased abundance, and as a result the mean age of the walleye in the commercial catch declined.

In the mid-1960's, both Minnesota and Ontario reduced commercial exploitation by increasing gillnet mesh size. Minnesota also closed Black Bay of Rainy Lake to sport fishing during the early part of the season, resumed stocking of walleye fry, and provided low-water spawning substrate by installing artificial spawning reefs in Black Bay to further encourage the recovery of the walleye population. Additionally the Minnesota legislature in 1983 authorized the Department of Natural Resources to purchase the walleye quotas issued by licence to commercial fishermen in the U.S. waters of Rainy Lake. This buy-out was completed in 1985.

Commercial fishing of walleye, however, still occurs in the Canadian waters of Rainy Lake. Since walleye move freely across the international boundary, this harvesting also affects U.S. stocks. The Ontario Ministry of Natural Resources has estimated the potential walleye harvest for the South Arm of Rainy Lake (that area of the lake along the international border) at 41,100 pounds in Ontario waters. Ontario commercial fishermen have a walleye quota of 18,300 pounds. Ontario sport fishermen in 1982 and 1983, however, harvested 36,700 pounds per year, thereby bringing the total walleye harvest to well over the estimated potential yield for walleye (OMNR and MDNR 1984). This overexploitation could reverse the recovery of the fishery.

Other species have also been overharvested. From 1924 to 1975, the commercial fishery in Rainy Lake (Ontario and Minnesota) averaged a total annual harvest of 823,500 pounds, exceeding the estimated allowable harvest of 569,100 pounds by 45 per cent (Chevalier 1977). Although the commercial harvest was somewhat erratic, an overall decline during this time span is evident, ranging from 990,000 pounds annually during the 1950's to 440,000 pounds in 1975 (ibid.)

In the park commercial fishing continues in the Minnesota and Ontario waters of Namakan Lake, including a small sturgeon fishery in the Ontario waters of Namakan Lake. Commercial harvesting of walleyes is not permitted in the Minnesota waters of these lakes. Lake Kabetogama was closed to commercial fishing in 1926. In Ontario commercially harvested species include walleye, northern pike and whitefish.

Sport Fishing. Sport fishing has traditionally been and continues to be the principal visitor activity in the lakes now included in the park. Kabetogama Lake receives the majority of the fishing pressure, most of which is directed at the walleye. There are indications that the walleye population is being overexploited. Total yields of walleye in 1977 and 1978 were 3.3 and 6.7 pounds per acre, respectively, (Ernst and Osborn 1980) while from 1983 to 1985 the annual yield was 1.8 pounds per acre (Kallemeyn 1986). In boreal shield

lakes such as Kabetogama, few lakes appear capable of sustaining percid yields greater than 1.3 pounds per acre per year (Adams and Olver 1977).

Yields higher than the actual carrying capacity of a lake may result in reduced average size of fish and a decline in catch rates. The increased harvest of two year old walleye from 1983-1985 would seem to indicate that such a change is occurring in the Kabetogama Lake fishery. Evidence also suggests that growth rates increased between 1966 and 1985 (Kallemeyn 1986). Increased growth rate characteristically occurs when a percid population is overexploited (Spangler et al. 1977). Angler catch rates are also indications of population strength and may to some extent determine the subjective quality of the angling experience. The walleye catch rate in 1946 was 0.58 fish per hour. In 1978 the rate had declined to 0.23 fish per hour (Osborn et al. 1981), and from 1983 to 1985 it was lower still, 0.12 fish per hour (Kallemeyn 1986). These recent rates for Kabetogama compare unfavorably with some other Minnesota lakes (Table 8-3).

In the South Arm of Rainy Lake, a portion of which lies within the park, the walleye population has been overexploited by both commercial fishing and sport fishing. Chevalier (1977) found a 58 per cent decline in the population between 1924 and 1975. He noted that exploitation acted to depress the number of spawners, an effect intensified because of the observed greater exploitation of younger age-groups and the subsequent loss of older age-groups. Changes in commercial fishing regulations, the closing of Black Bay to sport fishing in the early part of the season, and other measures have allowed the walleye population to recover somewhat in the early 1980's. This recovery is tenuous as it is mainly dependent on two year-classes, 1979 and 1980. However, levels of harvest exceeded the estimated potential yield by 14 per cent in 1982 and 1983 (OMNR and MDNR 1984). In 1985 walleye angling limits were increased in the Minnesota portion of Rainy Lake by the MDNR, a move that could reverse the recovery of an unstable population.

Wintertime sportfishing through the ice is also a popular visitor activity in the park. Walleye, northern pike, and other species are taken with hook and line, while Minnesota residents are also permitted to spear northern pike, roughfish, catfish and whitefish, with northern pike being the most popular catch. Little is known about the total harvest of fish removed during the winter, although MDNR personnel have conducted counts of ice-fishing houses on Kabetogama Lake and the Minnesota portion of Rainy Lake. From 1974 to January 1987 the average number of such houses was 50 per year on Kabetogama Lake and 94 per year on Rainy Lake (MDNR files, International Falls). Creel censuses would help determine the total ice-fishing harvest or catch per unit effort. It is also unknown what effect the spearing of fish through the ice has the northern pike population. Spear fishermen, unlike anglers, can see a fish entering the range of the spear, and therefore can selectively choose to spear very large fish. The removal of a percentage of the spawning population can reduce the potential number of young in the next year-class, and thus may reduce the stability of the population. Without harvest information it is difficult to assess the impact of this activity.

Rough Fish Removal. MDNR has in the past issued permits for the removal of so-called "rough" species of fish from state waters, including the waters now in the park. From 1966 to 1987, 110,436 pounds of white suckers were removed from tributaries of Rainy Lake. Thousands of pounds of burbot, cisco,

whitefish and northern redhorse suckers were also removed. Similar removals have occurred in Namakan Reservoir. In the 1970's, 46,677 pounds of white suckers were netted from Kabetogama Lake. These species of low economic value have been perceived as competitors of the game fish which are so important to the sport and commercial fisheries. Although the removals may occur outside of actual park boundaries, they occur in waters which are contiguous with park waters, and thus affect park fish populations which freely move back and forth. This type of management is inconsistent with the Service's policy of maintaining and restoring natural ecosystems in national parks. Instead, it serves special interest groups which view the propagation and rearing of game fish as the park's primary fisheries management goal. The selective removal of certain species disrupts natural species composition and imposes an artificial and inherently unstable balance in the system.

Bait Fishing. Bait fish are being commercially harvested in park waters, including Kabetogama Lake and one or more of the interior lakes. In addition, several individuals are licensed by the MDNR to collect bait fish in Ash River, which flows into Kabetogama Lake. No data is available on the species, numbers or sizes of harvested bait fish, and thus it is difficult to assess the impact that this activity has on fish and wildlife populations within or adjacent to the park. Bait fishing conflicts with the congressional mandate that prohibits commercial fishing in Voyageurs.

The MDNR recently prohibited commercial bait fishing for minnows and leeches in designated trout waters, wildlife management areas, state parks, and within 50 yards of any site where loons are nesting (Commissioner's Order No. 2263, February 20, 1987). Commercial taking of leeches in Minnesota state parks was found to be incompatible with the natural system goals of such units because leeching disturbs nesting common loons and other waterfowl and dramatically reduces reproductive success (see Common Loon Management, VOYA-N-010).

Fishing Regulations Enforcement. The size and geographical complexity of the park create a situation in which compliance with fishing regulations is difficult to monitor and enforce. MDNR records indicate that there is a high rate of compliance with state fishing license requirements. MDNR conservation officers routinely check fishing licences of visitors within park boundaries and have reported a low incidence of anglers with invalid or no licences. For this reason, park rangers generally check for licence compliance only in special instances, i.e. if visitor is stopped for another violation of park regulations.

Regulated Lake Levels. Levels of the four major lakes within Voyageurs are regulated by dams within limits set by the International Joint Commission. Namakan Reservoir encompasses Kabetogama, Sand Point, Namakan and Crane Lakes. Kabetogama Lake and portions of Sand Point and Namakan Lakes lie within the park while Crane Lake borders the park boundary. The water levels of these four lakes, which have a combined acreage of approximately 66,000 acres, were originally controlled by natural rock sills at the outlet of Namakan Lake. Two dams constructed at this outlet in 1914 are now used to regulate the water levels of all the lakes. Rainy Lake lies downstream from Namakan Reservoir and has a total area of 220,000 acres with approximately two-thirds of the 54,140 acres that lie in the United States being within the park. Water levels of Rainy Lake are controlled by a hydroelectric dam that was constructed on the outlet at International Falls/Fort Frances in 1909.

Since portions of Sand Point, Namakan, and Rainy Lakes lie in Canada, the dams and lake levels are regulated by the International Joint Commission. The dams are managed for the authorized purposes of navigation, flood control, pollution abatement, power generation, and fish propagation. The present water management programs or "rule curves" require that water levels be within a defined band of lake elevations at any particular time of the year. The water level pattern for both reservoirs consists of a gradual fall and winter drawdown followed by a spring and early summer buildup to peak levels which are maintained throughout the summer and early fall. The present average annual lake level fluctuation on Namakan Reservoir is nine feet, while on Rainy Lake it is approximately 3.5 feet. Namakan Reservoir's fluctuation is approximately three feet greater than the estimated "natural" or pre-dam fluctuation while Rainy Lake's is 2.5 feet less (Flug 1986).

Under the present water management program, winter drawdown of lake levels results in the dewatering of wetland and spawning areas by late March or early April. The breeding success of many types of park wildlife is affected adversely by this process (see Regulated Lake Level Management, VOYA-N-022). Fish species which prefer to spawn in the spring in shallow areas, on rocks or emergent vegetation, are often limited by the availability of appropriate spawning habitat. Recruitment of northern pike, walleye and yellow perch, has been found to be positively correlated with utilizable spawning area (Kallemeyn 1987b and 1987c).

In Kabetogama Lake, reproductive success of northern pike was related to spring water levels (ibid). During the period studied the most successful year-class, 1985, was associated with the highest spring water levels. However, with the present "rule curve" most of the emergent vegetation suitable for northern pike spawning would not be flooded at spawning times in most years. The comparatively small catches in 1983 and 1984 were associated with water levels too low to flood the majority of spawning areas.

In Kabetogama, Sand Point and Rainy Lakes, recruitment of walleye was significantly positively correlated with mean springtime lake levels (Kallemeyn 1987b). A strongly positive correlation was also found between lake levels and yellow perch success in the major park lakes. With the present "rule curve" the probability that the Namakan Reservoir will reach the minimal water level necessary for satisfactory spawning of walleye is only about fifty percent. Similarly, in Rainy Lake only the upper level of the "rule curve" range has been found to provide satisfactory spawning conditions for walleye.

Projections of natural or pre-dam conditions indicate that water levels usually dropped during the summer, approximately two feet in Rainy Lake and three feet in the Namakan Reservoir. This summer drop allowed satisfactory spawning habitat, including wave-washed gravel and emergent vegetation to develop at lower elevations. In contrast, under the current water management program, water levels are allowed to increase in late spring and early summer to peak levels which are maintained until fall. Because of this, the wave-washed gravel and rock substrates walleye prefer for spawning and the emergent vegetation necessary for northern pike spawning are restricted to relatively high elevations.

The "rule curve" could be adjusted in two ways to expand spawning habitat in Voyageurs and vicinity.Spring peak levels could be adjusted so that higher water levels cccur earlier in the spring, thereby ensuring the present spawning habitat at higher elevations is flooded. Secondly, more natural conditions could be achieved and more spawning habitat could be formed at lower elevations by summer drawdowns of lake levels.

Restoration of more natural fluctuations would be in keeping with the National Park Service's mandate to protect, perpetuate, and restore natural aquatic environments and native species in national parks. Changes in the water management program should be implemented so that the magnitude and timing of lake level fluctuations more closely approximate natural conditions. Such changes would affect international waters and so must be mandated by the International Joint Commission. A more thorough discussion of lake level management is presented in Regulated Lake Level Management, VOYA-N-022.

Septic Drainage and Other Habitat Degradation. The vicinity of what is now Voyageurs National Park has been extensively utilized by man since the late 1800's. Environmental damage has resulted from logging, mining, transportation, and related activities, and intensive development of ecologically sensitive areas for human habitation and use.

Logging began in the area which is now the park in the late 1800's. White pine, the preferred lumber species, was removed at a great rate until it was virtually gone by 1930. Since then, the logging of pulpwood species, particularly aspen, continued until 1971 when Voyageurs National Park was authorized. At localized areas benthic habitat may have been affected by the soil erosion and deposition of tree materials which attends logging activities. Evidence of this deposition is still apparent in Hoist Bay of Namakan Lake where benthic sampling in 1986 revealed a layer of bark covering the bottom of the bay, resulting from logging activities which ceased in 1926.

Shoreline modification and development has occurred to a great extent along the lakes that now lie partly or entirely within the park. Private year-round and seasonal residences, and small resorts are numerous in some areas bordering park waters. In addition, numerous retained use and occupancy cabins and some private residences remain within the park. Certain environmental problems have been associated with these developments. Septic drainage, navigational dredging, shoreline manipulation and soil erosion resulting from man's activities have caused habitat destruction and degradation. The input of organic and inorganic materials has changed the environment both physically and chemically.

These conditions have been mitigated in recent years by the application of county zoning ordinances which prohibit construction in a zone seventy-five feet inland from the shoreline. Ordinances also set conditions for septic leaching beds, prohibiting direct drainage into lakes and streams. Wetlands adjacent to park waters are protected by the permit system of the U.S. Army Corps of Engineers which controls activities such as dredging, channel modification and shoreline manipulation. Development within Voyageurs has been and will continue to be conducted in an environmentally sound manner to minimumize impacts on the park's interrelated aquatic and fisheries resources.

MANAGEMENT OF HUNTING, TRAPPING AND WILD RICE
VOYA-N-014

STATEMENT OF PROBLEM

Hunting and trapping in the area that is now Voyageurs National Park had been a traditional use since humans first inhabited the area until it was banned by the legislation establishing the park. Even after that a few local residents and landowners continued to hunt and trap in the park. Although all hunting and trapping were prohibited on federal lands and waters within the boundaries of Voyageurs when it was authorized, hunting and trapping are currently permitted on private lands within the park. Illegal hunting and trapping also continue on federal lands within the park. Wild rice (Zizania aquatica) was historically much more abundant and widely distributed in Rainy, Kabetogama, Sand Point and Namakan Lakes than it is today. Since the early 1900's these lakes have had their water levels elevated and artificially controlled by dams. The combination of inundating these major lakes with 4 to 6 feet of water and artificially fluctuating lake levels from 4 to 11 feet annually decimated the park's pre-dam wild rice population (see Regulated Lake Level Management, VOYA-N-022). These problems are incompatible with Voyageurs' legislative purpose and National Park Service policy and guidelines.

When creating the National Park Service, Congress specifically provided that the Service "shall promote and regulate the use of the Federal areas known as national parks" for the purpose for which they were established and "to conserve . . . the wildlife therein." Congress has explicitly charged the Secretary of the Interior and the National Park Service with the obligation to manage the wildlife (including huntable and trapable animals and wild rice harvesting) within National Park System units. Voyageurs' enabling legislation did not specifically allow for recreational hunting, trapping and wild rice harvesting activities within the park. Therefore, hunting, trapping and rice harvesting are not consistent the Voyageur's enabling legislation and the 1916 National Park Service Organic Act.

Consistent with existing law and Department of the Interior fish and wildlife policy (43 CFR Part 24) the Service may phase out hunting and trapping on private inholdings within Voyageurs upon a finding that such activities are not consistent with the purposes and values for which that unit of the National Park System was established. The United States Supreme Court decided in Hughes v. Oklahoma (1979) that the various States did not "own" the wildlife within their individual states. Although a state may regulate the taking and possession of wildlife, its authority is always subject to the paramount power of the United States. In Kleppe v. New Mexico (1976) the Supreme Court unanimously ruled that the property clause of the U.S. Constitution gives Congress the power to protect wildlife on the public lands, state law notwithstanding.

Although such actions by the National Park Service are to be taken in accordance with the applicable laws of the State of Minnesota and after consultation with the state, authority for such action is solely with the Secretary of the Interior. Consultation with the state is advisory only.

Such consultation does not require the NPS to conform to state requests or advice. It is required only that the state be given the opportunity to comment on a proposed action relating to the closure. Congress and the Supreme Court have therefore provided the Service with a broad mandate for actively managing the terrestrial and aquatic resources in Voyageurs National Park.

Hunting and Trapping. Although all hunting and trapping were prohibited on federal lands and waters within Voyageurs' boundaries when it was authorized (U. S. Public Law 91-661, 1971), hunting and trapping are currently permitted on private inholdings (2 percent of the lands within the park). After Voyageurs was established in 1975, the Minnesota Department of Natural Resources supported the Service's hunting and trapping ban. MDNR Commissioner Herbst's Order No. 1947, signed August 13, 1976, restricted hunting and trapping of wild animals on all lands (private inholdings included) and waters within the park. On December 1, 1979, a portion of the order was revoked by MDNR Commissioner Alexander and the state again declared private lands within the park open for hunting and trapping. These recreational activities have been permitted annually by the MDNR ever since.

In 1988, the Service began requiring all hunters and trappers to obtain a written permit to transport lawfully taken wildlife across lands and waters in Voyageurs National Park (Sec. 2.2(d), 1988 Compendium: 36 CFR 1.7(b)). Waterfowl transported across park lands at the Rainy Lake Visitor Center, however, does not require a written permit. Legally taken game may also be transported on NPS 1 from the Ash River Trail for a distance of 1.5 miles north without a permit. The mandatory permit may be issued in advance of the anticipated transport of wildlife and may be issued for the entire hunting or trapping season. After harvested animals are carried through the park, the permittee must advise the park of the number and species of animals transported. Seventy-four permits for transporting lawfully taken wildlife across park lands were issued in 1988, but not one permittee advised the park about the number and species of wildlife taken. If one assumes that there is probably a maximum of 50 percent compliance with this permit requirement, this indicates that about 150 permits might be issued if there was full compliance.

Numerous wildlife species on private lands within the park and those that leave the park and go to public and private lands outside and contiguous with the park are subject to legal harvest by hunters and trappers in Minnesota and Ontario. The harvests within the park boundary are inconsistent with NPS policies and regulations, Code of Federal Regulations and Public Law 91-661.

Native American Hunting and Fishing Rights. On January 25, 1983, in Lac Courte Oreilles vs. Voight, a U.S. 7th Circuit Court of Appeals decision re-affirmed off-reservation hunting, fishing, trapping, and rice gathering treaty rights to various Chippewa Indian tribes in Wisconsin, Minnesota, and Michigan. There is currently a great deal of controversy in northern Wisconsin as tribal members exercise their treaty rights on and off their reservations. Tribes are negotiating with the Wisconsin DNR and are developing biologically based wildlife management programs on their lands. Using the Voight decision as a precedent, the Grand Portage Band of Minnesota Chippewa filed a lawsuit in August, 1985 that challenged the State's authority to regulate hunting, fishing and trapping on publicly owned lands in northeastern Minnesota.

In response to the Voight decision and the Grand Portage Band lawsuit, a memorandum of agreement between the Lake Superior Chippewa and the State of Minnesota was signed in 1988. In the memorandum, the Chippewa agree to give up certain hunting and fishing rights in exchange for an annual payment to the Grand Portage, Bois Forte, and Fond du Lac Bands. The agreement is an effort by the State to resolve all hunting and fishing issues between the Grand Portage Band and the State and to avoid future court cases. The memorandum of agreement was adopted by the state legislature, and approved by the three Chippewa bands.

Wild Rice. Wild rice in Voyageurs was historically much more abundant and widely distributed in Rainy, Kabetogama, Sand Point and Namakan Lake shallows than it is today. Wild rice evolved in conjunction with naturally fluctuating water levels. Archeological evidence gathered from the park indicates that wild rice was a staple in the diet of prehistoric and historic native people. Life for the Blackduck, Laurel, Cree, and Ojibway people revolved around the seasonal harvest. In late summer when the wild rice ripened the people assembled at the rice beds for the harvest. Fire pits used by the Indians for processing the rice near these gatherings have been found within the park (Lynott et al. 1986). Ricing was an essential part of the seasonal rhythm, an important occasion for feasting, dancing and religious ceremonies (Searle 1977). That Indian ricing tradition persists today and many other Americans harvest rice as well.

Evidence recorded in the park's oral history collection indicates that before water control structures were completed at International Falls (1908) and Kettle Falls (1914) and the water levels raised, wild rice was found in most of the shallow bays and backwaters of Voyageurs' major lakes and streams. The lake basins have since had their water levels artificially controlled. The combination of inundating these park lakes with 4 to 6 feet of water and artificially fluctuating lake levels from 4 to 11 feet annually decimated the pre-dam wild rice population and eventually it disappeared from the aquatic zone it once inhabited. A new population was not able to quickly replace the old one because the aquatic grain could not readily adapt to the new water level regime. Most of the unharvested grain previously left on the lake bottom was apparently too deeply inundated to germinate. The remainder of the seed probably could not find enough suitable habitat to re-establish the population in the newly created littoral zone. New seed sources became scarce and subsequently the wild rice population remained relatively rare on most portions of the park's lakes for nearly thirty years.

But some park waters did eventually develop extensive populations of wild rice through human intervention. The Koochiching Sportsmens' Association, an International Falls based group, recognized the importance of wild rice in waterfowl habitat. The club wanted to attract and hold waterfowl in the area for hunting purposes. They planned and implemented a wild rice restoration project on the U. S. portion of Rainy Lake and some portions of Kabetogama Lake (Table 14-1 and Figure 14-1). The wild rice planting project encompassed many years. Beginning in the fall of 1940, members planted rice in Black and Cranberry Bays on Rainy Lake, and Lost and Daley Bays on Kabetogama Lake. Signs of the rice were spotted the following July. Club members again hand planted wild rice purchased from the Deer River, Minnesota area in the Black Bay and Rueter Creek portions of Rainy Lake in the late 1950's and early 1960's. Other area residents also occasionally planted wild rice to re-

establish the species locally. As a result of these efforts sizable wild rice populations were re-established on Black and Cranberry Bays on Rainy Lake. The planting efforts failed on Kabetogama and the population remains scarce and threatened there as well as on Namakan, and Sand Point Lakes where water levels annually fluctuate from 8 to 9 feet.

The Minnesota Department of Natural Resources supported those wild rice planting projects and when Voyageur's legislation became law the MDNR was keeping the areas in Black and Cranberry Bays officially closed to human harvest. When Voyageurs was established in 1975, park managers also recognized the importance of protecting the park's wild rice population but at the same time recognized the tradition of utilization of wild rice for human consumption and native American religious purposes. On August 10, 1977 the Superintendent announced a wild rice harvest on park waters but with prohibitions on harvesting for commercial purposes and with limitations of only 50 pounds per household. Two days later it was discovered that a MDNR Commissioner's Order was issued that permitted wild rice harvesting within Voyageurs National Park. According to the order a state permit was needed to rice in the park but there were no poundage or commercial restrictions described. The MDNR had not informed park officials about this management decision and a controversy concerning jurisdictional rights over the park's waters and subjects occurred.

Subsequently, the MDNR Commissioner and the park Superintendent developed a cooperative agreement to allow ricing within the park in 1978. A park permit, in addition to the MDNR permit was also required to rice in Voyageurs. But the Superintendent continued to ban harvesting for commercial purposes and allowed 50 pounds per household. These restrictions were unbeknownst to the MDNR Commissioner and he protested them because he believed that the federal regulations gave no legal rights to tie the hands of state residents. But the state did not choose to legally challenge the restrictions.

Wild rice harvesting was permitted in the park thereafter until 1987. That year, the Superintendent closed the park's wild rice harvest to the general public. The Black Bay wild rice population outside park boundaries remains open to public harvest. The Native American Religious Freedom Act, however, has provisions that allow native Americans to continue harvesting the park's wild rice for religious purposes. Because approximately 1,000 acres from Black Bay were deleted from the park to create the Gold Portage Wildlife Management Area in 1983, approximately one half of the wild rice formerly inside the park was removed from NPS jurisdiction. The Superintendent closed Voyageurs wild rice harvest because regulations promulgated since the last jurisdictional challenge required him to restrict wild rice harvesting within the park (36 CFR 2.1). That CFR allows for consumptive uses only after a determination that there will be no effect on park resources. Ricing will remain open to native Americans for religious and traditional (noncommercial) uses only (Sec. 2.1(c)(1), 1988 Compendium: 36 CFR 1.7(b)).

The National Park Service has the authority, consistent with existing law and the Department of the Interior fish and wildlife policy (43 CFR Part 24) to phase out wild rice harvesting within Voyageurs upon a finding that such activities are not consistent with the purposes and values for which that unit of the National Park System was established.

Restoring Wild Rice. Since 1988, the Resource Management Division has been studying the feasibility of restoring wild rice throughout Voyageurs by establishing and monitoring several test plots on the park's major lakes. To initiate this test project, rice was planted during the second week of September 1988 in Lost, Marion, and Finlander Bays on Rainy Lake, and in Rantas Bay on Kabetogama Lake. Rice is planted along five transects that are offshore, parallel to the shoreline and about fifty feet long. Transects are located at the following depths below the normal high water mark: 1.0, 2.0, 3.0, 4.0, and 5.0 feet. Along each transect, one cup of rice is scattered every five feet. The beginning and end of these transect lines are permanently identified on shore so they can be easily relocated. Test results are documented photographically and by a visual estimate of the percent cover occupied by wild rice. Each transect is photographed and visually evaluated when first planted and during subsequent summers during the first week of June, July, August and September.

Until a stand of rice is established, plots will be replanted each year in late August and early September. Once a stand is established, its long-term status and trend will continue to be documented photographically and visually. To supply seed for the project, Resource Management staff will harvest by canoe about 100 to 200 pounds of wild rice a year in Cranberry Bay. This represents less than a thousandth of one percent of the total production of rice in the bay, even in years with low production.

ALTERNATIVE ACTIONS AND THEIR PROBABLE IMPACTS

A. **Abandon Current Hunting, Trapping and Rice Management Program.** Under this alternative, the National Park Service's current program to manage hunting, trapping and wild rice within Voyageurs National Park would be abandoned. Wild rice harvesting throughout the park would be open to the general public and native Americans who possess a valid MDNR ricing permit. Efforts to restore additional wild rice populations in the park would be discontinued. The mandatory permit requirement to transport game across the park would be abandoned. Enforcement of hunting, trapping and wild ricing regulations would be discontinued. Fee simple title to private land within the park would continue to be acquired on a willing seller, willing buyer basis. Efforts to increase public information about prohibitions on hunting, trapping, and ricing in a national park would be discontinued. Programs to monitor hunting and trapping within the park, monitor wild rice populations, and monitor waterfowl, upland game bird, furbearer, ungulate, and black bear populations subject to legal harvest would not be initiated.

   Implementation of this alternative would not adequately protect Voyageurs' wildlife and wild rice populations from the adverse effects of human harvesting and disturbance within the park. Harvesting of wild rice by humans would reduce or eliminate an important local food source for waterfowl, and aquatic and upland wildlife in the fall, winter and spring. Competition for wild rice and disturbances during harvesting from humans may shorten fall stopover times by migrating waterfowl and locally reduce aquatic and upland wildlife populations. Harvesting may also slow the

EASTERN TIMBER WOLF MANAGEMENT
VOYA-N-015

STATEMENT OF PROBLEM

Although gray wolves (Canis lupus lycaon) are totally protected from human exploitation within Voyageurs National Park, the park's wolf population is subject to legal and illegal harvest in Ontario, and illegal harvest in Minnesota. Since only one or two of Voyageurs' six or more wolf pack territories is completely contained inside park boundaries, most park wolves spend much of their time outside the park searching for food and dens. Park wolves that venture into Ontario are legally trapped as a furbearer (Kolenosky 1983). Park wolves that venture into Minnesota are subject to predator control, vehicle collisions, accidental trapping, and illegal hunting and trapping. Wolves could potentially be replaced by coyotes within the park and vicinity. These man induced problems faced by the park's wolf population are incompatible with Voyageurs' legislative purpose, National Park Service policy and guidelines, and the Endangered Species Act.

The eastern timber wolf or gray wolf in Minnesota is classified as a threatened species under the Endangered Species Act of 1973 as amended (U.S. Fish and Wildlife Service 1986a). According to Section 7 of the Act "all federal agencies shall ensure that actions authorized, funded or carried out by them do not jeopardize the continued existence of such endangered species or threatened species or result in the destruction or modification of habitat of such species which is determined by the Secretary after consultation as appropriate with the affected States to be critical."

Originally, the eastern timber wolf occupied most of the eastern United States and southeastern Canada. At present, the U. S. population remains primarily in Minnesota, Michigan, and Wisconsin which comprises only about 3 percent of its original range. The eastern timber wolf is therefore restricted to the northwestern corner of its original range, an area contiguous to the Canadian population and one of short growing season, rocky outcrops, muskeg, infertile soil and low human density (U.S. Fish and Wildlife Service 1986b).

Historic information about how many wolf packs and wolves inhabited the park area prior to its establishment is lacking. Minnesota authorized a statewide wolf bounty system in 1849 which continued in effect until 1965. Wolves living in the park area throughout that period were shot, trapped and bountied. During the last 13 years that the bounty system was in effect, the average annual number of wolves bountied in Minnesota was 188 (Johnson et al. 1974). In addition to wolves being taken for bounty payments by private citizens, they were also taken by hunters and trappers employed by the State of Minnesota until 1956. The number of wolves taken by both of these activities averaged between 275-350 wolves annually from 1952-1956.

Aerial hunting probably played a major role in the apparent decline of wolves in the late 1940's and 1950's. From 1948 to 1965, it was legal for private citizens to hunt wolves from airplanes on areas outside the BWCAW if they had permits from the MDNR. Hunting wolves from airplanes by permit was a

provision of Minnesota bounty regulations. Minnesota also authorized a directed predator control program (M.S. 97.487) in 1969 which directed the MDNR to certify trappers to remove wolves from designated local areas where livestock losses from wolves were verified. An average of 65 wolves were taken annually through this program until 1974.

During the late 1960's, Minnesota's wolf population was apparently approaching it's highest level in recent times (Van Ballenberghe et al. 1975). Previously, an estimated 350 to 700 wolves were thought to exist in Minnesota in the 1960's and their numbers were considered to be static or decreasing (Chalane 1964). Since then, an intensive research program has been conducted on the wolf in Minnesota (U.S. Fish and Wildlife Service 1986b). The wolf was listed as an endangered species by the USDI in 1967 and the Superior National Forest lands of Minnesota (portions of which became the park in 1971) were closed to taking of wolves in 1970. The wolf was officially and legally protected by the federal Endangered Species Act of 1973, beginning in August of 1974. Wolves have been protected by state law in Minnesota since they were listed as threatened species in Minnesota Statute 97.488.

The Eastern Timber Wolf Recovery Plan (U.S. Fish and Wildlife Service 1986b) divides Minnesota's 31,000 square miles of wolf range into four management zones. Zones 1-3 (10,000 square miles) comprise Minnesota's primary wolf range and contain wilderness areas, regions of low human densities and levels of activities. Voyageurs lies within the extreme western portion of primary zone 1 (4,462 square miles). To the north of the park is Canada where wolves can be legally harvested. The area to the south of the park is adjacent to peripheral zone 4. The peripheral zone has a higher density of roads, farms, human activities, construction, and accessibility than all other primary zones. There are few areas within this peripheral range that are not within three miles of developed roads.

The variability and dynamic nature of wolf densities throughout various parts of northern Minnesota make it extremely difficult to arrive at an accurate estimate of wolf numbers. Four hundred wolves were estimated to inhabit the Superior National Forest in the winter of 1971-1972, or one wolf per 10 square miles (Mech 1973). By 1974-75, the wolf population on the forest had declined by about 40 percent, to one wolf per 17 square miles (Mech 1973) due to drastic declines in the numbers of deer (Mech and Karns 1977). The deer decline ended about 1977, and since then the deer population has remained low although relatively stable (Nelson and Mech 1986). Nevertheless the wolf population on a deer economy continued to decline for several more years. At low deer numbers, therefore, wolves are unable to kill enough deer to enable the wolves to maintain their numbers unless they can switch partly to alternate prey, such as moose (Mech 1986). Indications are that the number of deer and wolves in Voyageurs have fluctuated similarly, although not necessarily to the same degree.

The numbers of wolves that regularly used different areas in Voyageurs National Park (and a much larger area outside the park) over winter periods have been estimated each year since 1976 (Table 1) (Cole 1986). These wolves commonly used old logging roads, trails and lakeshore areas which had packed or hardened snow. This more dense snow often resulted from snowmachines (by themselves or grooming trails for skiing) as well as the natural effects of wind and sun on snow covered lakes. Packed or hardened snow increases the ef-

Table 15-1. Number of wolves that regularly used different areas in Voyageurs National Park over winter periods, 1976-86 (Cole 1986).

	Park Areas								
Winter	BB	KP	DB	KF	SN	MR	SB	Pairs or Single	Totals
1976-77	5	4	4	7	4	5	6	6	41
1977-78	4	2	4	8	4	4	6	10	42
1978-79	7	5	5	8	4	5	-	4	38
1979-80	8	2	7	6	4	5	-	-	32
1980-81	7	3	4	8	6	3	-	-	31
1981-82	8	7	5	2	7	4	-	1	34
1982-83	5	7	4	5	6	4	-	2	33
1983-84	6	4	6	4		8	-	3	31
1984-85	4	7	3	2		4	2	-	22
1985-86	4	5	5	2		7	-	2	25

Legend: BB, Black Bay; KP, Kabetogama Peninsula; DB, Daley Brook; KF, Kettle Falls; SB, Saginaw Bay; MR, Moose River; SN, South Namakan.

efficiency of wolves as predators by allowing them to travel to and kill prey with less energy than they would otherwise use.

Four main factors are critical to the long-term survival of the eastern timber wolf: 1) availability of adequate wild prey; 2) large tracts of land with low human densities and minimal accessibility; 3) ecologically sound management; and 4) adequate understanding of wolf ecology and management. If not for the human element, only the forest factor would be significant to wolf survival (U.S. Fish and Wildlife Service 1986b).

The need for increasing prey availability for wolves and other predators and scavengers in Voyageurs are thoroughly documented in other project statements. The Wildland Fire Management project statement (VOYA-N-024) proposes that lightning-caused fires and prescribed burns be used to maintain fire-dependent and early successional stage plant communities that will increase Voyageurs' capacity to support significantly larger deer and moose populations. The Restore Absent and Declining Native Wildlife project statement (VOYA-N-021) proposes that woodland caribou and elk populations be restored to the park and thereby significantly increase prey availability for Voyageurs' wolves.

Increasing road densities adjacent to the park in Minnesota and Ontario increase the susceptibility of Voyageurs' wolf population to increased human mortality. If road building trends continue, the proposed Boundary Waters Biosphere Reserve may one day become an island of wolf habitat isolated from other wolf populations by extensive human development. Thiel (1985) demonstrated that as road density exceeds the threshold of 0.93 miles of road per square mile of potential habitat, wolf populations could not survive. As accessibility into wolf habitat increases in the park area, wolf numbers would be reduced by legal and illegal trapping and hunting, predator control actions, accidental collisions with vehicles, and intentionally running them down with snowmobiles and other all-terrain vehicles. Although Mech et al. (1988) found that the average road density in Minnesota's primary wolf range was 0.34 mile of road per square mile, road densities are expected to increase as forestry practices become more intensive and human populations increase in the region.

Wolves normally avoid humans whenever possible as a result of hundreds of years of persecution by man (Mech 1970, Chapman 1979). In most cases, wolves are excluded from concentrations of human activity. At Isle Royale National Park, wolves began to avoid trails when spring visitor use increased (Peterson 1977). Most wolves avoided establishing den sites within 0.5 to 1.0 mile of trails. Trail and campsite development deterred wolves from using some rendezvous sites. Following repeated human disturbances, wolves may move pups away from homesites, thus exposing them to undue danger (Chapman 1979). It would be unlikely for wolves to become disturbed if human activities were excluded within a 0.5 to 1.0 mile radius of active use areas in Voyageurs. Expansion of human activities without documentation that such an expansion would not further reduce the amount of area available for wolf homesites or travel in the park consequently would not occur. Repeated disturbances of wolves may also result in reducing visitor opportunities to observe these social carnivores.

Hypotheses for both predicting and measuring the effects of winter trails and trail use on wolves and other park wildlife have been prepared by Cole (1986).

They predict that park areas with higher proportions of packed trails and trail use would have: (1) a higher proportion of wolf biomass to prey biomass; (2) a higher prey mortality rate from wolves; and (3) lower mean numbers of wolves, prey and scavenger species - to the extent prey does not compensate for higher mortality and wolves become more food-limited.

Some of the above effects would be different if trail use became heavy enough to restrict wolves from using areas. Areas with such use would have a lower proportion of wolf to prey biomass, lower prey mortality rates from wolves and lower mean numbers of wolves. The third case (#3) would not occur if prey populations compensate for any increased mortality from wolves or increase their mean numbers. It would only be possible to measure the effects of different amounts of winter trail use. Conditions without such use can only be inferred. A system for testing and refining these predictive hypotheses is described in Cole (1986).

A fairly comprehensive study of the effects of trail development and use on Voyageurs' wolf population would require yearly measurements of: the amount of packed trails and use on these; wolf, deer and moose numbers and biomass; and the proportions of deer and moose wolves kill in each pack territory (Cole 1986). The relative abundance of species that are sustained by scavenging on wolf kills as well as the location and frequency of kills relative to packed trails would be documented.

The timber wolf remains one of the most controversial wildlife inhabitants in Minnesota and Ontario. Opponents view it as an undesirable competitor for desired big game species such as white-tailed deer and moose, whereas supporters regard it as an intelligent, highly social carnivore with an exemplary family life. A highly protectionist attitude toward the wolf was found among Twin Cities residents by Kellert (1986). In contrast, northern counties rural residents living in proximity to this animal had a more pragmatic, more authoritarian, less protectionist attitude toward the timber wolf. Additionally, 38 to 58 percent of farmer, hunter, trapper and northern counties respondents reported knowing someone who had killed or captured a timber wolf. Finally, more than 30 percent of farmers, hunters and trappers, and 26 percent of northern counties respondents, indicated they might shoot a timber wolf if they encountered one while deer hunting.

Fundamental differences in perception, understanding and concern for the timber wolf among residents in different parts of Minnesota will be the basis for continuing protracted conflict regarding the management of this animal (Kellert 1986). A potentially serious problem of inordinate amounts of illegal killing and removal of timber wolves from the wild exists in the northern counties which surround Voyageurs National Park. Extensive public awareness and education programs, as well as innovative economic development efforts could nuture and broaden public support for protection of the timber wolf. Current efforts to develop a major recreational tourist attraction in Ely, the "International Wolf Center", could represent an opportunity to promote the practical value of the timber wolf for rural Minnesotans. An additional possibility of fostering agreement might involve the use of nontraditional conflict-resolution techniques based on the principles of negiotiation and compromise.

Voyageurs wolves have occasionally been harassed by aircraft engaged in buz-

zing wolves or photographing them at low altitudes. These actions are violations of (1) NPS regulations against harassing wildlife, (2) FAA regulations against harassing wildlife and possibly low-level flying, (3) the Endangered Species Act of 1973 prohibiting disturbances of wolves, and (4) federal laws against hunting or otherwise disturbing wildlife from aircraft (36 CFR 2.2 (a)(2).

Parasites and diseases carried by pets and wild canids may be a threat to park wolves. This is especially true of heartworm (Dirofilaria immitis) and canine parvovirus (CPV) which are relatively new to the eastern timber wolf. Heart worm has spread northward into wolf range probably via southern dogs brought to northern dog trails. CPV is currently infecting Minnesota wolves and can be fatal (Mech et al. 1986). It is conceivable that these diseases could become limiting factors for park wolf populations. Other diseases or parasites could have adverse impacts on wolves. The dog louse, Trichodectes canis, was recently observed on Minnesota wolves. It has never been reported previously but there were no indications that the infestations directly affected host survival (Mech 1985). Mange (Sarcoptes scabei), a widespread ectoparasite, has been observed in area wolves and could be an important factor in wolf mortality either directly through exposure to cold temperatures, or indirectly by weakening the host and increasing susceptibility to disease (Carbyn 1979).

The effects of epizootics and enzootics on wolves have not been well documented and they have not received enough attention as mortality factors effecting the dynamics of Voyageurs' wolf population. A wolf pack may be affected by contagious disease in any one of three ways: (1) through loss of experienced adults; (2) through reduced recruitment of young; and (3) through total decimation or permanent disruption of the pack. Throughout a recent wolf population decline in Riding Mountain National Park, Canada, disease was the second most common cause of wolf mortality (Carbyn 1983). Disease was strongly implicated in the dissolution and displacement of packs. Bovine tuberculosis and canine distemper directly affected recruitment of young there.

A no-pets-allowed policy is strictly enforced in Isle Royale National Park in order to protect the park's wolves and foxes from parasites and diseases. Dogs pose a special threat and even if confined to households and buildings, disease organisms could be transmitted to wild canids via feces or airborne hosts such as insects. The adoption of a similar no pets policy in Voyageurs may not be as effective as Isle Royale's because wolves and foxes would continually interact with infected pets when outside the park. Some restrictions, however, may be effective in minimizing contacts between uninfected park wolves and foxes and infected pets. Continuation of a no pets policy on Voyageurs' winter and summer trails would serve this purpose.

Political decisions involving a minimum of ecological input have historically determined wolf management policies in Minnesota. Many northern Minnesota residents inherently dislike wolves and in recent years have had to tolerate the problems associated with a dense wolf population. These include depredations on domestic livestock and dogs and cats, and competition with wolves for wild game. The MDNR and the U.S. Fish and Wildlife Service have tried unsuccessfully for the last twenty years to develop a joint management program that would permit public trapping of wolves in Minnesota (Anderson

1985). Legal action by environmental and animal protection groups in U.S. District Court have to date prevented the implementation of such programs. Without the broad legal umbrella of the wolf's threatened species status under the Endangered Species Act of 1973, these court challenges to state programs would have been unsuccessful. Political forces will continue to advocate the delisting of the eastern timber wolf as a threatened species in Minnesota for many years to come. Such a delisting might increase the mortality rate of Voyageurs' wolves when they are outside the park and consequently reduce the size of the park's population.

ALTERNATIVE ACTIONS AND THEIR PROBABLE IMPACTS

A. **Discontinue Current Wolf Management Program.** The current Voyageurs National Park program of monitoring winter wolf pack activities, informing visitors and park employees about wolves, and minimizing disturbances to wolves from park development activities would be discontinued due to lack of funding and insufficient personnel to implement the program. The effects of winter trails and users on wolves and other park wildlife would not be measured to determine the extent that snowmobiling, winter camping, snowshoeing and crosscountry skiing disrupt, exclude or have adverse effects on wolves and other park wildlife. Monitoring systems would not be established to measure the impacts from the construction and use of any trails. No attention would be given to park wolves and their critical habitats. Due to a lack of information about habitat use, human activities would not be excluded within a 0.5 to 1.0 mile radius of active wolf use areas in the park. Pets would continue to be prohibited on summer and winter trails. The opportunity to protect, maintain and perpetuate the wolf in Voyageurs would be reduced below current levels.

   Disturbances resulting from inadequate regulation of human activities in critical habitats would adversely affect wolf productivity and could result in the loss of denning and other use areas. Reduced populations of these predators would limit the visitor opportunities for viewing these canids in a wilderness setting. The effects of uncontrolled recreational activities (snowmobiling, crosscountry skiing, hiking, motorized traffic on frozen lakes and over safety portages, aircraft traffic, camping and day use activities) on wolf populations would not be monitored or evaluated. The ecological effects of absent and declining prey species on the park's wolf population would not be known. Influences of Voyageurs National Park, MDNR and OMNR wildlife management programs on the wolfs' food supply would not be monitored and evaluated.

   This alternative would conflict with direction given in the Endangered Species Act of 1973, the recovery objectives of the Eastern Timber Wolf Recovery Plan, and MDNR plans for wolf recovery and management. The lack of Voyageurs National Park management action would jeopardize the cooperative efforts by other agencies and private groups to preserve and improve the status of wolves in and on the periphery of the park. Population data and wolf pack boundary data would no longer be available to those studying wolf ecology and developing management strategies for them. Implementation of this alternative would be contrary to Voyageurs'

REGULATED LAKE LEVEL MANAGEMENT
VOYA-N-022

STATEMENT OF PROBLEM

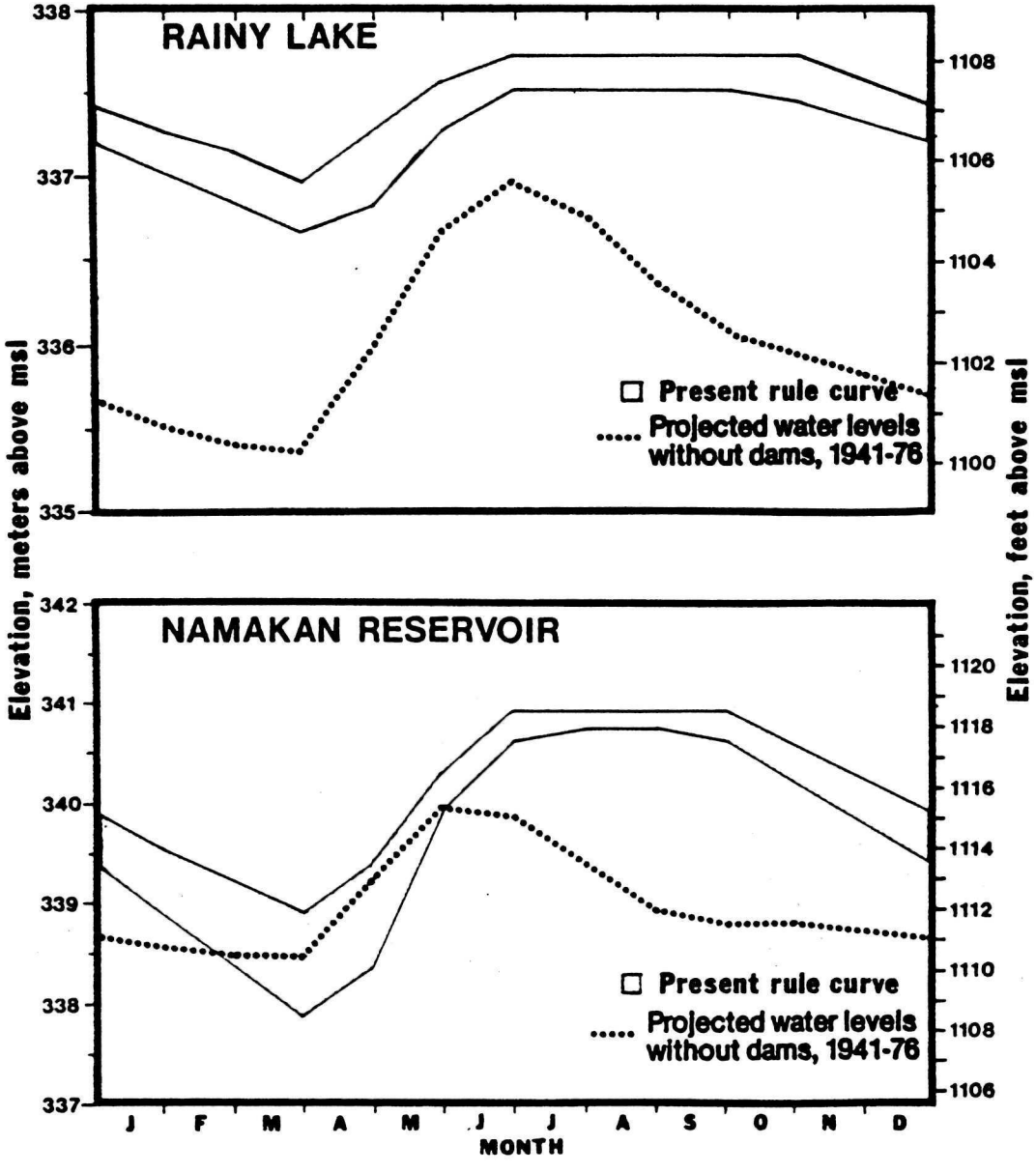
With the establishment of Voyageurs National Park in 1975, the National Park Service became one of many interest groups concerned with the regulation of Rainy Lake and three of five Namakan Reservoir lakes located inside the park (Kabetogama, Namakan, and Sand Point), which are a part of the larger Lake of the Woods watershed. Lake levels in these bodies of water are controlled by a single hydropower facility and two small regulatory dams that are located on or outside Voyageurs' boundary. The water regulatory system, which is controlled by the International Joint Commission (IJC), uses larger than natural fluctuations in lake levels on Namakan Reservoir to maintain less than natural fluctuations on Rainy Lake; the timing of fluctuations is also different under the regulated system. The park's enabling legislation directed the NPS to work within the established water regulatory system while preserving the scenery, natural and historic objects and wildlife, and providing for the enjoyment of same in ways that leave them unimpaired for future generations.

The Congress directed that nothing in the establishing legislation for Voyageurs (PL 91-661, Sec. 304) should be construed to affect the provisions regarding the September 15, 1938 Convention Between the United States and Canada on Emergency Regulation of Level of Rainy Lake and of Other Boundary Waters in the Rainy Lake Watershed (54 Stat. 1800). This convention, which was ratified on October 3, 1940, empowered the International Joint Commission "to determine when emergency conditions exist in the Rainy Lake watershed, whether by reason of high or low water, and to adopt such measures of control as to it may seem proper with respect to existing dams at Kettle Falls and International Falls, as well as with respect to any existing or future dams or works in boundary waters of the Rainy Lake watershed, in the event the Commission shall determine that such emergency conditions exist."

Even though development for commercial water power within the boundaries of the park is specifically prohibited in its enabling legislation (PL 91-661, Sec. 301c), water levels in the park's four large lakes are regulated by the IJC and controlled by dams that lie on or outside the park boundary. A hydropower facility located at International Falls/Fort Frances controls Rainy Lake while two dams located at the outlet of Namakan Lake at Kettle Falls/Squirrel Falls control the water levels in Kabetogama, Namakan, Sand Point, Crane, and Little Vermillon lakes. The latter two lakes are outside the park. Collectively, the five lakes are referred to as Namakan Reservoir for water management purposes. The Rainy Lake dam has been in operation since 1909 while the Kettle Falls/Squirrel Falls dams were completed in 1914.

The IJC, using studies conducted by its subsidiary, the International Rainy Lake Board of Control (IRLBC), developed their 1949 Order which defined when emergency conditions existed in the Rainy Lake watershed and prescribed how lake levels should be regulated to preclude the occurrence of such conditions on Rainy and Namakan lakes (International Rainy Lake Board of Control 1984). The IJC, responding to public input and the advice of the IRLBC, amended the 1949 Order with Supplementary Orders in 1957 and 1970. The latter Order is

Figure 22-1. Present water management programs (rule curves) and computed natural lake levels for Rainy Lake and Namakan Reservoir, Minnesota and Ontario (Flug 1986). Elevations given in meters or feet above mean sea level.



presently in effect.

While the dams are regulated by the IJC, they are actually owned and operated by the International Falls Power Company, a subsidiary of the Boise Cascade Corporation. Day-to-day control of the dams and the associated lake levels has generally been left to Boise Cascade as long as they operate in accordance with the IJC Orders. The IJC through the IRLBC has only become involved in the regulation of the lakes when their Orders were not or could not be followed.

The water management programs under the three IJC Orders, which are commonly referred to as "rule curves", have all used larger than natural fluctuations in lake levels on Namakan Reservoir to maintain less than natural fluctuations on Rainy Lake (Figure 22-1). Under the terms of the 1970 Order, Namakan Reservoir's average annual water level fluctuation is about 8.9 feet while Rainy Lake's is about 3.6 feet. The fluctuation of Namakan Reservoir is about 3.0 feet greater than the estimated natural or pre-dam fluctuation while Rainy Lake's is about 2.6 feet less (Flug 1986). Namakan Reservoir's overwinter (October to April) drawdown under the 1970 Order has averaged 7.5 feet which is approximately 6.6 feet greater than the estimated natural fluctuation for this time period (Flug 1986). Rainy Lake's overwinter drawdown under the 1970 Order has averaged 2.6 feet, which is similar to the 2.3 feet estimated for natural fluctuation. The timing of the fluctuations is also different under the regulated system. Regulated lake levels on the Namakan Reservoir lakes usually peak in late June or early July rather than late May or early June as they did prior to dam construction. They then remain stable on both Rainy Lake and Namakan Reservoir throughout the summer rather than gradually declining.

Effects of Regulated Lake Levels on Voyageurs' Aquatic Ecosystem. Concerns about the effects of regulated lake levels on Rainy and Namakan reservoir's aquatic biota have existed ever since the dams were constructed. The Governments of the United States and Canada in submitting the Rainy Lake Reference to the IJC for their consideration in February 1925, indicated their concerns by requesting that "for fishing purposes" be included as one of the advantageous uses of the waters of Rainy Lake and the other border lakes. The IJC's Final Report on the Rainy Lake Reference (1934), which was the basis for the 1940 Convention, included statements from numerous parties expressing concern about the possible impact of raising and regulating lake levels. The State of Minnesota and the Province of Ontario, in particular, expressed concerns about the possible impact on muskrats and other animals which make their home in or over shallow water, fish propagation, and nesting grounds of certain aquatic fowl. Both parties also indicated that recreation would be negatively impacted. These concerns were apparently recognized because in its 1949 Order the IJC included recreation and other beneficial public purposes in its list of advantageous uses of these waters; the other recognized public purposes are navigation, sanitation, domestic water supply, and power production.

Implementation of the IJC's 1949 Order and the subsequent 1957 and 1970 Supplementary Orders, however, did not resolve the issue concerning the impact of regulated lake levels on the aquatic biota. Questions continued to be raised, particularly about the relationship between the regulated lake levels and the fish community (Sharp 1941, Johnson et al. 1966, Chevalier 1977, Osborn et al. 1981). Outfitters and private citizens concerned with

navigation and the use of docks on Namakan Reservoir have frequently expressed their displeasure to the IRLBC about spring water levels.

The establishment of Voyageurs National Park with its emphasis on restoring and preserving the natural environment, raised additional questions about the impacts of regulated lake levels on the aquatic ecosystem in Rainy Lake and Namakan Reservoir (Cole 1979, 1982). As had been the case with the Minnesota and Ontario natural resource agencies 50 years before, one of the National Park Service's primary concerns was with the effects regulated lake levels have on organisms and plants that occur in the littoral or shallow-water zone and consequently are most affected by the fluctuating water levels. Due to concerns about the effects of regulated lake levels on Voyageurs' aquatic biota, the Service initiated an extensive research program in 1983 (Kallemeyn and Cole 1988).

This research program consisted of two principal components. The first assessed the effects of the present water management program (1970 Rule Curves) on some of the major elements of Voyageurs' aquatic ecosystem. The second component developed a hydrological model that could be used to assess the effects of alternative regulatory programs on power generation or other public purposes. This approach allows the National Park Service to present meaningful recommendations to the IJC for alternative regulatory programs if research results showed that the current water management program was having adverse impacts on the aquatic biota. This approach would also allow testing whether alternative programs that more closely approximated natural conditions could be used to reduce adverse effects on the aquatic biota without seriously conflicting with the other presently authorized uses of water (Cole 1982). Should the IJC authorize an alternative program, this information would serve as baseline information which could be used to evaluate the impacts of the new regulatory system on authorized water uses.

The first component was addressed by examining the effects of regulated lake levels on selected species and communities thought to be sensitive to changes in water levels. While an extensive study of the total system would have been preferable, funding and time constraints made it necessary to use an indicator species approach. Studies were conducted on the impacts of regulated lake levels on: (1) littoral vegetation (Monson 1986, Meeker and Wilcox 1988) and benthic organisms (Kraft 1988); (2) the fish community, particularly walleye, Stizostedion vitreum, yellow perch, Perca flavescens (Kallemeyn 1987a), and northern pike, Esox lucius (Kallemeyn 1987b); (3) shore and marsh nesting birds, particularly the common loon, Gavia immer and red-necked grebe, Podiceps grisegena (Reiser 1988); (4) beaver, Castor canadensis (Smith and Peterson 1988), and muskrat, Odonata ziebethicus (Thurber and Peterson 1988), colonies; (5) osprey, Pandion haliaetus (Cuthbert and Rothstein 1988); and (6) river otter, Lutra canadensis (Route and Peterson 1988).

Additional studies conducted to obtain baseline information pertinent to the regulated lake level issue dealt with primary production in Voyageurs' four large lakes (Kepner and Stottlemyer 1988) and the relationship between lake levels and boat docks. Results of studies conducted by other researchers, while not specifically a part of this program, were used to assess the impact of the regulated lake levels on the park's archeological resources (Lynott 1984, Lynott et al. 1986).

Results from these research studies and the scientific literature were used by Kallemeyn and Cole (1988) to develop and evaluate twelve alternative regulatory systems using Flug's (1986) hydrological model. Initial evaluations were done on computer simulations developed with the hydrology model. Final evaluations, however, must await selection and implementation of a specific alternative by the IJC. Following extensive agency and public review of Kallemeyn and Cole's (1988) draft report, a consensus report on Alternatives for Reducing the Impacts of Regulated Lake Levels on the Aquatic Ecosystem of Voyageurs National Park will be submitted by the Service to the IJC for action in the spring or fall of 1989.

The species and biological communities that were investigated in Voyageurs were found to be adversely affected by the present water management programs. Negative impacts were caused by the greater than natural water level fluctuations on the Namakan Reservoir lakes. These plants and animals have not adapted to the changes in the magnitude and timing of lake level fluctuations since the dams were constructed, and in particular to the water management program implemented in 1971.

Negative impacts on Voyageurs' aquatic ecosystem occurred throughout the year with those that occurred in a particular season frequently the result of a combination of water level conditions that occurred in previous seasons. For example, high stable summer and early fall water levels contribute to spring spawning problems for walleye and northern pike by causing potential vegetative and wave washed gravel spawning substrates to develop at relatively high elevations. This in combination with a large winter drawdown makes their flooding the following spring unlikely, particularly in low runoff years. Thus, while poor spawning conditions are usually blamed on the low spring water levels, they are actually the culmination of a series of water management actions that occurred throughout the year and over several years.

Similar interactions were observed for the other elements of the aquatic system that were studied. The large winter drawdown on Namakan Reservoir and the resultant low spring water levels, which contribute to the large water level changes necessary in May and June, were found to adversely affect common loon and red-necked grebe nesting success and establishment of wild rice stands. High stable summer water levels, while extremely favorable for navigation, appeared to limit the establishment of wild rice and other aquatic vegetation. They also caused beaver and muskrat to build their houses and food caches at elevations that left them extremely susceptible to the larger than natural winter drawdown Namakan Reservoir experiences annually. The large winter drawdown, which caused up to 25 percent of the area of the Namakan Reservoir lakes to be dewatered annually, forced otter to alter their home ranges and limited the diversity and abundance of benthic organisms, an important food source for fish. Similar effects were noted for aquatic vegetation.

Most of these negative impacts could be mitigated by implementation of a water management program more closely approximating the magnitude and timing of natural fluctuations in lake levels with which these species evolved. In wetlands management, utilization of management procedures that simulate the natural, seasonal and annual fluctuations in water levels are believed to benefit more plants and animals and to result in a more typical marsh community than artificial management techniques (Ball 1985, Weller 1978).

Obviously, complete restoration of natural conditions in the park is not possible due to the presence of the dams and the competing requirements of other water users. Development of an alternative water regulatory program that is more ecologically sound is possible, however, given our understanding of the relationships between water levels and various biological factors.

Alternative regulatory systems should be evaluated biologically on their ability to simulate natural seasonal and annual fluctuations in water levels at the higher stages associated with the dams. On the basis of the projected natural or predam levels, this would require modifying the 1970 Rule Curves for Rainy Lake and Namakan Reservoir so that they provide for an earlier rise in water levels in the spring, relatively stable levels during June (< 1.0 feet change), summer drawdowns of 2.0 and 3.0 feet, respectively, an increase of 2.4 feet in the winter drawdown on Rainy Lake, and a reduction of 3.3 feet in the winter drawdown on Namakan Reservoir. The latter changes would increase the overall fluctuation on Rainy Lake to 5.4 feet while decreasing it to 5.6 feet on the Namakan Reservoir lakes. Realistically, these values can only be considered as goals since their complete implementation would undoubtedly result in significant conflicts with other water uses.

Restoration of a relatively natural hydrological pattern will not only benefit the aquatic ecosystem but also the other water users. Higher water levels earlier in the spring, besides providing better spawning for walleye and northern pike, would increase the usability of docks and boat launching ramps and improve navigation. Additionally, the earlier high water levels will have a positive impact on aquatic bird nesting success by maintaining relatively stable water levels during the June nesting period. Wild rice would also benefit from this change.

Summer drawdowns will reduce the frequency of floods and damage to docks from above normal precipitation, particularly during fall equinox storms. They will also make beaches more available for recreational use and lessen the destruction of archeological resources. They will allow emergent vegetation to grow at lower elevations and thereby increase northern pike spawning habitat. Walleye spawning habitat will also benefit. Beaver and muskrat in the Namakan Reservoir lakes will also benefit from the summer drawdown, particularly if it is combined with a reduction in the winter drawdown. Depending on their magnitude, summer drawdowns will reduce late summer and fall navigation and usability of docks. On the basis of modeling results, summer drawdowns on Rainy Lake would adversely affect hydropower production.

Reductions in winter drawdowns to more natural levels especially on Namakan Reservoir should have a positive effect on beaver, muskrat, otter, benthic organisms, and aquatic vegetation. By preventing the dewatering of spawning beds, winter drawdowns may also have a positive effect on the reproductive success of fall spawning fish, such as whitefish and cisco (Gaboury and Patalas 1984).

Effects of Regulated Lake Levels on Archeological Resources. The 1976 archeological survey conducted by the University of Minnesota indicated the majority of prehistoric and historic occupants of the park area lived along the shorelines of the large lakes (Gibbon 1977). Subsequent intensive surveys of beaches exposed during the spring when water levels are lowest, demonstrated that prehistoric and historic Indian sites were present in high

numbers, but that many of the sites had been either damaged or destroyed by the artificial rise in lake levels resulting from the building of dams at Kettle Falls/Squirrel Falls and International Falls (Gibbon 1978, Lynott et al. 1986). About 75 percent of the prehistoric sites examined in 1979 and 1980 had been completely eroded, displaced from their original context, and redeposited (Lynott et al. 1986).

Although some archeological sites on the Namakan Reservoir lakes are located at higher elevations, the majority are located between the elevations of 1116 and 1118 feet msl and thus, lie in the beach zone which is subject to the annual fluctuations in lake levels (Lynott 1984). A similar distribution of sites has been found on Rainy Lake, with the majority of the the sites occurring between the elevations of 1107.6 and 1110.6 feet msl (J. Richner, Midwest Archeological Center, pers. comm.). Even those sites located above the present maximum lake levels are impacted by the fluctuating water levels. Intense wave action during the period when lake levels are at their summer peaks is particularly destructive to archeological sites since it causes undercutting and bank slumping. The only sites in the park which have escaped damage are those located behind and protected by bedrock shorelines.

In 1984, the National Park Service initiated a site stabilization program to protect significant archeological resources from shoreline erosion resulting from the elevated and fluctuating lake levels (Lynott 1984). Site protection is accomplished by piling sediment against the eroding bank to decrease the slope. This is then covered with a layer of filter fabric which is followed by another layer of soil. Native grass is seeded into this layer and covered with a turf stabilization mat. Rock rip-rap is placed at the summer high water level to protect the bank from wave action. Through 1989, four sites have been protected on Namakan Reservoir at a cost of approximately $115,000 (see VOYA-C-003, Archeological Site Stabilization).

FERC License for International Falls Hydroelectric Project. On February 27, 1984, Boise Cascade applied to the Federal Energy Regulatory Commission (FERC) for a fifty year license under Part I of the Federal Power Act for that portion of the International Falls Dam which lies south of the international boundary. As part of the license application, Boise proposed to restore the existing turbines, and clean and inspect the existing generators in order to improve the performance of the facility and extend its economic life. This rehabilitation would allow the turbines to better utilize the same flow of water currently going through the facility: the efficiency of the existing facility is 51 percent while the efficiency of the rehabilitated facility would be 67 percent. In its license application, Boise asserted that rehabilitation of the dam will have "no adverse environmental effect which cannot be avoided should the proposal be implemented. The project has been in place and has been operated for some 70 years. The environment has been stabilized in that period so that local wildlife, aquatic animals, plants and humans have adapted to conditions as they presently exist" (page E-1).

Incorporating comments from Voyageurs N.P., the Department of the Interior on January 29, 1985 informed FERC that "we perceive the operation of the dam and the rehabilitation of its hydoelectric facility as potentially serious threats to the natural integrity of Voyageurs N.P.'s ecosystems." "Recent studies conducted in Voyageurs N.P. and vicinity, by a variety of agencies, indicated that the unnatural fluctuating water levels in the park's large lakes have a

profound negative effect on some fish and wildlife populations, aquatic plants, and archeological resources. These studies clearly show that not all species have adapted to present fluctuations in water levels. Much current research in the park has been designed to help identify mitigating measures for some of these impacts." The DOI recommended the following actions prior to issuing this license: (1) that Boise cooperate with the NPS in the development of a lake water level management program that would proximate levels which would occur under natural conditions, even if a small amount of generating capacity were lost; (2) that Boise confer with the NPS to develop recommendations for the IJC concerning the regulation of lake water levels; (3) that the dams at Kettle Falls and International Falls be linked by Boise for the management of lake water levels; and (4) that the research currently being conducted by the NPS concerning the effects of lake level fluctuations and mitigation proposals be completed prior to licensing the project.

FERC issued Boise Cascade a license for the International Falls Hydroelectric Project on December 31, 1987. Based on Section 10(j) of the Federal Power Act, as amended, the Commission included license conditions for the protection, mitigation, and enhancement of fish and wildlife within Rainy Lake. Article 402 of the license states that Boise shall "develop a water level management plan for Rainy Lake to ensure the protection and enhancement of water quality, fish and wildlife, and recreational resources in Rainy Lake" in consultation with U.S. Fish and Wildlife Service, NPS, and MDNR. "The recommendations contained in the plan shall be based on the results of the studies being conducted by the Voyageurs National Park and other studies conducted by the licensee after consultation with the USFWS, NPS, and the MDNR." Article 403 states that Boise shall operate the project for the protection and enhancement of spring spawners, such as walleye and northern pike, in Rainy Lake. Article 404 states that Boise "shall develop and implement a cultural resources management plan to protect significant archeological sites and any remains of historic sites within the project boundaries and outside the Voyageurs National Park." On January 29, 1988, Boise Cascade formally appealed to FERC to reconsider these articles and others in this license.

ALTERNATIVE ACTIONS AND THEIR PROBABLE IMPACTS

A. **No Action, Continue Current Regulated Lake Level Management Program.** The consensus report on Alternatives for Reducing the Impacts of Regulated Lake Levels on the Aquatic Ecosystem of Voyageurs National Park would be submitted to the IJC for action. The Service would work with the IJC, the International Rainy Lake Board of Control, other agencies, such as the Army Corps of Engineers, and Boise Cascade to develop an interagency Lake Level Management Plan for Rainy Lake. Interpretation of the effects of regulated lake levels on Voyageurs' aquatic ecosystem would continue to be limited by a severe lack of funding. The Service would coordinate with Boise Cascade on archeological surveys outside the park on Rainy Lake. The Service would continue archeological surveys and stabilizing severely eroding archeological sites that are of special significance within the park. Limited monitoring of the aquatic ecosystem affected by regulated lake levels would be implemented by the Resources Management Division. No

funding would be available for intensive research studies or long-term monitoring to document the effectiveness of modifications to the present rule curves for Rainy and Namakan reservoirs.

Modification by the IJC of the rule curves for Rainy and Namakan reservoirs based on the Service's consensus report would restore a relatively natural hydrological pattern that would benefit the biological system, improve navigation and increase usability of docks and boat launching ramps during spring, reduce the frequency of floods and damage to docks from above normal precipitation, make beaches more available for recreational use, and reduce destruction of archeological resources. Depending on their magnitude, summer drawdowns will reduce late summer and fall navigation and usability of docks, and reduce hydropower production. Improved turbine and generator efficiency at the International Falls Dam could offset any reductions in annual power production from implementation of this alternative. The usability of some docks in late summer and fall could be increased by dredging and/or lengthening. Implementation of this alternative would not result in a completely natural system since it will not allow for the year-to-year variation that is inherent in nature.

Limited funding for interpretation and long-term monitoring and research would undermine the utility of the recently completed regulated lake level effects research. A variety of interpretative media are needed to garner public support for efforts to minimize the effects of regulated lake levels on the park's aquatic ecosystem. Once the IJC modifies the rule curves for Rainy and Namakan reservoirs, a long-term monitoring and research program is needed to document the effectiveness of the new lake level management program in protecting park resources and values and providing for other public benefits. Without such quantification, it would be impossible to evaluate the modified rule curves and make adjustments when and where necessary. This would also not allow testing whether an alternative rule curve can reduce the adverse effects on Voyageur's aquatic biota without seriously conflicting with the other water uses.

All archeological resources inundated in the early 1900's by elevated lake levels in Voyageurs were either destroyed and lost forever or severely damaged and threatened with destruction. Those sites which remain are threatened by extensive shoreline undercutting and bank slumping caused by intense wave action during periods when lake levels are at summer peaks. The only sites in the park which have escaped damage are those located behind and protected by bedrock shorelines. Since funding for archeological site stabilization is limited, only a few sites which are deemed significant for understanding the prehistory and history in the boundary waters region in northern Minnesota and northwestern Ontario would be stabilized. A total of four sites were stabilized during the winters of 1985, 1986, 1988, and 1989. Intensive shoreline surveys of archeological resources outside the park by Boise Cascade would further document the extent and significance of prehistoric and historic resources before they were lost to erosion or vandalism. By restoring more natural hydrologic conditions, this alternative would adequately help the National Park Service fulfill its dual legislative mandate regarding the management of Voyageurs National Park.

B. **Implement Comprehensive Regulated Lake Level Management Program.** The Service would submit the consensus report to the IJC for action. It would work with the IJC, the International Rainy Lake Board of Control, other agencies, and Boise Cascade to develop an interagency Lake Level Management Plan for Rainy Lake. The Service would encourage Boise Cascade to renovate the dams at Kettle Falls/Squirrel Falls to make them more responsive to sudden changes in lake levels. The Service would work with other agencies and organizations to increase the number of stream gauging stations in the Rainy Lake watershed and the timeliness and utility of inflow forecasts. Interpretation of the effects of regulated lake levels on Voyageurs' aquatic ecosystem would be increased significantly. The Service would coordinate with Boise Cascade on archeological surveys outside the park on Rainy Lake. The Service would continue archeological surveys and stabilizing eroding archeological sites that are of special significance within the park. Resources Management would implement a long-term monitoring program to document the effects of modified rule curves on the park's aquatic ecosystem. Intensive research studies would also document the effectiveness of modifications to the rule curves for Rainy and Namakan reservoirs for certain species and communities.

Modification by the IJC of the rule curves for Rainy and Namakan reservoirs based on the Service's consensus report would restore a relatively natural hydrological pattern that would have similar effects and impacts as described under Alternative A. Improvements in inflow forecasts in the Rainy Lake watershed and new control gates at Kettle Falls/Squirrel Falls dams should permit further refinements to water management programs in the basin. Implementation of this alternative would also not result in a completely natural system since it will not allow for the year-to-year variation that is inherent in nature.

Adequate funding for interpretation and long-term monitoring and research would increase the utility of the recently completed regulated lake level effects research. A variety of interpretative media would be used to garner public support for efforts to minimize the effects of regulated lake levels on the park's aquatic ecosystem and archeological resources. Once the IJC modifies the rule curves for Rainy and Namakan reservoirs, a long-term monitoring and research program would document the effectiveness of the new lake level management program in protecting park resources and values and providing for other public benefits. This would allow testing whether alternative rule curves can reduce the adverse effects on Voyageurs' aquatic biota without seriously conflicting with the other water uses. Based on such research results, the modified rule curve could if necessary be adjusted to achieve desired results for all.

All archeological resources inundated in the early 1900's by elevated lake levels in Voyageurs were either destroyed and lost forever or severely damaged and threatened with destruction. Those sites which remain are threatened by extensive shoreline erosion during periods when lake levels are at summer peaks. Since funding for archeological site stabilization is limited, only a few sites which are deemed significant for understanding the prehistory and history in the boundary waters region would be stabilized. Intensive shoreline surveys of archeological resources outside the park by Boise Cascade would further document the extent and significance of prehistoric and historic resources before they

were lost to erosion or vandalism. By restoring more natural hydologic conditions, this alternative would maximally help the National Park Service fulfill its dual legislative mandate regarding the management of Voyageurs National Park.

RECOMMENDED COURSE OF ACTION

The recommended course of action is the adoption of Alternative C, Implement Comprehensive Regulated Lake Level Management Program. All of the activities identified in Alternative B would be implemented as follows.

A. Resource Management Actions.

VOYA-N-022-01: NPS Regulated Lake Level Management Recommendations to International Joint Commission. After extensive public involvement and other agency review, the Service's consensus report on Alternatives for Reducing the Impacts of Regulated Lake Levels on the Aquatic Ecosystem of Voyageurs National Park would be submitted to the IJC for action.

VOYA-N-022-02: Increase Public Information about Effects of Regulated Lake Levels on the Aquatic System. A variety of interpretative media would be used to garner public support for efforts to minimize the effects of regulated lake levels on the park's aquatic ecosystem and archeological resources. Visitor center exhibits, slide and video tape programs, site bulletins, wayside exhibits, the park newspaper, guided nature walks, nature trail brochures, evening interpretative programs, and contacts with uniformed NPS personnel would sensitize visitors to the impacts of regulated lake levels on Voyageurs' aquatic system.

VOYA-N-022-03: Interagency Lake Level Management Plan. Boise Cascade's FERC license requires it to consult with the National Park Service, USFWS, and MDNR in developing a water level management plan for Rainy Lake to ensure the protection and enhancement of water quality, fish and wildlife, and recreational resources. The recommendations contained in the plan would be based on the results of studies conducted by Voyageurs N.P. and other studies conducted by the licensee after consultation with the USFWS, NPS, and the MDNR.

The Service would encourage Boise Cascade to renovate the dams at Kettle Falls/Squirrel Falls to make them more responsive to sudden changes in lake levels. The Service would also work with other agencies and organizations to increase the number of stream gauging stations in the Rainy Lake watershed to increase the timeliness and utility of inflow forecasts.

VOYA-N-022-04: NPS Coordinate with Boise Cascade on Archeological Surveys on Rainy Lake. Boise Cascade's FERC license requires it to consult

with the National Park Service and the Minnesota State Historic Preservation Office when developing and implementing a cultural resources management plan to protect significant archeological sites and any remains of historic sites within the project boundaries and outside Voyageurs N.P. (see VOYA-C-001 and VOYA-C-002, Cultural Sites Inventory - Archeological and Historic, respectively).

VOYA-N-022-05: Stabilize Eroding Archeological Sites. The Service would continue stabilizing significant archeological sites to protect them from shoreline erosion resulting from elevated and fluctuating lake levels (see VOYA-C-003, Archeological Site Stabilization).

B. Monitoring Actions.

VOYA-N-022-10: Monitor Effects of Modified Regulated Lake Levels on Aquatic Ecosystem and Archeological Resources. Resources Management would conduct long-term monitoring studies on the effects of modified regulated lake levels on: wild rice, a variety of fish species, common loon, red-necked grebe, bald eagle, osprey, cormorant, gulls, beaver, muskrat, river otter, usability of boat docks, and archeological resources.

VOYA-N-022-11: Monitor Interagency Lake Level Management Plan. Data from long-term monitoring and research would be used to periodically reevaluate the effectiveness of the new lake level management program in protecting park resources and values and providing for other public benefits. This would allow testing whether modified rule curves are reducing the adverse effects on Voyageurs' aquatic biota without seriously conflicting with other water uses. Based on such evaluations, the modified rule curves could if necessary be adjusted to achieve desired results for all.

C. Research Actions.

Once the IJC has modified the rule curves for Rainy and Namakan reservoirs, the National Park Service would conduct a comprehensive, problem oriented research program that would provide management with factual knowledge that tests whether these modified rule curves are reducing the adverse effects on Voyageurs' aquatic biota without seriously conflicting with other water uses. Based on such research, the modified rule curves could if necessary be adjusted to achieve desired results for all. Research studies would be conducted on the:

VOYA-N-022-20: Effects of Modified Rule Curves on Primary Production.

VOYA-N-022-21: Effects of Modified Rule Curves on Aquatic Vegetation.

VOYA-N-022-22: Effects of Modified Rule Curves on Benthos.

VOYA-N-022-23: Effects of Modified Rule Curves on Fisheries.

COMMITMENT TO ACCOMPLISHMENT

Fiscal years 1989 through 1993: Once the IJC has modified the rule curves for Rainy and Namakan reservoirs and the National Park Service has thoroughly researched the effects of those modified curves on Voyageurs' aquatic biota, annual regulated lake level management activities and operating expenses would remain similar each year. Additional funds and the need for an increase in seasonal and permanent personnel and equipment at Voyageurs for regulated lake level management are shown on the five-year natural resources programming sheets.

WILDLAND FIRE MANAGEMENT
VOYA-N-024

STATEMENT OF PROBLEM

Fire has been no less important than rain, sun and frost in shaping the ecosystem of Voyageurs National Park through evolutionary periods of time. Fire has been a major factor controlling nutrient cycles and energy pathways, and in maintaining the diversity, productivity, and stability of whole ecosystems (Wright 1976). All of the park's vegetation and wildlife evolved over millions of years in response to periodic lightning-caused fires (Wright 1964, 1968, Mutch 1970, Heinselman 1973, Woods and Day 1975, 1976a, 1976b, 1977a, 1977b, 1977c, 1977d, 1977e, Kurmis et al 1980, Coffman et al 1980, Cole 1982, 1986, Apfelbaum and Haney 1986).

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 manpower, equipment and other support costs.

The exclusion of fire from Voyageurs' fire-maintained ecosystems, 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, 1986). 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, 1986). 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 park ecosystems (U.S. NPS 1977) would only increase the overwinter ungulate biomass by an estimated 19,200 lbs. to 42,800 lbs, which is still only 62 percent of the park's pre-1890 level of 69,120 lbs (Cole 1982, 1986). 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."

FIRE AND ECOSYSTEM INTERACTIONS

The section below describes how the physical and biological characteristics of Voyageurs National Park's ecosystems 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' ecosystems 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 park ecosystems 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 European man arrived, and even before aboriginal man migrated to North America (Craig 1972, Swain 1973, 1980, 1981, Alexander 1980). A detailed record of the past 1200 years shows that the average frequency of fire in the region is approximately 60-70 years, with a range of about 10 to 100 years between fires. 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 1868 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 too 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 quite 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 man-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, once 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 man. Almost all of the park's man-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 man-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

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, red squirrel, raven, jays, chickedees, and bald eagle) have been dramatically reduced below pre-1890 levels by human intervention into Voyageurs' ecosystems (Cole 1982, 1986). 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 (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. 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 (Heinselman 1973). 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 IMPACTS

A. **No Action, Continue to Suppress all Fires.** All lightning and man-caused fires originating within or from outside Voyageurs National Park 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 needs to prevent all man-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 man-caused fires. Continuation of our present policy of fire suppression, therefore, would only increase the interval between successive burns on any given acre. Temporary decreases in smoke production resulting from the suppression of all lightning and man-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.

The environmental and social costs of implementing this alternative would: minimize the total area of early successional stages and fire maintained communities; minimize nutrient cycling; minimize the availability of critical winter habitat for white-tailed deer and moose; minimize the overwinter food supply for predators and scavengers, particularly the threatened gray wolf and bald eagle; maximize fire intensity and size due to fuels buildup and increased vegetation/fuel continuity; maximize risk of fire-caused injury or death and property lose for park visitors, employees and neighbors; and maximize costs for fire suppression during large, project fires that may be as high as $100,000 per day in manpower, equipment and other support costs. Implementation of this alternative would also minimize the number of man-caused wildfires in Voyageurs.

Exclusion from park ecosystems of one of the evolutionary forces that have shaped them for millions of years would fail to adequately protect, preserve and maintain Voyageurs' ecosystems 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 park ecosystems.

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.

All man-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' ecosystems, and the needs to prevent all man-caused fires and report all fires to the park.

The environmental and social costs of implementing this alternative would: maximize the total area of early successional stages and fire maintained communities; maximize nutrient cycling; maximize the availability of critical winter habitat for white-tailed deer and moose; maximize the overwinter food supply for predators and scavengers, particularly the threatened gray wolf and bald eagle; moderate fire intensities and sizes due to fuel reductions and decreased vegetation/fuel continuity; moderate risks of fire-caused injury or death and property lose for park visitors, employees and neighbors; moderate visibility reduction due to smoke production during long burning fires; and minimize costs for fire suppression during large, project fires that may be as high as $100,000 per day in manpower, equipment and other support costs. Implementation of this alternative would also minimize the number of man-caused wildfires in Voyageurs.

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. The use of prescribed burning in these areas would greatly reduce such risks.

Reintroduction of lightning fire to Voyageurs' ecosystems would preserve and maintain them for the enjoyment of present and future generations. The risk of fire escape beyond Voyageurs' boundaries, however, would be remain at an unacceptable level in some 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 the park boundary 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.

All lightning and man-caused fires originating within or from outside Voyageurs National Park 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' ecosystems, and the needs to prevent all man-caused fires and report all fires to the park.

The environmental and social costs of implementing this alternative would: maximize the total area of early successional stages and fire maintained communities; maximize nutrient cycling; maximize the availability of critical winter habitat for white-tailed deer and moose; maximize the overwinter food supply for predators and scavengers, particularly the threatened gray wolf and bald eagle; minimize fire intensities and sizes due to fuel reductions and decreased vegetation/fuel continuity; minimize risks of fire-caused injury or death and property lose for park visitors, employees and neighbors; minimize visibility reduction due to smoke production during prescribed burns; maximize costs for prescribed burning; and minimize costs for fire suppression during large, project fires that may be as high as $100,000 per day in manpower, equipment and other support costs. Implementation of this alternative would also minimize the number of man-caused wildfires in Voyageurs.

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.

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' ecosystems, however, would not adequately preserve and maintain them 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 Voyageurs' Wildland Fire Management Plan.** Voyageurs' Wildland Fire Management Plan divides the park into three units: fire suppression, and prescribed natural and conditional fire management units. 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 man-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 will be maintained in the vicinity of park developed areas to create fuelbreaks that will reduce the intensity of fires entering these areas. Periodic prescribed understory burning and planting of red and white pine will 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, caribou 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 fire dependent ecosystems 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 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 will 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 critically needed winter habitat for moose, deer, caribou and elk. To the maximum extent possible, this program would simulate the effects of the park's natural fire rotation or cycle on ecosystems 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 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.

All man-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' ecosystems, and the needs to prevent all man-caused fires and report all fires to the park.

The environmental and social costs of implementing this alternative would: maximize the total area of early successional stages and fire maintained communities; maximize nutrient cycling; maximize the availability of critical winter habitat for white-tailed deer and moose; maximize the overwinter food supply for predators and scavengers, particularly the threatened gray wolf and bald eagle; moderate fire intensities and sizes due to fuel reductions and decreased vegetation/fuel continuity; minimize risks of fire-caused injury or death and property lose for park visitors, employees and neighbors; moderate visibility reduction due to smoke production during prescribed natural fires and prescribed burns; minimize costs for prescribed burning; and minimize costs for fire suppression during large, project fires that may be as high as $100,000 per day in manpower, equipment and other support costs. Implementation of this

alternative would also minimize the number of man-caused wildfires in Voyageurs.

Although the objective of prescribed burning in Voyageurs' fire suppression and conditional fire management units 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.

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 fire dependent ecosystems. Voyageurs' conditional fire management units, on the other hand, would strike a balance between restoring and perpetuating fire dependent ecosystems and protecting life and property within and beyond park boundaries. While Voyageurs' fire suppression units exist to 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 Voyageurs' 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. The park would train all permanent personnel with fireline responsibilities as crew bosses and prescribed burn bosses. The park would also develop in these employees 500 level course fire behavior management skills. At least one employee in the park would be certified at the Incident Commander Extended Attack level or higher. All employees, except Fire Monitoring Team members, working on suppression or prescribed fire assignments within or outside Voyageurs would be certified to at least the Firefighter level. Fire Monitors would be trained in the operation of belt weather kits, fuel typing, calculating rates of spread, estimating flame lengths, and recognizing factors which contribute to blow-up conditions.

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 caused-fires in the park and vicinity. Two aerial fixed-wing flights would be flown each day when the park's Manning Class was II 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: Continue Cooperation with State and Local Agencies Responsible for Smoke Management during Prescribed Natural Fires and Prescribed Burns. . State and local air quality 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 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 Fire Management Overhead Team in order to protect Voyageurs' cultural resources during fire management activities.

B. Monitoring Actions.

VOYA-N-024-10: 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-024-11: 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-024-12: Increase Long-term Monitoring of Fire Effects. A few prescribed natural fires and prescribed burns would be intensively monitored 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. Fire behavior observations made on these permanent plots would permit fire managers to make more refined predictions of the effects of different fire intensities on the park's plant and animal communities. Such observations would also permit the park to improve fire behavior prediction by adjusting and adapting the

stylized fuel models in the Northern Forest Fire Laboratory Fire Behavior System to Voyageurs' unique vegetation/fuel complexes.

VOYA-N-024-13: 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. Eventually, a transmissometer that measures atmospheric extinction would be added to this visibility monitoring system.

C. Research Actions.

VOYA-N-024-20: Refine Prescriptions for Prescribed 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 Voyageurs' unique vegetation-/fuel complexes.

VOYA-N-024-21: 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-024-22: 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 presettlement 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 presettlement levels and thereby restore the park's depauperate predator and scavenger populations (see Restore Absent and Declining Native Wildlife, VOYA-N-021).

COMMITMENT TO ACCOMPLISHMENT

Fiscal years 1988 through 1992: Once the fire research program has been completed, annual wildland fire management activities and operating expenses would remain similar each year. Large project fires, however, would periodically require the short-term acquisition of significant amounts of additional personnel, equipment and supplies. Additional funds and the need for an increase in seasonal and permanent personnel at Voyageurs for wildland fire management are shown on the five-year natural resources programming sheets.